The association between hypertensive disorders of pregnancy and postpartum depression in Ghana.

THE ASSOCIATION BETWEEN HYPERTENSIVE DISORDERS OF PREGNANCY AND POSTPARTUM DEPRESSION IN GHANA

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Declaration

I declare that this thesis, titled "The Association Between Hypertensive Disorders in Pregnancy and Postpartum Depression in Ghana," represents my own work, and all sources used and cited have been duly acknowledged. I have not engaged in any act of plagiarism or unauthorized use of intellectual property. This work has not been previously submitted for any academic award.

I understand the importance of academic integrity and have adhered to ethical standards throughout the research process. The findings presented in this thesis contribute to the field of global health, specifically in understanding the complex relationship between hypertensive disorders in pregnancy and postpartum depression in the Ghanaian context.

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Abstract

This research explores the intricate association between hypertensive disorders in pregnancy (HDP) and postpartum depression (PPD) through a multidimensional approach. A systematic review and meta-analysis synthesize evidence, revealing a robust link between HDP and heightened risks of depressive symptoms postpartum. Notably, severe variants of HDP exhibit the highest likelihood of subsequent PPD. Complementing this quantitative synthesis, qualitative interviews with healthcare professionals in Ghana shed light on the experiences and challenges within the local healthcare system.

Our study spans diverse ranks of healthcare practitioners with experience in several regions in Ghana, ensuring comprehensive insights. The prevalence estimates from doctors and midwives underscore the extensive reach of HDP, with rates varying based on geographical and cultural factors. Co-occurrence rates of PPD among HDP patients, estimated at 2-50%, emphasize the vulnerability of this population. Conversely, most unaffected women exhibit lower rates of postpartum depression, highlighting the specific challenges faced by those with HDP.

The research reveals a complex interplay of physiological and psychological factors contributing to the association between HDP and PPD. Stressors related to labour, financial strain, and lack of awareness emerge as common threads, emphasizing the need for a holistic approach to maternal healthcare. The absence of standardized screening tools and variations in clinical judgment practices underscore potential areas for improvement.

Findings indicate a substantial need for continuous monitoring, heightened awareness, and comprehensive support during the perinatal period. Recommendations include standardizing definitions and screening practices, building healthcare capacity, designing targeted interventions, implementing patient education programs, and conducting further research to elucidate mediators between HDP and PPD.

List of abbreviations

ABPM = Ambulatory Blood Pressure Monitoring

ACOG = American College of Obstetrics and Gynaecologists

AKI = Acute Kidney Injury

ALT = Alanine transaminase

AST – Aspartate transaminase

BAG = Bcl2-Associated Oncogene 6

BP = Blood Pressure

CEDS = Centre for Epidemiological Studies Depression Scale

DBP = Diastolic Blood Pressure

DIC = Disseminated Intravascular Coagulopathy

ENOS = Endothelial Nitric Oxide Synthase

EPDS = Edinburgh Postnatal Depression Scale

GHS = Ghana Health Service

HADS = Hospital Anxiety and Depression Scale

HBPM = Home Blood Pressure Monitoring

HDP = Hypertensive Disorders of Pregnancy

INR = International Normalised Ratio

ISSHP = International Society for the Study of Hypertension in Pregnancy

IUFD = Intrauterine Foetal death

JBI = Joanna Briggs Institute

LMIC = low to middle income countries

MDG = Millennium Development Goal

MMP = Matrix Metalloproteinases

MMR = Maternal Mortality Ratio

NHS = National Health Service

NICE = National Institute for Health and Care Excellent

PE = Preeclampsia

PMH = Perinatal Mental Health

PPD = Postpartum Depression

RCGO = Royal College of Obstetricians and Gynaecologists

SBP = Systolic Blood Pressure

SDG = Sustainable Development Goal

SNPS = Single Nucleotide Polymorphisms

STAI = State-Trait Anxiety Inventory

STIM1 = Stromal Interaction Molecule

TGFβR2 = Transforming Growth Factor Beta 1 Receptor 2

UGMC = University of Ghana Medical Centre Ltd

UNICEF = United Nations International Children's Emergency Fund

UWL = University of West London

WHO = World Health Organization

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Chapter 1: Introduction

1.1 Background

Hypertensive disorders of pregnancy (HDP), the most common medical disorders in pregnancy, are one of the leading causes of maternal and neonatal morbidity and mortality worldwide (Abalos et al., 2013; Duley, 2009; Habli et al., 2008; Steegers et al., 2010; Braunthal and Brateanu, 2019). These disorders which may start before, during or after pregnancy (delivery) include pre-eclampsia, gestational hypertension, chronic hypertension, etc. with pre-eclampsia being the most severe. HDPs complicate up to 10% of pregnancies (Say et al., 2014; Abalos et al., 2013) and are particularly dangerous in low to middle income countries (LMICs), contributing substantially to maternal deaths (Duley, 2009). The incidence of HDP increased from 16.30 million [95 % UI 13.56 to 19.42 million] to 18.08 million (95 % UI 15.26 to 21.11 million) globally, with a total increase of 10.92 % from 1990 to 2019 (Wang et al., 2021). In Ghana specifically, the maternal mortality ratio remains high at 263 per 100,000 live births, with HDPs cited as the second leading cause after postpartum haemorrhage (World Bank Open Data, 2024).

In many African countries, both low-income and middle-income, a sobering reality unfolds: a significant majority, ranging from 76 percent to as high as 99 percent, of individuals grappling with severe mental disorders find themselves without access to the vital treatment they desperately need for their mental well-being (Faydi et al., 2011). Respected scholars like Forster (1962) and Read, Adiibokah, and Nyame (2009) passionately argue that the combination of political apathy towards mental health issues and the all-encompassing societal stigma surrounding them creates formidable barriers to the advancement of mental healthcare in Ghana.

The stigma attached to mental illness carries weighty consequences, casting a shadow not only on those directly affected but also extending its reach to institutions and healthcare professionals dedicated to the care of individuals with mental health conditions (Barke, Nyarko and Klecha, 2011). Tragically, individuals who are either diagnosed with or simply perceived to have mental disorders often face daunting

hurdles when it comes to accessing essential services. This, unfortunately, happens primarily because of the deeply entrenched attitudes of stigma and discrimination. Regrettably, these negative perceptions not only stand as roadblocks to efforts in both prevention and treatment but also contribute to the exacerbation of the consequences of mental health disabilities.

Perinatal depression among mothers is a significant population health concern. A meta-analysis estimates postpartum depression (PPD) affects approximately 13% of women globally (Woody et al., 2017). In Ghana, reported prevalence ranges widely from 4 - 36% depending on measurement methods (Dako-Gyeke and Asumang, 2013; Noonan et al., 2018). PPD can adversely impact maternal-infant bonding and child development if not treated appropriately (Peñacoba Puente et al., 2021). Prior research proposes hypertensive pregnancy complications may increase susceptibility to PPD. A systematic review found 2-3-fold higher PPD risks among women with HDPs compared to normotensive pregnancies (Xu et al., 2021). Proposed biological pathways relate to placental ischemia, inflammation, and medications used to manage hypertension. Psychologically, traumatic childbirth experiences and adjustment difficulties may also contribute (Byrn and Penckofer, 2015). Socioculturally, inadequate social support and stigma towards mental illness may worsen outcomes in the Ghanaian context (Dako-Gyeke and Asumang, 2013). However, most studies examining relationships between HDPs, and maternal depression have been conducted in high-income countries. Evidence from sub-Saharan Africa is scarce, especially Ghana where dynamics may differ.

1.2 Definitions

1.2.1 Hypertensive disorders of pregnancy

“Hypertensive disorders” is defined as condition(s) presenting with either or both elevated blood pressure above normal range (hypertension) and appearance of proteins in urine (proteinuria) in pregnancy (Davey and Macgillivray, 1986). The most dangerous HDP is pre-eclampsia, which is responsible for over 500,000 foetal and neonatal deaths and over 70,000 maternal deaths globally each year. There are instances where pre-eclampsia is superimposed on women with chronic hypertension and/or with an underlying renal condition. Evidence suggests that this happens in

about 25% of women with these pre-existing medical conditions (Magee et al, 2022; Majak et al., 2017). With the tendency to deteriorate a woman's health rapidly and without warning, the International Society for the Study of Hypertension in Pregnancy (ISSHP) does not recommend classifying pre-eclampsia as non-severe or severe.

Table 1.1: Classification of HDP

TYPE OF HYPERTENSIVE DISORDER	DEFINITION
Pre-pregnancy or at < 20 weeks	
Chronic hypertension	Hypertension detected pre-pregnancy or before 20 weeks' gestation.
Essential	Hypertension without a known secondary cause.
Secondary	Hypertension with a known secondary cause (e.g., renal disease).
White coat hypertension	sBP ≥140 and/or dBP ≥90 mmHg when measured in the office or clinic, and BP <135/85 mmHg using HBPM or ABPM readings.
Masked hypertension	BP that is <140/90mmHg at a clinic/office visit, but ≥135/85mmHg at other times outside the clinic/office.
≥ 20 weeks	
Gestational hypertension	Hypertension arising *de novo* at ≥ 20 weeks' gestation in the absence of proteinuria or other findings suggestive of pre-eclampsia.
Transient gestational hypertension	Hypertension arising at ≥20 weeks' gestation in the clinic, which resolves with repeated BP readings.
Pre-eclampsia*	
De novo	Pre-eclampsia (de novo) is gestational hypertension accompanied by one or more of the following new-onset conditions at ≥ 20 weeks' gestation: 1. Proteinuria 2. Other maternal end-organ dysfunction, including: • Neurological complications (e.g., eclampsia, altered mental status, blindness, stroke, clonus, severe headaches, or persistent visual scotomata) • Pulmonary oedema • Haematological complications (e.g., platelet count <150,000/µL, DIC, haemolysis) • AKI (such as creatinine ≥90 µmol/L or 1 mg/dL) • Liver involvement (e.g., elevated transaminases such as ALT or AST>40 IU/L) with or without right upper quadrant or epigastric abdominal pain) 3. Uteroplacental dysfunction (e.g., placental abruption, angiogenic imbalance, foetal growth restriction, abnormal umbilical artery Doppler waveform analysis, or intrauterine foetal death).

Superimposed on chronic hypertension	Among women with chronic hypertension, development of new proteinuria, another maternal organ dysfunction(s), or evidence of uteroplacental dysfunction (as above).
ABPM (ambulatory 24-hour BP monitoring), AKI (acute kidney injury), ALT (alanine aminotransferase), AST (aspartate aminotransferase), BP (blood pressure), dBP (diastolic BP), DIC (disseminated intravascular coagulation), HBPM (home BP monitoring), HDPs (hypertensive disorders of pregnancy), sBP (systolic BP) * Some components of the definition will require use of locally accepted definitions (such as foetal growth restriction) and clinical judgement. Also, the term 'severe pre-eclampsia' should not be used in clinical practice, as all women with pre-eclampsia are at risk of developing severe features.	

Magee et al, (2022) The Hypertensive Disorders of Pregnancy: The 2021 International Society for the Study of Hypertension in Pregnancy Classification, Diagnosis and Management Recommendations for International Practice.

Chronic hypertension is linked to a higher occurrence of unfavourable outcomes for both mothers and foetuses, including the development of superimposed pre-eclampsia. Its prevalence is estimated to range from 3% to 5% in pregnancies (Seely and Eckar, 2014; Sibai and Baha, 2009). Essential hypertension is the primary cause in most cases, commonly associated with a familial history of hypertension and frequently accompanied by overweight or obesity (Magee et al., 2022; Seely and Eckar, 2014).

Gestational hypertension (GH) can be grouped into transient or persistent gestational hypertension. GH is expected to return to normal by the 12th-week postpartum visit. It has an incidence rate of 5.9% in Canada and 6.3% in Nigeria (Yemane et al., 2021). Transient gestational hypertension carries a 40% risk of subsequently developing true gestational hypertension or pre-eclampsia (Hawkins et al., 2012). On the other hand, the outcomes associated with persistent gestational hypertension are contingent on the gestational age at which hypertension manifests after 20 weeks. Approximately 25% of women who present with gestational hypertension at less than 34 weeks are likely to progress to pre-eclampsia, leading to poorer outcomes (Magee et al., 2021; Saudan et al., 1998).

White-coat hypertension is prevalent in approximately 30% of cases of chronic hypertension and is linked to an elevated risk of pre-eclampsia (Magee et al., 2022; Oparil et al., 2018; Brown et al., 2005). The literature provides inconsistent estimates

of its prevalence during pregnancy, ranging from as low as 4% to as high as 30% in certain studies.

Salazar and colleagues suggest that the prevalence of masked hypertension is approximately 33.3% among normotensive women undergoing a high-risk pregnancy. Diagnosis typically involves home blood pressure monitoring (HBPM) or ambulatory blood pressure monitoring (ABPM), initiated when there is evidence of hypertensive target organ damage in the mother (e.g., unexplained chronic kidney disease or left ventricular cardiac hypertrophy) or uteroplacental dysfunction, even in the absence of apparent hypertension in the clinic (Magee et al., 2022).

1.2.2 Postpartum depression

Postpartum depression (PPD) is a mood disorder that can affect women after giving birth. Following childbirth, mothers may experience a wide spectrum of emotions, ranging from joy and contentment to feelings of sadness and episodes of tearfulness. These emotional episodes, commonly known as "baby blues," typically diminish within the first two weeks post-delivery (Mughal et al., 2022).

In contrast to the relatively short-lived nature of baby blues, postpartum depression tends to persist and significantly disrupts a woman's ability to resume regular functioning. This condition has far-reaching effects, impacting both the mother and her connection with the infant. The functioning of the maternal brain and her behaviour are notably affected by postpartum depression (Zauderer, 2019).

Symptoms of PPD can include anxiety, irritability, feelings of hopelessness, guilt, or worthlessness, changes in sleep and eating patterns, difficulty bonding with the baby, and in some cases suicidal thoughts (Mughal et al.,2022). PPD usually begins within a few weeks of childbirth, but symptoms can emerge up to a year later as well. PPD is common, affecting 10-20% of new mothers (Bobo and Yawn, 2014).

There are several risk factors that can increase a woman's chances of developing PPD. Women with a previous history of depression, or anxiety are at higher risk, as are those who experienced postpartum depression after a previous pregnancy. Lack of social support, stressful life events, and relationship, financial, or parenting stress also elevate risk for PPD (Ghaedrahmati et al., 2017). Hormonal changes after

pregnancy, including drops in oestrogen and progesterone levels, can play a role in triggering depressive symptoms as well. Chemical changes in the brain involving neurotransmitters like dopamine and serotonin have also been implicated. (Yim et al., 2017; Trifu et al., 2019).

The exact causes of PPD are still being researched but are believed to involve a combination of hormonal factors, genetics, physiological stress from childbirth, and environmental/social triggers (Rupanagunta et al., 2023; Yu et al., 2021)

Fortunately, there are effective treatments for PPD. Many women benefit from a combination of antidepressant medication and psychotherapy approaches like cognitive behavioural therapy or interpersonal counselling (Milgrom et al, 2015, Stamou, 2018). With various treatment options available, the prognosis for women with postpartum depression is generally good (Valverde et al., 2023). However, left untreated PPD can significantly impact not only mothers' well-being, but their abilities to form secure attachments with and care for their babies (Stuart, 2012). Research conducted by Beck in 2006 suggests that a substantial portion of new mothers experiencing PPD go undiagnosed.

This lack of diagnosis can be attributed to issues of privacy and a reluctance to divulge such personal matters to close family members. Unfortunately, the stigma surrounding new mothers and their mental health contributes to this silence, as disclosing PPD symptoms might lead to concerns about abandonment and a perceived absence of support. That is why it is important for all women giving birth to be screened for PPD risk factors and monitored in the postpartum period. Increased awareness, screening, and support can go a long way in catching PPD early on and speeding recovery.

1.2.3 Perinatal anxiety

Perinatal anxiety refers to the experience of excessive and persistent anxiety symptoms during the period encompassing pregnancy and the postpartum phase (McCarthy et al., 2021). It may involve various anxiety disorders, including generalized anxiety disorder, panic disorder, and specific phobias that emerge or worsen during this pivotal life stage (Shang et al., 2022). These symptoms can significantly impact the well-being of both the parent and the developing child.

Perinatal anxiety and stress exhibit a strong correlation, stemming from distinct factors such as limited material resources, inadequate social support (Vijayaselvi et al., 2015), the interplay of work and family responsibilities (Dunkel Schetter and Tanner, 2012), and complications during pregnancy (Bayrampour et al., 2015). The prevalence of perinatal anxiety is estimated at approximately 17% among women (Fairbrother et al., 2016), while perinatal stress affects up to 84% of women (Woods, 2010)

The repercussions of perinatal anxiety and stress extend beyond individual well-being, negatively impacting the health of both women and children (Matvienko-Sikar et al., 2020). These conditions have been linked to an elevated risk of preeclampsia, miscarriage, low infant birth weight, and preterm delivery (Deklava et al., 2015). Moreover, perinatal anxiety and stress influence maternal behaviours, including alcohol consumption (Westerneng et al., 2017), breastfeeding practices (Doulougeri et al., 2013), and smoking habits (Rodriguez et al., 2000).

Adverse outcomes for children associated with perinatal anxiety and stress encompass an increased likelihood of poor cardiovascular health (Plana-Ripoll et al., 2016), obesity, and difficulties in self-regulation and neurodevelopment (Van den Bergh et al., 2005). The intricate interplay between perinatal anxiety, stress, and their consequential effects underscores the importance of recognizing and addressing these mental health aspects for the overall well-being of both mothers and children.

Perinatal anxiety and stress among women arise from insufficient social support, unfavourable healthcare encounters, unrealistic societal norms and expectations, and health-related anxieties. There is a pressing requirement to enhance attention to perinatal anxiety and stress within both research and practical domains (McCarthy et al., 2021).

1.3 Prevalence of hypertensive disorders in pregnancy

Hypertensive disorders in pregnancy (HDP) encompass a range of conditions characterized by high blood pressure, including chronic hypertension, gestational hypertension, preeclampsia, and eclampsia (Mammaro et al., 2009). Globally, these disorders affect up to 10% of pregnancies worldwide and confer risks for multi-organ dysregulation as well as adverse maternal and foetal outcomes (Abalos et al., 2013; Say et al., 2014). A systematic review unveiled that in developed countries, the

prevalence is comparatively lower, standing at 2.8%, while in Latin America, it rises to 6.5%, and in Africa, it soars to 9.2% and beyond (Say et al., 2014).

HDP constitute approximately 15% - 18% of maternal deaths worldwide, with most of these occurrences taking place in developing countries (Goldenberg et al., 2011). HDP impose a considerable burden of perinatal morbidity and mortality within the obstetric population in Ghana. Approximately 25% of perinatal deaths in these settings can be attributed to HDP (Duley, 2009). These disorders stand out as a major contributor to maternal mortality in Sub-Saharan Africa, impacting both tertiary and rural hospitals in Nigeria (Ekele et al., 2007), major tertiary health facilities in Ghana, and other countries (Adu-Bonsaffoh, Obed & Seffah, 2014). Remarkably, they persist as the primary cause of maternal deaths at Komfo Anokye Teaching Hospital (KATH) for nearly two decades (Kwawununu et al., 2012). Adverse outcomes are more prevalent in cases of preeclampsia when compared to other hypertensive disorders (Adu-Bonsaffoh et al., 2017; Dassah et al., 2019).

In Ghana, a closer examination of the data underscores the significant concern posed by HDP. Various prevalence studies conducted in hospitals reveal a broad spectrum, ranging from 3% to 37.5% (Boachie Ansah et al., 2023; Bugri et al., 2023). Further categorization by type indicated that chronic hypertension constituted 41% of cases, gestational hypertension accounted for 31%, preeclampsia for 25%, and eclampsia for 3%. This breakdown aligns with patterns observed across Sub-Saharan Africa. The 2017 Ghana Maternal Health Survey contributed additional insights, reporting an overall hypertensive disorder rate of 11% within its sampled population.

Key risk factors for HDP in the Ghanaian pregnant population closely align with those identified globally. Noteworthy factors include advanced maternal age, specifically those over 40 years old, obesity, primigravid status, multiple pregnancies, family history, co-morbid diabetes, and chronic antecedent hypertension. The underlying aetiology of HDP involves abnormal placentation and endothelial dysfunction. Additionally, psychosocial stress has demonstrated associations as a risk amplifier, contributing to systemic inflammation and vascular strain (Sánchez-Aranguren et al., 2014).

Despite the universal principles governing HDP management worldwide, the disproportionately high incidence of adverse pregnancy outcomes in resource-

constrained settings is primarily a result of challenges related to the management and quality of care for HDPs in these contexts (Danso and Opare-Addo, 2010). The noticeable differences in HDP prevalence, especially with a much higher burden in developing regions like Africa, highlight the urgent need for research that caters to the unique needs of individual countries. This emphasizes that healthcare challenges vary greatly worldwide, calling for personalized, context-specific solutions. Understanding the actual impact of HDP within each country is not just essential for implementing effective strategies and providing crucial care to pregnant women; it is also vital for grasping the full scope of the issue within a specific nation. This knowledge is key to making a real difference in the lives of expectant mothers and their families.

1.4 Prevalence of Postpartum Depression

Postpartum depression (PPD) constitutes one of the most prevalent maternal mental health conditions worldwide, affecting nearly 15% of birthing mothers (Woody et al., 2017). When it comes to PPD, a global analysis in 2013 found that, on average, about 13% of new mothers experience it. However, the actual rates vary quite a bit depending on when and how the assessment is done (Woody et al., 2017). Similarly, the rates of PPD differ significantly between hospitals in Ghana, ranging from 4.3% to 50.4% (Dako-Gyeke and Asumang, 2013; Okronipa et al., 2012). For instance, a study using in-depth interviews in a rural part of Ghana discovered that 4.3% of mothers were dealing with PPD at 6-8 weeks after giving birth (Weobong et al., 2009). Keku and colleagues stated in their review that community-based research in Northern Ghana found prevalence rates between 16.8 and 33.5 percent, whereas estimates from the rest of the nation were between 3.8 and 11.3 percent. On a different note, when using the Edinburgh Postnatal Depression Scale (EPDS), 50.4% of new mothers screened positive for likely depression between 2-12 weeks postpartum (Daliri et al., 2023).

Risk amplifiers for PPD encompass biological susceptibilities like hormonal shifts, psychosocial stressors such as trauma or violence, and structural barriers regarding social marginalization or inadequate care access (Norhayati et al., 2015). While risks peak in low-middle income regions like Sub-Saharan Africa given higher rates of poverty, malnutrition, and gender violence, stigma shrouds transparency. Distress

often remains undiscovered, particularly as focus fixates narrowly on physical recuperation after childbirth while emotional needs remain discounted.

These variations underscore the importance of conducting careful studies with reliable methods and tools to accurately understand how prevalent PPD is (Noonan et al., 2018). It is not just about the numbers; it is also crucial to explore how different culture's view and talk about perinatal depression, as these perspectives can influence how people report and understand their experiences (Dako-Gyeke and Asumang, 2013; Okronipa et al., 2012).

1.5 Impact of hypertensive disorders of pregnancy

The dangers associated with HDPs are not to be underestimated. They pose a significant threat, with a two to fivefold increased risk of severe maternal complications and, in some cases, even mortality, especially in countries with limited resources (Ghulmiyyah and Sibai, 2012; Say et al., 2014). The repercussions of HDPs extend to both the well-being of newborns and mothers. Despite numerous global, regional, and local initiatives, the challenges stemming from HDPs persist as a major public health concern, especially in countries with limited resources (Vestering et al., 2021; Meazaw et al., 2020). Complications include renal failure, liver damage, placental abruption, pulmonary oedema, and neurological sequelae. There are higher odds of intensive care admission among eclamptic patients compared to normotensive controls, as well as markedly increased risks for blood transfusion, intubation, dialysis, and neurological deficits.

Even though Ghana has made progress in reducing its maternal mortality rate over the past 25 years, declining from 740 per 100,000 live births in 1990 to 308 in 2017 (WHO, 2019), this reduction fell short of the Millennium Development Goal (MDG) 5's target. The goal aimed to reduce the maternal mortality rate by 75% and ensure universal access to reproductive health services. Addressing maternal mortality remains a top priority within the Sustainable Development Goals (SDGs) (Gemechu et al., 2020; Adu-Bonsaffoh et al., 2017).

Adverse perinatal outcomes in Ghana include stillbirth, early neonatal death, restricted foetal growth, low birth weight, prematurity, and neonatal respiratory distress/asphyxia, with some infants requiring ventilatory support and admission to neonatal intensive care units. Maternal outcomes also exhibit heightened risks,

including conditions such as placental abruption, acute renal failure, disseminated intravascular coagulation, and intracerebral haemorrhage, which are notably more common in women with pre-eclampsia compared to those with other hypertensive disorders (Adu-Bonsaffoh et al., 2017).

1.6 Associations Between HDPs and PPD in LMICs

A comprehensive review which delved into the connections between HDPs, and maternal depression revealed that women grappling with hypertensive disorders face a 2-3 times higher risk of PPD compared to those with normal blood pressure (Xu et al., 2021).

A study by Vinaccia et al. (2006), aimed at examining the relationship between preeclampsia and depression in pregnant women beyond 20 weeks of gestation, found using the Centre for Epidemiological Studies Depression Scale (CEDS) that women with preeclampsia exhibited more severe depressive symptoms.

Cetin et al. (2017) aimed to investigate psychopathological symptoms, emotional states, dreams, anxiety, and insomnia in postpartum women with healthy, mild, and severe preeclampsia and their connection to the severity of preeclampsia. They used the Hospital Anxiety and Depression Scale (HADS) and discovered that both severe and mild preeclampsia cases exhibited more severe depressive symptoms compared to healthy controls.

An Ethiopian study did shed light on a significant finding, showing that women with HDPs had more than double the odds of experiencing depression (Gelaye et al., 2017). Similarly, an analysis in Nigeria also discovered a doubled prevalence of PPD among women with hypertensive disorders (Bakare et al., 2016).

However, the picture is not clear when it comes to Ghana. Numerous studies have assessed the prevalence of PPD in Ghana. Nonetheless, there is a gap in research, as no study has investigated the connection between HDP and PPD, emphasizing the need for more in-depth exploration within the local context.

1.7 Pathogenesis of HDP

In a normal pregnancy, cells from the foetus' placenta invade into the mother's uterus. This invasion remodelling of the maternal blood vessels leads to changes that help

provide adequate blood flow between mother and developing foetus (Saghian et al., 2019). It is believed issues with this placental development and vascular remodelling contribute to high blood pressure disorders.

Any hypertensive disorder during pregnancy has the potential to lead to preeclampsia. The mechanism underlying this transition or superposition of preeclampsia is not fully understood, but it is believed to be associated with reduced placental perfusion causing systemic vascular endothelial dysfunction (Braunthal and Brateanu, 2019).

One proposed mechanism is abnormal cytotrophoblast invasion. Cytotrophoblasts are placental cells that remodel these uterine vessels (Taylor et al., 2022; Kaufmann et al., 2003). In preeclampsia they fail to adequately invade and reshape arteries to handle the dramatic blood supply needs of pregnancy. This causes reduced placental perfusion pressure and placental ischemia/hypoxia (Boeldt and Bird, 2017). The poorly developed placenta then releases factors into the mother's bloodstream that damage other organs like the liver and kidneys and cause systemic vascular dysfunction. Factors released include cytokines, cellular debris, oxidative stress chemicals, and antibodies against the foetus (Ngene and Moodley, 2018).

Maternal risk factors like hypertension, obesity and diabetes also heighten risk and seem to similarly alter early placental angiogenesis signalling (Powe et al., 2011). Mitochondrial and endothelial cell dysfunction, inflammation, and immune maladaptation may play synergistic roles too in placental abnormalities leading to clinical symptoms of dangerously high blood pressures (Phipps et al., 2019; Lamarca, 2012).

Genetic analysis also indicates inadequate oxygen signalling and mechano-transduction contributes (Arishe et al., 2020). During normal pregnancy with increased uterine artery pressure, oxygen sensing leads to downstream signals modulating early placental development (Osol et al., 2019). Faulty expression of some genes likely impairs this oxygen sensing and leads to shallow cytotrophoblast invasion (Fisher, 2004). Issues with blood vessel stretching mechano-sensing signals seem linked as well (Tiezzi et al, 2022).

An impediment to the binding of angiogenic factors like vascular endothelial growth factor and placental growth factor to their receptors contributes to the reduction of nitric oxide synthesis, a critical factor in vascular remodelling and vasodilation. This reduction may otherwise alleviate placental ischemia (Osol et al., 2019). Elevated histamine during pregnancy has also been shown to dysregulate genes involved in various processes such as placental oxygen sensing, contractile activity, junctional protein regulation, cell signalling, gene regulation, tissue proliferation and morphogenesis, inflammation, and immune regulation (Brew, Sullivan & Woodman, 2016).

Numerous association studies have investigated various gene polymorphisms in hypertensive disorders of pregnancy (HDP), including those related to renalase (Zhang et al., 2020), transforming growth factor beta 1 receptor 2 (Li et al., 2017), and stromal interaction molecule 1 (Shinya et al., 2018). Despite these studies, there is limited evidence of genomic differences between different HDP subtypes.

Yuan et al. (2021) explored the role of endothelial nitric oxide synthase (eNOS), matrix metalloproteinases (MMP)-9, and Bcl2-associated oncogene 6 (BAG-6) gene polymorphisms, as well as the combined role of single nucleotide polymorphisms (SNPs) in HDP patients. They found no statistically significant difference in the SNPs of eNOS, MMP-9, and BAG-6 gene allele and genotype frequencies between HDP or subtypes and controls. However, haplotype analyses suggested three haplotypes with protective effects against HDP development, and one haplotype was identified as a risk factor.

Zhang et al. (2020) examined renalase gene polymorphisms and their potential impact on HDP development. They found that one of the polymorphisms (rs2296545) was significantly associated with HDP and PE risk, and another polymorphism (rs2576178) might increase susceptibility to HDP.

Li et al. (2017) discovered a significant association between a haplotype of four transforming growth factor beta 1 receptor 2 (TGFβR2) SNPs and preeclampsia and gestational hypertension. Additionally, Shinya et al. (2018) proposed that the stromal interaction molecule 1 (STIM1) gene could be a susceptibility gene for HDP.

Though exact mechanisms require further study, clearly abnormal placentation very early in pregnancy seems pivotal to the pathogenesis of preeclampsia/eclampsia and related hypertensive disorders. Earlier detection of placental dysfunction is a promising avenue to allow for tighter monitoring or early delivery to avoid complications.

1.8 Management of HDP

For women with non-severe hypertension or preeclampsia lacking maternal end-organ involvement following initial assessment, the option of receiving care outside the hospital may be considered. Those being considered for outpatient management should: be educated about concerning symptoms, including when and how to report them, and be prepared to do so; be equipped with home blood pressure monitoring (HBPM) capability, if possible; reside at a reasonable distance from the hospital; have easy access to maternal and foetal surveillance; and be under the care of an experienced and well-organized team. The management approach can be categorized into non-pharmacological, pharmacological, and surgical interventions, as detailed in Table 1.2 below.

Table 1.2: Management of HDP.

Non-pharmacological therapy	▪ There is insufficient evidence to recommend for or against restricted activity, in hospital or at home, for any HDP. ▪ Concerns about thromboembolism risk should caution practitioners against recommending strict bed rest, due to the potential for harm in the absence of demonstrable benefit. ▪ Uncontrolled hypertension of any type, and pre-eclampsia specifically, are absolute contraindications to exercise.
Antihypertensive therapy	▪ Hypertension in pregnancy should be treated with antihypertensive therapy, irrespective of the underlying HDP. ▪ Severe hypertension in pregnancy (i.e., sBP≥160mmHg or dBP≥110mmHg) requires *urgent* antihypertensive therapy, in a monitored setting. ▪ The target BP for antihypertensive therapy should be a dBP of 85mmHg, regardless of sBP. ▪ Non-severe hypertension should be treated with the first-line agents oral methyldopa, labetalol, or nifedipine.

	Severe hypertension should be treated with the first-line agents oral nifedipine, oral labetalol, IV labetalol, or IV hydralazine.
Magnesium sulphate	▪ Women with eclampsia should receive magnesium sulphate to prevent recurrent seizures. ▪ Women with pre-eclampsia who have proteinuria and severe hypertension, or hypertension with neurological signs or symptoms, should receive magnesium sulphate for eclampsia prevention.
Timed birth	▪ Indications for planned birth, regardless of gestational age, apply to 'complicated' pre-eclampsia include: ▪ Abnormal neurological features (such as eclampsia, severe intractable headache, or repeated visual scotomata). ▪ Repeated episodes of severe hypertension despite maintenance treatment with three classes of antihypertensive agents. ▪ Pulmonary oedema. ▪ Progressive thrombocytopenia or platelet count < 50x109/L. ▪ Transfusion of any blood product. ▪ Abnormal and rising serum creatinine. ▪ Abnormal and rising liver enzymes. ▪ Hepatic dysfunction (INR >2 in absence of DIC or warfarin), haematoma or rupture. ▪ Abruption with evidence of maternal or foetal compromise; or non-reassuring foetal status (including death)
Magee et al, (2021) The Hypertensive Disorders of Pregnancy: The 2021 International Society for the Study of Hypertension in Pregnancy Classification, Diagnosis and Management Recommendations for International Practice.	

1.9 Person-centred interventions - The future of HDP management

Precision Medicine, is the healthcare approach that emphasizes on identifying personalized treatment and prevention strategies, considering individual variations in genes, environment, and lifestyle. This departure from the 'one size fits all' and less effective trial-and-error method in healthcare allows for customized diagnosis and treatment based on information derived from the patient's own genome and specific environmental factors (Carrasco-Ramiro, Peiró-Pastor and Aguado, 2017; NHS England, 2016).

Precision, or P4 (predictive, preventive, personalized, and participatory), medicine represents a shift from the conventional approach to treating patients with a particular

condition. Instead, it employs new methodologies to better manage patients' health and target therapies for optimal outcomes in disease management or predisposition to disease (NHS England, 2016). A key objective of incorporating genomics into clinical care is to enhance diagnosis by identifying genomic conditions, thereby improving clinical management, preventing complications, and promoting health (Wise et al., 2019).

The less efficient non-Precision Medicine (trial-and-error) approach, which can result in drug toxicity, severe side effects, reactive treatment, and misdiagnosis, contributes to rising healthcare costs. Increased patient stratification enables a more effective application of Precision Medicine and proactive treatment plans, leading to reduced costs and an enhancement in the quality of life (Mathur and Sutton, 2017). The adoption of Precision Medicine will yield more efficient and equitable healthcare, access to modern healthcare methods, improved control by individuals of their health data, and economic development in the health sector (Vicente, Ballensiefen and Jönsson, 2020; Mathur and Sutton, 2017).

Typically, individualizing therapy is based on the pharmacogenomic makeup of the individual and environmental factors that affect drug disposition and response. During pregnancy, a woman's body undergoes various changes that can impact the therapeutic efficacy of medications. However, there is limited research on personalized medicine in obstetrics (Quinney, Patil and Flockhart, 2014).

There is a growing trend in the use of AI in obstetrics (Wright, Wright, and Nicolaides, 2020). Yet, a comprehensive understanding and the use of AI to establish accurate antepartum and intrapartum predictive monitoring parameters are still to be fully achieved. Nevertheless, the benefits of person-centred intervention in low- and middle-income countries appear to outweigh current limitations, underscoring the need to explore its impact in African populations.

1.10 Problem Statement

Despite global, regional, and local initiatives, complications from HDP remain a major public health issue, especially in low-and-middle-income countries (LMICs) (Vestering et. al. 2021; Meazaw et al., 2020).

Although Ghana has halved its maternal mortality ratio (MMR) over 25 years (740 per 100,000 live births in 1990; 308 in 2017) (WHO, 2019), the MMR reduction remained far below Millennium Development Goal (MDG) 5's target (to reduce maternal mortality ratio by 75% and achieve universal access to reproductive health) and continues to be a priority in the Sustainable Development Goals (SDGs) (Gemechu et al. 2020; Adu-Bonsaffoh et al, 2017).

In Ghana, the life-time risk of maternal death (one in 82) is substantially higher than high-income countries (e.g., one in 8,500 in UK; one in 11,900 in Netherlands; one in 3,000 in USA) (World Bank Open Data , 2023). 30.0 to 31.7% of maternal deaths in a tertiary hospital in Ghana were due to hypertensive disorders of pregnancy, specifically pre-eclampsia (Adu-Bonsaffoh et al., 2013; Adu-Bonsaffoh et al., 2014). Adverse perinatal outcomes in Ghana include stillbirth, early neonatal death, intrauterine growth restriction, low birth weight, prematurity, neonatal respiratory distress/asphyxia with some requiring ventilatory support and neonatal intensive care unit admission. Maternal outcomes including placental abruption, acute renal failure, disseminated intravascular coagulation, intracerebral haemorrhage and others are significantly common in women with pre-eclampsia than in those with other hypertensive disorders (Adu-Bonsaffoh et al., 2017).

Given the substantial health burden of hypertensive disorders in pregnancy, especially in LMICs, there is an increasing need to optimize diagnosis and management of these conditions. Majority of the complications caused by HDP may be reduced by early detection, prevention, and appropriate management (Ouasmani et al., 2018).

Maternal health is a paramount concern in the global healthcare landscape, with a particular focus on the perinatal period encompassing pregnancy and the postpartum phase. Within this critical timeframe, the association between HDP and PPD has emerged as a multifaceted challenge, posing significant risks to the well-being of mothers in Ghana.

Despite a growing body of evidence globally highlighting the heightened risk of postpartum depressive symptoms among women with, the specific knowledge of this association within the Ghanaian context remains unavailable.

Considering these complexities and gaps in understanding and practice, this research aims to unravel the intricate dynamics between HDP and PPD in Ghana, provide

evidence-based insights, and formulate recommendations to guide future healthcare strategies. By addressing this critical gap, we aspire to contribute to the development of targeted interventions, policies, and practices that enhance the maternal well-being of Ghanaian women during the vulnerable perinatal period.

1.11 Aims and Objectives

Our research embarks on a comprehensive exploration with the overarching aim of unravelling the intricate association between HDP and PPD among women in Ghana. The multifaceted nature of this association demanded a multifaceted research approach, blending systematic review, meta-analysis, and qualitative interviews with healthcare professionals. Through this integrated methodology, we aimed to achieve these specific objectives:

1.11.1 Systematic Review:

Objective: Conduct a systematic review to synthesize existing evidence on the association between HDP and PPD in LMICs.

Rationale: By analysing the collective findings from previous studies, our goal was to establish a robust foundation of knowledge, identify trends, and quantify the magnitude of the association.

1.11.2 Meta-Analysis:

Objective: Perform a meta-analysis to quantitatively analyse and synthesize data from selected studies, providing a pooled estimate of the association between HDP and PPD.

Rationale: The meta-analysis aimed to quantitatively assess the strength of the association, identify patterns, and produce pooled effect sizes to contribute to the existing evidence base.

1.11.3 Qualitative Interviews:

Objective: Engage healthcare professionals in qualitative interviews to gain insights into the lived experiences and perspectives regarding the association between HDP and PPD in Ghana.

Rationale: The qualitative component aimed to complement quantitative evidence with rich contextual information, exploring nuances, and offering a deeper understanding of the factors influencing the association within the Ghanaian healthcare landscape.

1.12 Hypothesis

The research aims to investigate the hypothesis that there exists a significant association between hypertensive disorders in pregnancy (HDP) and postpartum depression (PPD) among women in Ghana. Specifically, we hypothesized that women experiencing hypertensive disorders during pregnancy are at a higher risk of developing postpartum depression compared to those without such hypertensive conditions. We assume that the complex interplay of physiological, psychological, and social factors contributes to an elevated risk of postpartum depression in women with hypertensive disorders during pregnancy, necessitating a comprehensive understanding for effective healthcare interventions. The research aimed to test and substantiate this hypothesis through a systematic review, meta-analysis, and qualitative interviews with healthcare professionals in Ghana, providing adequate insights into the intricate relationship between HDP and PPD within the local context.

1.13 Research questions.

To achieve the aim, the following research questions will be addressed:

1. What is the evidence regarding the association between HDP and PPD in LMICs?
2. What is the quantitative strength of the association between HDP and PPD based on a meta-analysis of existing studies?

3. What are the experiences and perspectives of healthcare professionals in Ghana regarding the association between HDP and PPD?

Chapter 2: Research Methodology

2.1 Introduction

This section explores the methodology employed in the present study. Our research aims to illuminate the complex association between hypertensive disorders during pregnancy (HDP) and postpartum depression (PPD) in Ghana (section 1.11) by employing a mixed methods approach underpinned philosophically within a pragmatic paradigm, the philosophical perspective that prioritizes the practical utility of methods over rigid adherence to any specific philosophical doctrine. The adoption of a pragmatic research paradigm underscores the flexibility required to navigate the complexities of the chosen research problem. This paradigm accommodates methodological pluralism, advocating for an inclusive approach that integrates both quantitative and qualitative research methods (Morgan, 2014).

As the study utilizes multiple methods encompassing both qualitative and quantitative evidence, the pragmatic framework supports combining empirical precision with experiential depth to best illuminate the research problem. Our pragmatic study integrates quantitative systematic review and meta-analytic findings with qualitative insights from semi-structured interviews with healthcare experts to facilitate robust triangulation.

Investigating the connections between HDP and PPD requires a comprehensive and context-sensitive approach, considering the intricate relationship influenced by complex biological, social, and healthcare system factors. Quantitative data offers empirical precision in identifying correlation strength, while qualitative experiences articulate pathways through which physiological and emotional risks interact against the sociocultural backdrop of Ghana.

This chapter delineates the methodological framework employed, encompassing research design, paradigm positioning, specific methods, analysis procedures, ethical considerations, and strengths/limitations.

First, a systematic review and series of meta-analyses quantify the overall association between HDP and PPD through statistical synthesis of published literature. To complement these empirical findings, semi-structured interviews conducted with

midwives and physicians in Ghana provide experiential insights into local risk patterns and care barriers witnessing first-hand the impacts of HDP on postpartum wellbeing.

This pragmatic mixed methodology, prioritizing methodological versatility aligned to research questions rather than paradigmatic loyalty, facilitates robust triangulation across data sources (Feilzer, 2010). Combining empirical precision with contextual depth and a variety of perspectives holds the potential to enhance a more comprehensive understanding of HDP and PPD within the unique sociocultural environment of maternal care in Ghana.

The remainder of this chapter details the systematic review protocol, meta-analytic procedures, interview methods, positionality statement, ethical provisions, rigor supports and limitations underpinning the mixed methodology.

2.2 Research Paradigm

2.2.1 Philosophical Foundation: The Pragmatic Paradigm

This research is anchored philosophically within the paradigm of pragmatism, which orients the investigator toward solutions that “work” in practice through flexible use of diverse methodological tools (Creswell and Creswell, 2017). Pragmatism, in contrast to fixed assumptions about the nature of knowledge or reality found in post positivism or constructivism, emphasizes a strong focus on the research question by employing pluralistic approaches to derive practical and workable answers (Morgan, 2014).

As articulated by seminal pragmatist philosopher William James, “Truth happens to an idea. It becomes true, is made true by events” (James, 1907). In other words, validity stems from the practical ability of ideas or theories to successfully solve emerging problems. This aligns with the mixed methods leverage of “what works” to investigate complex research phenomena using qualitative and quantitative tools as appropriate.

A pragmatic lens supports integrating meta-analysis, experiments and statistics with semi-structured interviews and thematic analysis without contorting research questions to fit a single paradigm (Kish-Gephart et al., 2023). The opportunity for methodological plurality enables pragmatic researchers to extract richness from both numbers and narratives in better matching the complexity of real-world health issues like HDP and PPD (Bailie et al., 2022, Willis et al., 2014).

This study embraces pragmatism's versatility in using systematic review, statistical synthesis and experiential insights from midwives and doctors to shine light on HDP and PPD links. Blending empirical precision with embedded care perspectives scaffolds greater knowledge depth, aligning with pragmatism's cardinal focus on "knowing through doing" (Kelly et al., 2020; Choo, 2015). This paradigm empowers the researcher to match methodology directly to the intricacy of the problem.

Grounded in pragmatism, the research paradigm emphasizes the practical utility of methods over strict adherence to philosophical dogma (Kaushik and Walsh, 2019). Pragmatism, as the guiding philosophy, encourages the researcher to prioritize the effectiveness and applicability of methods in addressing the multifaceted nature of the research problem at hand (Allemang et al., 2022). Unlike strict adherence to a particular philosophical stance, pragmatism allows for a dynamic and adaptive research process that is responsive to the evolving needs of the study (Nowell, 2015). This flexibility is crucial in ensuring that the chosen methods align with the overarching goals of the research and can yield valuable and actionable insights.

In the context of examining relationships between pregnancy-related health conditions and postpartum mental health outcomes, a purely constructivist qualitative study may lack the empirical rigor to determine correlation strength. Yet a solely postpositivist quantitative analysis forfeits the explanatory power regarding subjective risks and barriers operating within a local cultural landscape that interviews can provide. Hence pragmatism supports integrating metadata with thematic data.

This research follows principles of methodological appropriateness, using approaches with demonstrated applied value for investigating connections between HDP and PPD. The incorporation of both quantitative and qualitative approaches exemplifies the methodological pluralism inherent in the pragmatic paradigm (Frost and Bailey-Rodriguez, 2020). This deliberate combination allows the researcher to harness the strengths of each approach, leveraging empirical precision from quantitative methods while simultaneously capturing the experiential depth inherent in qualitative research (Schroder, 2012). By embracing this methodological diversity, the study aims to achieve a more comprehensive understanding of the research problem, acknowledging that certain aspects may be better addressed through quantitative

measures, while others may require the nuanced insights provided by qualitative inquiry.

This paradigm accommodates methodological pluralism, allowing the study to leverage both quantitative and qualitative approaches to best address the multifaceted research problem (Johnson and Onwuegbuzie, 2004). Pragmatism aligns with the study's aim to extract valuable insights from diverse methods, combining empirical precision with experiential depth. Pragmatic pluralism's adaptability allows for the exploration of risk pathways using qualitative experiential data, while simultaneously quantifying the extent of association through meticulous meta-analysis (May et al., 2017).

Avoiding dogmatism about any single research paradigm, this study utilizes mixed methods tailored specifically to address the complexity of its focal research problem. By adopting a pragmatic stance, the research methodology strives to strike a balance between the need for empirical rigor and the desire to explore the richness of experiential data. The pragmatic orientation of the research paradigm is in harmony with the study's overarching goal – the extraction of valuable insights from diverse methods. This approach seeks to transcend traditional boundaries and embraces a holistic perspective that recognizes the complementary nature of various research techniques.

2.2.2 Theoretical Framework

The study employs a biopsychosocial (BPS) framework recognizing that HDP and PPD onset involve complex interactions between biological changes, psychological experiences, and social context across the prenatal and postpartum period.

The concept of "biopsychosocial" was introduced by Roy Grinker in 1952. Building on his interest in systems theory, Engel further developed the model in 1977, employing it to speculate about the integration of mind and body. Despite its limitations, the BPS model continues to be relevant and valuable (Lugg, 2022).

The biopsychosocial model offers a useful theoretical lens for examining the complex interconnections between HDP and PPD. This model proposes that health outcomes are influenced by an intricate interplay of biological, psychological, and social factors.

This framework, depicted visually in Figure 2.1 below, posits that physiological and psychosocial factors dynamically influence one another to shape maternal mental health outcomes.

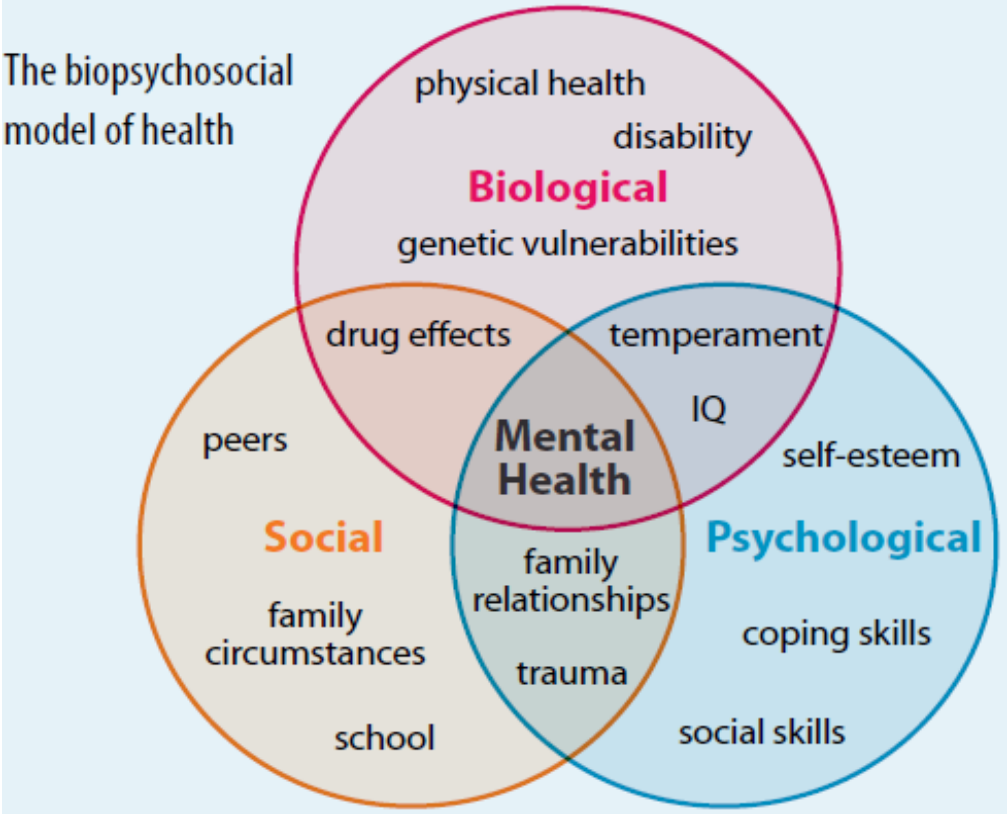

Figure 2.1: Grinker's Biopsychosocial Model of Health. Source: Physiopedia.com

The biopsychosocial viewpoint aligns with Young's (2004) argument that singular and compartmentalized approaches to comprehending illness behaviour lack the capacity to fully unravel the intricacies of this phenomenon. Hence, a more comprehensive and methodically structured analysis of illness behaviour can be realized by incorporating a blend of qualitative and hierarchical/structural quantitative methodologies.

In the context of maternal health, the biopsychosocial perspective recognizes that pregnancy and the postpartum period involve significant physiological changes, as well as emotional adjustments and lifestyle changes situated within cultural contexts. Specifically, the experience of a high-risk pregnancy complicated by HDP triggers substantial biological stress in terms of inflammation, hypertension, metabolic changes and more that can dysregulate multiple body systems. This physiological

disruption interacts bidirectionally with emotional states of distress, uncertainty, grief over adverse outcomes, and mental health vulnerability.

Additionally, social facets add further layers of complexity - a woman with HDP may lack social support, experience stigma or abuse, confront financial strain, and have reduced access to affordable quality care. These social adversities can independently exacerbate mental health risks, as well as add stress to an already distressed biological and psychological system. The cumulative loads across biological, psychological, and social domains contribute to a 'tipping point' of breakdown that manifests as postpartum depression.

This integrated perspective provides a scaffold for investigating how biological aspects of HDP like hypertension, inflammation and stress physiology entwine with social stressors, trauma, and lack of support to potentiate risks for postpartum mood disorders. Therefore, the biopsychosocial perspective emphasizes the need to address all three spheres of risk factors, rather than siloing the "medical" and "mental" aspects. Providing integrated care through screenings, counseling, peer support groups, and postpartum surveillance that acknowledges this multidimensionality holds promise for improving maternal outcomes in the context of Ghana.

2.3 Research Design

This research utilizes a mixed methods design encompassing both quantitative meta-analysis and qualitative descriptive analysis using content from semi-structured interviews with healthcare experts. The meta-analysis synthesizes published empirical literature to identify the presence and strength of an association between HDP and subsequent PPD. The descriptive qualitative component explores obstetric care professionals' perspectives regarding this relationship and factors mediating risks. This allows rigorous statistical interrogation via meta-analysis to be combined with in-depth explanatory insights from practitioner expertise.

2.3.1 Mixed-Methods Design

A mixed-methods research design was chosen to capitalize on the strengths of both quantitative and qualitative approaches. This design allowed for a multifaceted

exploration, combining the statistical rigor of a meta-analysis with the contextual insights gained from qualitative interviews. The integration of diverse methodologies enriched the overall understanding of the research questions.

A mixed-methods research design was deliberately chosen to leverage the strengths inherent in both quantitative and qualitative approaches. This approach facilitated a multifaceted exploration, merging the statistical precision of a meta-analysis with the nuanced insights garnered from qualitative interviews. The deliberate integration of diverse methodologies significantly enriched the overall understanding of the research questions.

This mixed-methods design, encompassing a systematic review, meta-analysis, and qualitative interviews, offered a thorough exploration of the association between HDP and PPD. The seamless blending of various methodologies not only deepened but also broadened the research, contributing to a more holistic understanding of this intricate relationship.

Within the context of a pragmatic mixed-methods study, which embraces diverse data types, our goal is to advance a comprehensive understanding of the connection between hypertensive disorders during pregnancy and postpartum depression, specifically within the unique sociocultural landscape of Ghana. By employing pluralistic approaches, we aim to open new perspectives and triangulate insights on this critical maternal health issue.

2.4 Methods

2.4.1 Systematic Review

To answer research question one (section 1.13) and achieve objective one (section 1.11.1), a systematic review was conducted to identify and evaluate existing literature on the association between HDP and PPD in LMIC. Comprehensive searches were conducted on major databases, including PubMed, Embase, and PsycINFO. Inclusion criteria encompassed studies focusing on HDP and PPD with clear outcome measures. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were followed to ensure a systematic and transparent approach to literature selection.

2.4.2 Meta-Analysis

In addressing research question two (as outlined in section 1.13) and accomplishing objective two (as detailed in section 1.11.2), we conducted a meta-analysis on chosen studies to quantitatively synthesize their findings. Statistical analyses were performed using metafor package in R software employing statistical methods to analyze pooled effect sizes and explore heterogeneity.

2.4.3 Semi-structured Interviews

To delve into research question three (highlighted in section 1.13) and fulfil objective three (outlined in section 1.11.3), we intentionally selected a varied group of healthcare professionals in Ghana through purposive sampling. This approach ensured that we captured a diverse range of perspectives in our study. Semi-structured interviews were conducted, exploring experiences and viewpoints related to HDP and PPD. Thematic analysis was applied to derive meaningful insights.

2.4.3.1 Participant Selection

Healthcare professionals in Ghana, including doctors and midwives, were purposefully selected to provide diverse perspectives. Ten female participants, comprising five doctors and five midwives with at least 5 years of experience, were chosen for data saturation.

2.4.3.2 Data Collection

In-depth qualitative interviews were conducted using a semi-structured interview guide. The guide covered topics such as experiences with HDP and PPD, awareness levels, contributing factors, and screening practices. Interviews were audio-recorded and transcribed verbatim for analysis.

2.4.3.3 Thematic Analysis

Reflexive thematic analysis was employed to identify patterns and themes within the qualitative data. This iterative process involved familiarisation with the data, coding of the data, data categorizing, and interpreting the data to derive meaningful insights.

2.5 Ethical Considerations

The research proposal and Research Ethics Risk Assessment were submitted to the University of West London's College of Nursing, Midwifery and Healthcare for ethical approval prior to the commencement of the study. Again, ethical approval was obtained from the Institutional Review Board (IRB) of University of Ghana Medical Centre Limited (UGMC). Copies of the letters evidencing the approvals are in Appendix E and F. Ethical guidelines outlined in the Declaration of Helsinki were strictly adhered to throughout the research process.

2.6 Data Analysis

2.6.1 Systematic Review

Selected studies underwent systematic data collection, encompassing study characteristics, participant demographics, and outcome measures pertaining to HDP and PPD. Methodological quality of these studies were evaluated to uphold the reliability and validity of results. Data synthesis consolidated findings, identifying key patterns across studies. The implications of these findings, alongside recommendations for future research and clinical practice, were discussed considering the research question and existing literature.

2.6.2 Meta-Analysis

Quantitative data from selected studies were synthesized using statistical methods. Pooled effect sizes and confidence intervals were calculated to assess the overall association between HDP and PPD. Heterogeneity among studies was examined using statistical tests, and subgroup analyses were performed to explore potential sources of heterogeneity.

2.6.3 Thematic Analysis

Qualitative data underwent thematic analysis, following Braun and Clarke's (2022) six-phase approach. Emerging themes were identified, and patterns within the data were systematically explored. Member checking and peer debriefing were employed to

enhance the trustworthiness and validity of the qualitative findings. Details of specifics, such as participant feedback and researcher deliberations were documented to ensure transparency and rigour in analysis.

2.7 Data management

Concerning the qualitative interview data, all information was securely stored on password-protected devices to uphold the privacy and confidentiality of the participants. The audio files were structured to contain minimal identifying information wherever feasible. To ensure anonymity, participants were assigned pseudonyms during the analysis stage. These pseudonyms are utilized when presenting the data in chapters 5 and 6. Any subsequent communication of the work, whether written or verbal, maintains the anonymization of all references to participants.

2.8 Summary of the chapter

In this chapter, we have delved briefly into the methods we used to tackle the research questions we introduced in Chapter 1. We have shared the reasoning behind our choice of paradigm, the adoption of a mixed methods design, and the application of our theoretical framework. Each part of the study has been briefly outlined, highlighting the considerations that guided our decisions throughout.

We also took a thoughtful approach to the ethical aspects of our study, addressing how ethical approval was attained as well as how the data generated was managed. This, coupled with meticulous data analysis, will add strength and credibility to our findings. This chapter serves as the bedrock for what follows in subsequent chapters—where we will unfold and discuss the results of our research.

Chapter 3: Association of Hypertensive Disorders of Pregnancy (HDP) and Perinatal Mental Health (PMH) in Low- and Middle-Income Countries (LMICs): A Systematic Review

3.1 Introduction

Hypertensive disorders of pregnancies (HDPs) are the most common medical disorders during pregnancy and one of the leading causes of maternal and infant mortality worldwide (Abalos et al., 2013; Duley, 2009; Habli et al., 2008; Steegers et al., 2010; Braunthal and Brateanu, 2019). These conditions are characterized by high blood pressure and often involve issues with the blood vessels throughout the body. This can result in adverse effects such as damage to the mothers' organs, complications during birth, and stunted foetal growth (Mammaro et al., 2009). The combination of experiencing a life-threatening complication and its management may culminate in psychological trauma (Furuta, Sandall and Bick, 2012).

Globally, maternal mental health problems pose a significant public health challenge. Approximately 10% of pregnant women and 13% of postpartum women encounter a mental disorder, primarily depression. In developing countries, these rates are even higher, reaching 15.6% during pregnancy and 19.8% after childbirth (W.H.O., 2019; Miafo et al., 2023). In severe instances, mothers may experience such intense suffering that it could lead to suicidal tendencies. Moreover, affected mothers may struggle to function adequately, potentially impacting the growth and development of their children negatively. It is essential to note that maternal mental disorders are treatable, and effective interventions can be administered by well-trained non-specialist health providers (W.H.O., 2019).

While the physiological and medical aspects of HDP have been extensively studied, there is a growing recognition of the potential impact of these disorders on maternal mental health (Biaggi et al., 2016). Pregnancy itself is a period of significant physiological and psychological changes, and the presence of a medical complication like hypertensive disorders could potentially exacerbate stress and anxiety levels among pregnant women (Field et al., 2010). While the evidence indicates the potential development of major depressive disorders during the perinatal period, mental illness

during this time is frequently underestimated, overlooked in assessments, undiagnosed, and consequently left untreated (Apter et al., 2011).

Since HDPs remain a significant public health issue, especially in LMICs, where the risk of maternal death is higher compared to high-income countries despite global and regional efforts to address them (Vestering et al., 2021; Meazaw et al., 2020), understanding the potential associations between hypertensive pregnancy disorders and perinatal mental health is crucial for several reasons.

Unfortunately, the exact nature and extent of these associations, and the subsequent impact on postnatal psychological health in LMICs have not been comprehensively explored, resulting in an evidence gap to support provision of appropriate care for these women. While some individual studies have hinted at potential connections between HDP and maternal mental health, a systematic literature review is warranted to provide a comprehensive and evidence-based understanding of these associations. Given the effects, on the health of the mother, the unborn child, and the entire family, if there is indeed a connection between hypertensive disorders during pregnancy and negative mental health outcomes for mothers, it could significantly impact how we manage and care for pregnant individuals. By identifying and addressing these links, we can develop interventions and support systems especially for women in LMICs who are at risk of developing HDP. This in turn will contribute to improved outcomes for pregnancies. The insights provided in this review can serve as a resource, for healthcare professionals, researchers and policymakers looking to develop targeted interventions that address the psychological needs of pregnant individuals dealing with hypertensive disorders during pregnancy.

3.1.1 Aims

The systematic literature review seeks to determine whether there are significant associations between hypertensive disorders of pregnancy and adverse perinatal psychological well-being (section 1.11). By identifying patterns, potential influencing factors, and research gaps, the review aims to inform clinical practices and interventions that address the mental health needs of pregnant individuals with hypertensive disorders. Ultimately, this review will contribute to the corpus of knowledge on maternal and foetal health by offering insights that can enhance both

care strategies and future research directions in this field. Our objective is to systematically review and synthesize the existing literature to comprehensively understand the association between HDP and PMH outcomes, specifically stress, anxiety, and depression, among women residing in LMICs. Additionally, our systematic review seeks to uncover other significant factors that are associated with the development of perinatal mental health issues in LMICs.

The objectives, inclusion criteria and methods of analysis for this review were specified in advance and documented in an a priori protocol with registration number CRD42023464675 in International prospective register of systematic reviews (PROSPERO).

3.1.2 Research questions.

Crafting the research question stands as a pivotal and fundamental aspect of research integrity (Kabir et al., 2023; Eldawlatly et al., 2018). To structure our research inquiries and formulate effective search strategies aligned with our objectives, we employed the specialized population – exposure - outcome (PEO) framework, chosen for its efficiency in quantitative studies.

In this study, the focus centres on women who experienced HDP during their perinatal period. The targeted outcome variable revolves around perinatal mental health outcomes, specifically stress, anxiety, and depression. Building upon this foundation, we devised these research questions:

1. Among women with HDP in LMICs, how does the presence of these disorders relate to perinatal mental health outcomes such as anxiety, and depression?
2. What are the additional factors that influence the development of perinatal PMH issues among women HDP in LMICs?

3.2 Methods

The methodology used for conducting systematic reviews on aetiology and risk, as detailed in chapter 7 of the 2020 publication "JBI Manual for Evidence Synthesis," edited by Aromataris and Munn, served as the foundation for this review.

3.2.1 Inclusion Criteria

To accomplish our review objectives, we chose to follow the protocol outlined in chapter 7 of the Joanna Briggs Institute (JBI) manual for evidence synthesis, which is dedicated to conducting a systematic review on aetiology and risk factors. Only women living in LMICs who suffered HDP were included in this review. Non-English studies, studies conducted on animals, incomplete studies where required data is inaccessible/unavailable, studies without primary data, and studies which were not conducted in LMICs were excluded.

3.2.1.1 Population

We focused our review on articles that included women residing in LMICs who either have experienced HDPs or are currently dealing with the aftermath of such conditions.

3.2.1.2 Exposure of interest

In this review, we focused on HDP as our exposed variable. To establish a clear understanding and classification of these pregnancy-related disorders, we relied on the guidelines provided by the International Society for the Study of Hypertension in Pregnancy (ISSHP) in 2021. These guidelines offer comprehensive recommendations for the classification, diagnosis, and management of HDP that are globally recognized. HDP, as per the ISSHP definition, refers to a condition where a pregnant individual exhibits SBP equal to or exceeding 140 mm Hg and/or diastolic blood pressure equal to or exceeding 90 mm Hg.

3.2.1.3 Outcome of interest

Perinatal mental health pertains to mental health conditions that either existed prior to pregnancy or arise or worsen during the period encompassing pregnancy through the first postnatal year. These conditions encompass a range of challenges such as depression, anxiety, psychosis, eating disorders, post-traumatic stress disorder, and others, varying in severity, which require diverse forms of care and treatment.

The World Health Organization has identified several factors that can predispose women to develop perinatal mental health issues, including poverty, migration,

exposure to various forms of violence (such as domestic, sexual, and gender-based violence), conflict situations, natural disasters, and inadequate social support (W.H.O., 2019). In this review, we focused specifically on the experiences of depression and anxiety among women during their perinatal period.

Efforts have been made to identify and address PPD through various screening tools. One commonly utilized assessment is the Edinburgh Postnatal Depression Scale (EPDS), a questionnaire comprising 10 items that individuals complete themselves. This survey requires only a few minutes to fill out. By establishing an EPDS cutoff score of 13 or higher, medical professionals can determine whether patients are at risk of developing postpartum depression.

One commonly used tool to measure anxiety, including perinatal anxiety, is the "State-Trait Anxiety Inventory" (STAI). The STAI is a widely recognized self-report questionnaire that assesses both state anxiety (current feelings of anxiety) and trait anxiety (general tendencies towards anxiety) across various populations and contexts, including perinatal stages. It consists of separate scales for measuring state anxiety (STAI-State) and trait anxiety (STAI-Trait), each comprising 20 items.

3.2.1.4 Types of studies

The primary focus of these reviews involved the examination of observational research, encompassing prospective and retrospective cohort studies, case-control studies, and cross-sectional studies.

3.2.2 Sources to Search

The following key databases and register were meticulously explored: Academic Search Elite (ASE), APA PsycINFO, CINAHL, Cochrane Central Register of Controlled Trials (CRCT), Cochrane Database of Systematic Reviews (CDSR), Embase, Maternity and Infant Care Database (MICD), MEDLINE, PubMed, and Scopus. All searches were conducted using the same search techniques, with unique modifications made to each database's requirements. All databases were subject to restrictions, which included only studies published in English. However, certain databases also had additional filters, as shown in the table below, such as peer review status, date restrictions, subjects related to humans, women, and pregnancy, among others.

3.2.3 Search Strategy

("hypertensive disorders of pregnancy" OR "chronic hypertension" OR "white-coat hypertension" OR "masked hypertension" OR "gestational hypertension" OR “pregnancy induced hypertension” OR "transient gestational hypertension" OR "pre-eclampsia" OR "Pre eclampsia" OR "Preeclampsia" OR "Pre-eclampsia superimposed on chronic hypertension" OR "Eclampsia" OR "HELLP syndrome")

AND

("perinatal mental health" OR "maternal mental health" OR "maternal mental health" OR "postpartum depression" OR "postpartum psychosis" OR "maternal anxiety" OR "maternal stress").

AND

("low- and middle-Income countries" OR "developing countries" OR "Afghanistan" OR "Albania" OR "Algeria" OR "American Samoa" OR "Angola" OR "Argentina" OR "Armenia" OR "Azerbaijan" OR "Bangladesh" OR "Belarus" OR "Belize" OR "Benin" OR "Bhutan" OR "Bolivia" OR "Bosnia and Herzegovina" OR "Botswana" OR "Brazil" OR "Bulgaria" OR "Burkina Faso" OR "Burundi" OR "Cabo Verde" OR "Cambodia" OR "Cameroon" OR "Central African Republic" OR "Chad" OR "China" OR "Colombia" OR "Comoros" OR "Democratic Republic of Congo" OR "Côte d'Ivoire" OR "Cuba" OR "Djibouti" OR "Dominica" OR "Dominican Republic" OR "Ecuador" OR "Egypt” OR "El Salvador" OR "Equatorial Guinea" OR "Eritrea" OR "Eswatini" OR "Ethiopia" OR "Fiji" OR "Gabon" OR "Gambia" OR "Georgia" OR "Ghana" OR "Grenada" OR "Guatemala" OR "Guinea" OR "Guinea-Bissau" OR "Guyana" OR "Haiti" OR "Honduras" OR "India" OR "Indonesia" OR "Iran" OR "Iraq" OR "Jamaica" OR "Jordan" OR "Kazakhstan" OR "Kenya" OR "Kiribati" OR "Korea" OR "Kosovo" OR "Kyrgyz Republic" OR "Lao PDR" OR "Lebanon" OR "Lesotho" OR "Liberia" OR "Libya" OR "Madagascar" OR "Malawi" OR "Malaysia" OR "Maldives" OR "Mali" OR "Marshall Islands" OR "Mauritania" OR "Mauritius" OR "Mexico" OR "Micronesia Federation" OR "Moldova" OR "Mongolia" OR "Montenegro" OR "Morocco" OR "Mozambique" OR "Myanmar" OR "Namibia" OR

"Nauru" OR "Nepal" OR "Nicaragua" OR "Niger" OR "Nigeria" OR "North Macedonia" OR "Pakistan" OR "Palau" OR "Papua New Guinea" OR "Paraguay" OR "Peru" OR "Philippines" OR "Russian Federation" OR "Rwanda" OR "Samoa" OR "São Tomé and Príncipe" OR "Senegal" OR "Serbia" OR "Sierra Leone" OR "Solomon Islands" OR "Somalia" OR "South Africa" OR "South Sudan" OR "Sri Lanka" OR "St. Lucia" OR "St. Vincent and the Grenadines" OR "Sudan" OR "Suriname" OR "Syrian Arab Republic" OR "Tajikistan" OR "Tanzania" OR "Thailand" OR "Timor-Leste" OR "Togo" OR "Tonga" OR "Tunisia" OR "Turkey" OR "Turkmenistan" OR "Tuvalu" OR "Uganda" OR "Ukraine" OR "Uzbekistan" OR "Vanuatu" OR "Vietnam" OR "West Bank and Gaza" OR "Yemen" OR "Zambia" OR "Zimbabwe")

3.2.4 Search Results

The databases were initially explored without any filters. After the initial hits were examined, filters were subsequently applied to streamline the outputs to the objectives of this study. The cumulative outcome of these searches, amounting to 1444 results, were then exported to RefWorks, as indicated in Table 3.1.

Table 3.1: Summary of databases that were used in the review.

Date	Database	Hits_1	Limiters	Hits_2	Comment
19/08/2023	CINAHL complete	85	Peer Reviewed, English, Human, Pregnancy, Female Exclude MEDLINE	9	Boolean Search mode Apply related words. Apply equivalent subjects
19/08/2023	MEDLINE	153	Peer Reviewed English Human Female	123	Boolean Search mode Apply related words. Apply equivalent subjects
19/08/2023	EMBASE	285	1974 to 2023 August 18 English, Human	122	Boolean Operators
19/08/2023	APA PsycINFO	56	Peer Reviewed English	42	Boolean Operators
19/08/2023	ASE	141	Peer Reviewed English	128	Boolean Search mode Apply related words. Apply equivalent subjects
19/08/2023	MICD	50	1971 to August 08, 2023 English, Human	50	Boolean Operators
19/08/2023	SCOPUS	358	Human, Female, maternal stress,	204	Boolean Operators

			mental health, postnatal depression, anxiety, perinatal period, pre-eclampsia, puerperal psychosis, antenatal depression, hypertension, pregnancy induced		
19/08/2023	PUBMED	876	English, Human	693	Boolean Search mode
19/08/2023	CCRCT	38	English, Human	38	Boolean Operators
19/08/2023	CDSR	35	English, Human	35	Boolean Operators
TOTAL		**2077**		**1444**	

CINAHL: Cumulated Index to Nursing and Allied Health Literature, MEDLINE: Medical Literature Analysis and Retrieval System Online, APA: American Psychological Association, ASE: Academic Search Elite, MICD: Maternal and Infant Care Database, CCRCT: Cochrane Central Register of Controlled Trials, CDSR: Cochrane Database of Systematic Reviews.

Duplicates within our reference collection, featuring identical titles and authors and published in the same year, and originating from a specific journal, were subjected to a de-duplication process. This process considered the DOI (Digital Object Identifier), ISBN (International Standard Book Number), and ISSN (International Standard Serial Number) to ensure comprehensive identification and elimination of redundant entries. After the completion of the de-duplication process, a total of 17 redundant articles were successfully removed. As a result, the remaining articles slated for screening amounted to 1427.

3.2.5 Screening of Results

The search results underwent through title and abstract examination to determine article eligibility for this review. Titles in the initial search results were analysed to identify potentially relevant studies based on research questions and PEO criteria. At the end of this phase, 44 studies were identified for full text retrieval. However, full-text access could not be obtained for 9 of these studies, resulting in 35 studies available for comprehensive full-text review. These studies underwent a rigorous assessment of eligibility for this review, conducted in accordance with the established inclusion criteria.

The inclusion criteria encompassed studies that explored the impact of hypertensive disorders of pregnancy (HDP) on the development of perinatal mental health (PMH) within low- and middle-income countries (LMICs). Several types of study designs were

considered suitable for inclusion, including cross-sectional studies, cohort studies, case-control studies, and randomized controlled trials. On the other hand, certain types of studies were excluded from this review, such as non-English studies, investigations involving animals, review articles, opinion pieces, case reports, and incomplete studies that lacked accessible or necessary data. Furthermore, studies that did not feature primary data or were conducted outside the realm of LMICs were also excluded.

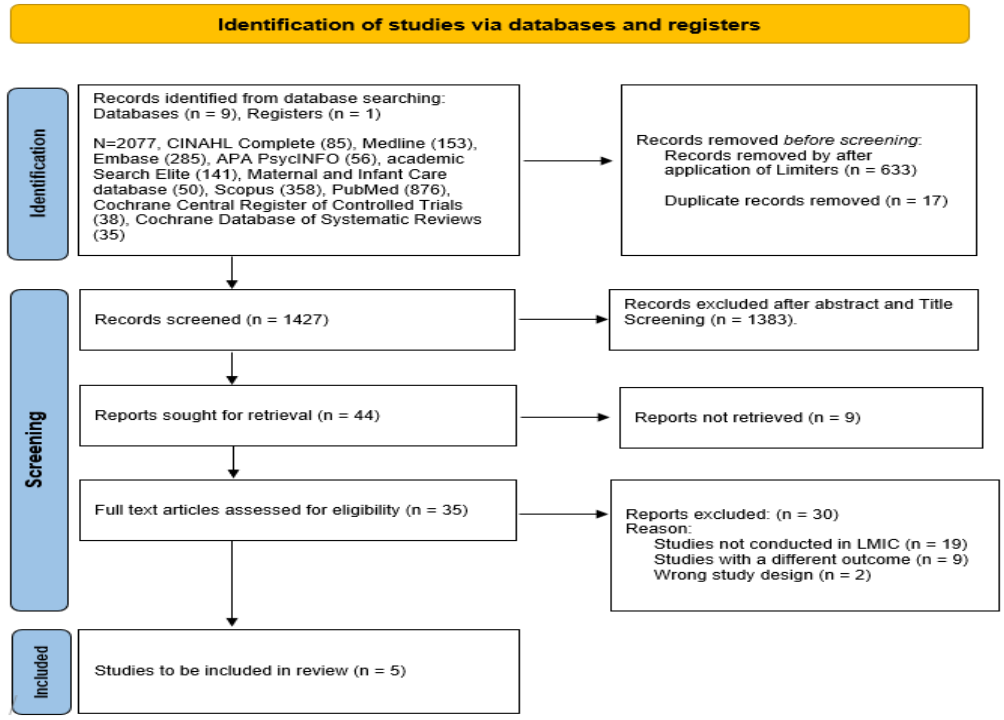

Figure 3.1: PRISMA flow chart showing how studies were selected for the review.

3.2.6 Critical Appraisal

The critical appraisal of selected studies was conducted using the rigorous frameworks provided by The Joanna Briggs Institute (JBI) critical appraisal tools, which were chosen for their comprehensive assessment criteria and established reliability in evaluating research methodologies and outcomes.

JBI is a standing organization located at the University of Adelaide, in Australia. Founded by Professor Alan Pearson in 1996, JBI originated as a research institute at

the Royal Adelaide Hospital in South Australia. The establishment of JBI was made possible through a grant from the Royal Adelaide Hospital Research Foundation. JBI was named after Mrs. Joanna Briggs, who served as the Matron of the Royal Adelaide Hospital in 1855 as a gesture of appreciation. Originally known as the Joanna Briggs Institute for Evidence Based Nursing, its name was later shortened to the Joanna Briggs Institute in 2001 to reflect its expanded focus beyond nursing to include other disciplines. By 2010 JBI became part of the Faculty of Health and Medical Sciences at the University of Adelaide.

JBI is well known for its dedication to improving healthcare practices and outcomes through evidence-based information, software tools, education programs and training initiatives. With operations spanning over 90 countries worldwide, JBI is highly respected for its expertise, in evidence-based healthcare practices. At the core of its mission is conducting reviews that involve evaluations of existing literature to assess the effectiveness of healthcare interventions, conditions, or topics.

JBI has crafted methods and protocols, for assessing and amalgamating types of evidence promoting well informed clinical decision making grounded in evidence. Notably, JBIs approach to evidence-based healthcare underscores the importance of considering feasibility, appropriateness, meaningfulness, and effectiveness (FAME) in healthcare practices.

With its focus on improving healthcare practices and results JBI is committed to offering evidence-based information, education, and training. A significant aspect of JBI's work involves conducting reviews that involve examinations of existing literature to determine the efficacy of interventions, conditions, or healthcare issues. To support this effort, JBI has created evaluation tools that assist in evaluating the quality of included studies to ensure the credibility and validity of the evidence presented. This study utilized three such tools: the JBI Critical Appraisal Checklist for Cohort Studies, the JBI Critical Appraisal Checklist for Case-Control Studies, and the JBI Critical Appraisal Checklist for Analytical Cross-Sectional Studies.

The JBI Critical Appraisal Checklist, for Cohort Studies is a tool used to evaluate the quality of research studies within the cohort design framework. This checklist consists of eleven criteria that are crucial for assessing the rigor and validity of cohort studies. Initially the checklist examines whether the two comparison groups were alike and

drawn from the population, ensuring that any differences observed are due to the exposure being studied rather than external factors. It then focuses on how exposures were measured, highlighting the need for consistency and reliability in categorizing individuals into exposed and unexposed groups. The accuracy and consistency of exposure measurement methods are factors evaluated in another section aiming to ensure data collection methods are reliable. The checklist also looks at how confounding factors are identified and addressed emphasizing the importance of minimizing biases that could impact study results.

Furthermore, it checks if participants did not have the outcome at the beginning of the study, which is crucial for establishing relationships, between exposure and outcome. It also assesses how outcomes are measured to ensure they accurately represent the phenomena being studied. The assessment also investigates how well follow up periods were carried out focusing on whether the time frames allowed for capturing outcomes. They examine the strategies used to deal with follow ups, understanding the importance of reducing bias due to dropouts and ensuring data accuracy throughout the study. The checklist also reviews the suitability of statistical analysis methods stressing the importance of using techniques that properly address variables that could influence results and potential biases typical in cohort studies.

Case-control studies are a type of observational research that compares individuals with a particular outcome (cases) to those without the outcome (controls), retrospectively assessing exposures or risk factors. The JBI Critical Appraisal Checklist for case - control studies comprise eleven questions aimed at evaluating various aspects of study design, conduct, and analysis. These questions cover key domains such as comparability of groups, exposure measurement, identification and handling of confounding factors, and appropriateness of statistical analysis.

The JBI Critical Appraisal Checklist for cross-sectional studies is a comprehensive tool designed to evaluate the quality of research within the framework of analytical cross-sectional studies. Comprising eleven criteria, this checklist assesses various aspects of study design, conduct, and analysis to ensure methodological rigor and validity.

By using these checklists, researchers can methodically assess how well studies were conducted, improving the credibility and dependability of evidence compiled in reviews and guiding evidence-based healthcare approaches.

After conducting a comprehensive review of the 35 full-text articles in question, we made the decision to include 5 specific studies for the purpose of critical appraisal. The exclusion of certain articles stemmed primarily from the fact that they were not conducted within LMICs, and, in part, since some of the reported outcomes did not align with the specific variables we were aiming to investigate. Additionally, two studies were omitted due to concerns related to the suitability of their research designs. To ensure the integrity and reliability of our research, we conducted a rigorous evaluation of the selected articles' quality and relevance.

We conducted a rigorous quality assessment tailored to the specific study designs under consideration. Each item within the checklist was assigned a numerical score based on the assessment criteria: "Yes" received 1 point, "No" was assigned 0 points, and "Unclear" or "Not applicable" also received 0 points. The total score for each type of study varied according to the number of questions within the respective appraisal questionnaire. For cohort studies, the total score was 11; for case-control studies, it was 10; and for cross-sectional studies, it amounted to 8. Importantly, all studies considered in the assessment had a minimum score of 0. The overall grade used to assess the quality of the selected studies and quality rating for each study have been presented in Tables 3.2 and 3.3, respectively.

Table 3.2: Scale used in critical appraisal of selected articles.

Grade	**Cohort**	**Case-Control**	**Cross-Sectional**
Poor	0 - 4	0 - 3	0 – 3
Moderate	5 - 8	4 - 7	4 – 6
Good	9 - 11	8 - 10	7 – 8

A cohort study done by Abedian and colleagues, in 2015 looked at a group of participants. The study met important checklist requirements, receiving an overall rating of "Good." The study successfully dealt with comparing groups and ensuring the accuracy of the data collected. However, areas needing improvement were found in

recognizing and handling factors that could impact the study's accuracy suggesting biases. With these drawbacks the study's strong methods outweighed its weaknesses justifying its consideration for analysis.

When we used the JBI Critical Appraisal Checklist on a case – control study conducted by Chen et al. in 2019, we observed that the study showed quality meeting 8 of the 11 criteria evaluated. The groups were matched well. The way exposure was measured was consistent and dependable, for both cases and controls. The study also correctly identified factors that could cause confusion although it did not clearly mention strategies to address these factors. Moreover, the time of interest, for exposure was considered adequate and suitable statistical analysis methods were utilized.

In evaluating the studies by Mbarak et al. (2019), Sarosh et al. (2022) and Strapasson et al. (2018) using the JBI critical appraisal checklist for cross sectional studies, all three showed quality meeting seven of the eleven criteria considered. These studies clearly outlined inclusion criteria for their samples, provided descriptions of study participants and settings, and used methods to measure exposure. While confounding factors were acknowledged in each study, consistent strategies to address them were not always specified. The outcomes were consistently measured in a reliable manner across all three studies with appropriate statistical analysis techniques being generally applied.

Upon careful evaluation, 4 out of 5 studies received a good-quality rating, indicating strong methodological rigor and adherence to research standards. The other study received moderate-quality rating. The limitations observed in these studies predominantly revolved around their approach to addressing confounding factors and statistical tools used.

Specifically, in 4 out of the 5 studies, there was a notable absence of documented strategies for mitigating the influence of potential confounders. In 1 study, there was uncertainty regarding whether participants were free of the outcome variable at the commencement of the study. Although data collection commenced at the inception of the research, there was no explicit mention of the participants' baseline status in relation to the outcome variable. From a statistical perspective, it is important to note that in all 4 studies, the researchers did not employ effect size or odds ratio as tools to draw conclusions about the relationship between the two variables. Following a

comprehensive quality assessment, the decision was made to include all five studies in the subsequent data extraction phase of the review process.

Table 3.3: Critical appraisal of selected studies

Authors	Abedian et al.	Chen et al.	Mbarak et al.	Sarosh et al.	Strapasson et al.
Check List 1	1	1	1	1	1
Check List 2	1	1	1	1	1
Check List 3	1	1	1	1	1
Check List 4	1	1	1	1	1
Check List 5	1	1	1	0	1
Check List 6	0	0	0	0	0
Check List 7	1	0	1	1	1
Check List 8	1	1	1	1	0
Check List 9	1	1	0	0	0
Check List 10	0	1	0	0	0
Check List 11	0	0	0	1	1
Total	**8**	**8**	**7**	**7**	**7**
Rating	Moderate	Good	Good	Good	Good
Decision	Include	Include	Include	Include	Include

3.2.7 Data extraction

Five studies from the previous stage were identified for data extraction under the following key categories: population characteristics, independent variable, dependent variable, statistical techniques, and results (see Table 3.4 – 3.6). Data from these five studies was manually extracted in the tables below.

Table 3.4: Population characteristics of selected studies

Population Characteristics						
Author	**Study Location**	**Study Design**	**Inclusion Criteria**	**Exclusion Criteria**	**Sampling technique**	**Sample Size**
Abedian et al., 2015	Iran	Cohort study	Women of at least 18 years of age (mean: 27 ± 6 years), gestational age ≥36 weeks (mean: 37.9 ± 1 weeks), singleton pregnancy, and	History of medical conditions except preeclampsia, history of mental health hospitalization and history of visit a psychiatrist, taking psychiatric drugs,	Convenience sampling	122

			diagnosed preeclampsia (at least hypertension 140/90 mmHg and proteinuria ≥30 mg/dl) in the recent, alive, and normal neonate's week based on ACOG classification.	infertility, history of hospitalization during pregnancy, prenatal death, hospitalization of neonate in NICU for more than 24 h, stressful event during the study, and unhealthy birth.		
Chen et al., 2019	China	Case – Control study	Diagnosed with preeclampsia (PE) based on ACOG guidelines in 2012 or part of control group, Age between 20 to 40 years old, Gestational age ≥ 28 weeks, Vaginal delivery, or caesarean section with neonatal survival	Obstetric complications other than PE, Previous history of PPD, anxiety, or family history of mental disorders, Stillborn foetus, or lethal induction of labour	Purposive sampling	180 (90 PE, 90 non-PE)
Sarosh et al., 2022	Pakistan	Cross-sectional study	Women who suffered from hypertensive disorders of varying degrees of severity in the ante partum, intra partum and postpartum period (Group A). Women who were not diagnosed with hypertensive disorders were included in the control group (Group B). These women delivered after 28 weeks of gestation by caesarean section or vaginal delivery and the	Women with a history or family history of postpartum depression ,obstetric complications other than hypertensive disorders having a depressive or psychiatric illness, women having a still born baby or perinatal death.	Purposive sampling	220 (110 hypertensive disorder subjects, 110 normal pregnant controls)

			baby was alive at the time of study.			
Strapasson et al., 2018	Brazil	Cross-sectional study	Eligible participants were women with or without HDP who had recently delivered (vaginal or caesarean delivery), and their newborns. Women with HDP diagnosed after 20 weeks of pregnancy were subdivided by disease severity into those with gestational hypertension; pre-eclampsia; pre-eclampsia superimposed on chronic hypertension; eclampsia; or HELLP (haemolysis, elevated liver enzymes, and low platelet count). Newborns were admitted to either the rooming- in facility or the NIC	Maternal age younger than 18 years; foetal malformation; foetal death; and current or previous psychiatric disease.	Convenience sampling	160 women (40 with pre-eclampsia and 120 normotensive)
Mbarak et al., 2019	Tanzania	Cross-sectional study	Postpartum women diagnosed with pre-eclampsia or eclampsia during pregnancy. Women who delivered and attended the postnatal clinic (PNC) at Muhimbili National Hospital (MNH) for follow-up.	Having obstetric complications other than pre-eclampsia or eclampsia. Having a previous history of postpartum depression or anxiety, or a family history of depression or other mental disorders. Having a stillborn foetus or undergoing	Convenience sampling	386

				lethal induction of labour.		

Table 3.5: Exposure and Outcome Variables with Measurements.

Author	Exposed Variable (EV)	Measurement (EV)	Outcome Variable (OV)	Measurement (OV)
Abedian et al., 2015	Preeclampsia	Diagnostic criteria based on American College of Obstetricians and Gynaecologists classification	Depression and anxiety	Beck-II Depression Inventory, State-Trait Anxiety questionnaire of Spielberger
Chen et al., 2019	Pre-eclampsia	Clinical guidelines published by ACOG in 2013	Postnatal Depression	Edinburgh Postnatal Depression Scale. Threshold for PPD is 10 or more points.
Sarosh et al., 2022	Hypertensive Disorders of Pregnancy	Not stated	Postpartum Depression	Edinburgh Postnatal Depression Scale. Threshold for PPD is 10 or more points.
Strapasson et al., 2018	Hypertensive Disorders of Pregnancy	Diagnostic criteria established by the International Society for the Study of Hypertension in Pregnancy.	Postpartum Depression	Edinburgh Postnatal Depression Scale. Threshold for PPD is 12 or more points.
Mbarak et al., 2019	Pre-eclampsia & Eclampsia	Mild Pre-eclampsia was defined as new onset of hypertension (systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg) and proteinuria (≥ 0.3 g. protein in 24 h urine specimen or ≥ 1+ using a urinary dipstick) after 20 weeks of gestation in a previously normotensive	Postpartum Depression	Edinburgh Postnatal Depression Scale. Threshold for PPD is 13 or more points.

		woman. Severe Pre-eclampsia was characterized by systolic blood pressure ≥ 160 mmHg, diastolic blood pressure ≥ 110 mmHg at two occasions at least 4 h apart, with one or more complications such as thrombocytopenia , impaired liver function, renal insufficiency, pulmonary oedema, and new onset cerebral or visual disturbance. Eclampsia was defined as the presence of new onset grand-mal seizures in a woman with pre-eclampsia.		

Table 3.6: Statistical Techniques and Results Across Studies

Author	Statistical Technique	Results
Abedian et al., 2015	Chi-square, Fisher's exact test, Mann-Whitney U test, ANOVA	Test of within-subject effect showed a significant difference within the scores of depressions ($F = 3.8$, $P < 0.001$), state anxiety ($F = 1.52$, $P < 0.001$), and trait anxiety ($F = 1.5$, $P < 0.001$) at admission and 6 weeks postpartum. Test of within-subject contrasts showed no significant interaction differences between time and depression ($F = 0.096$, $P = 0.758$), time and state anxiety ($F = 0.452$, $P = 0.503$), and time and trait anxiety ($F = 0.452$, $P = 0.503$) with the severity of preeclampsia. Test of between-subjects effect showed that the severity of preeclampsia was not significantly associated with the state anxiety ($F = 0.03$, $P = 0.847$), trait anxiety ($F = 0.03$, $P = 0.847$), and depression ($F = 0.539$, $P = 0.464$). There was a significant difference between anxiety and depression at admission and 6 weeks after delivery in preeclamptic women. Severity of depression increased and that of anxiety

		decreased from admission to 6 weeks postpartum in preeclamptic women as a function of time after delivery. Severity of preeclampsia was not an independent risk factor of subsequent depression and anxiety.
Chen et al., 2019	Descriptive statistics, Mann-Whitney U test, Chi-square test, Multiple logistic regression.	In the PPD group, 24 women had PE with a much higher incidence rate than in the NO-PPD group, in which 66 women suffered from PE (24/35 vs. 66/145, P=0.014). Thus, PE may be a risk factor for PPD. There was no significant difference between the two groups in demographic characteristics, mode of delivery, and premature birth rate. On the other hand, 26.67% (24/90) of patients with PE screened positive for PPD, which was two times more than the number of normal puerperal screening positive for PPD. Among the 90 patients, 52 patients had severe PE. The incidence of PPD was 28.85% (15/52) in patients with severe PE. The average score of the EPDS (4.42 vs. 7.27, $p < 0.05$) was obviously higher in patients with PE compared with normal women. When patients had severe PE, the average score was 8.65 with a significant difference to normal women. multiple logistic regression to estimate the adjusted odds ratio, with PPD as the dependent variable and the presence of PE, gravidity, parity, previous caesarean section, gestational weeks, neonatal weight, BMI before delivery, and mode of delivery as the independent variables. The result showed that women who had PE had nearly 3-fold increased odds (AOR=2.753, 1.056-7.178 @ 95%CI) of PPD compared to normal women. When "severe PE" was used in the model, it had a more than 4-fold increased (AOR=4.540, 1.194-17.255 @ 95%CI) risk for screening positive for PPD. This finding indicates that the risk of PPD will increase with the aggravation of PE.
Sarosh et al., 2022	Descriptive statistics, Chi-square test	The prevalence of postpartum depression to was found to be 27 % in subjects with hypertensive disorders with varying degrees of severity and 13% in the normotensive control group of women. In the cohort with postpartum depressive illness 30 women had hypertension with a much greater incidence than in the NO-PPD cohort, where 80 women suffered from one or another form of hypertension (30/45 vs. 80/175 p value=0.015). Thus, establishing the fact that severe hypertension may be regarded as a risk factor for postpartum depression. The incidence of new onset PPD increases with the severity of hypertension. The patients suffering from Gestational HTN, Pre-eclampsia, PIH +Superimposed Pre-eclampsia and eclampsia had an ascending rate of incidence of PPD of 20%, 30%, 32% and 35% respectively.
Strapasson et al., 2018	Descriptive statistics, Student t-test, Mann-Whitney U test, Chi-	The final cohort comprised 168 women. Depressive symptoms were found among 15 of the 42 women diagnosed with HDP and 25 of the 126 normotensive women. The participants

	square test, Spearman correlation coefficient.	were mainly white (n=125, 74.4%) and educated to high-school level (n=64, 38.1%). They also tended to be multiparous, especially in the group with depressive symptoms (n=29, 72.5%; P=0.258). Vaginal delivery was most prevented among women with no depressive symptoms (n=80, 62.5%), whereas women with depressive symptoms tended to undergo caesarean delivery (n=22; 55.0%; P=0.066). The highest rates of breastfeeding in previous pregnancies were recorded among women with depressive symptoms (n=25, 62.5%; P=0.104). Investigation of HDP severity was mostly performed in the depressive symptoms group (n=15,37.5%; P=0.028). The presence of premonitory signs for eclampsia also displayed an increased frequency in this group (n=13, 32.5%; P=0.047), as did the implementation of magnesium sulfate therapy (n=15, 37.5%; P=0.018). Adverse events related to HDP (i.e. placental abruption and bleeding) presented at low frequency among all groups; however, these adverse events exhibited statistically non-significant increases among the women with depressive symptoms. The median age was 22.0 years (95% CI 20.8–29.8 years) in the group without depressive symptoms and 32.0 years (95% CI 21.4–39.6 years) in the group with depressive symptoms (P=0.060). The values for parity, spontaneous abortions, duration of breastfeeding in previous pregnancy, and diastolic blood pressure were all higher in the depressive symptoms. group than in the no depressive symptoms group (P=0.017, P=0.029, P=0.048, and P=0.033, respectively). Rates of hospitalization in the NICU were eight (6.3%) in the no depressive symptoms group versus six (15.0) in the depressive symptoms group. The depressive symptoms group recorded increased frequencies for the use of milk formula and pacifiers, whereas the no depressive symptoms group recorded an increased use of feeding bottles. However, none of these differences were statistically significant. The likelihood of postpartum depression was increased by diagnosis of HDP (rS 0.219; P=0.004); parity (rS 0.254; P=0.001); spontaneous abortions (rS 0.164; P=0.033); type of delivery (rS 0.151; P=0.050); number of previous children (rS 0.180; P=0.020); duration of breastfeeding during previous pregnancy (rS 0.179; P=0.021); use of milk formula during hospitalization (rS 0.152; P=0.048); diastolic blood pressure (rS 0.165; P=0.033); pre-monitory signs of eclampsia (rS 0.171; P=0.027); and therapeutic use of magnesium sulfate (rS 0.199; P=0.010).
Mbarak et al., 2019	Descriptive statistics, Chi-square test, Crude odds ratio, Multivariate logistic regression.	Seventy-nine out of 386 participants had an EPDS score of 13 and above. This category was considered as having PPD giving a prevalence of 20.5%. The mean score on the EPDS was 7.82 ± 5.09, with scores ranging from 0 to 25. The magnitude of PPD was higher in eclampsia, and severe pre-eclampsia compared to mild pre-eclampsia ($p < 0.001$). Young (<20, OR 7.55(2.71-21.04), AOR(10.19(1.99-52.02), P=0.05)), (2-34, OR

		2.71(1.24-5.94), AOR(5.7(1.93-17.06), P=0.002))), single women (OR 8.34(4.63-15.04), AOR(3.18(1.02-9.95), P=0.047)), lower education level (OR 2.59(1.39-4.83), AOR(3.83(1.45-10.19), P=0.007), those who had perinatal death (OR 2.96(1.76-4.99), AOR(5.14(2.53-10.94, P<0.01), were more likely to have PPD. Moreover, those who lacked family support (OR 18.9(9.30-38.52), AOR(7.06(1.25-39.99, P=0.027), and who reported having experienced stressful event (OR 16.4(4.45-60.34), AOR(15.14(3.28-96.19, P=0.004) during pregnancy had higher chances of having PPD as compared to those who had family support and did not experience any stressful event.

3.3 Results

In this section of our review, a comprehensive amalgamation of multiple research endeavours exploring the relationship between PPD and HDP was conducted using the primary categories extracted from the data table.

3.3.1 Study details.

The studies reviewed were authored by Abedian et al (2015), Chen et al (2019), Sarosh et al (2022), Strapasson et al (2018), and Mbarak et al (2019). Each study provides valuable insights into the relationship between women with HDP and PPD. The study by Abedian and his team further looked in anxiety in postpartum women.

3.3.2 Population characteristics

Abedian et al (2015) conducted their study in Iran, employing a cohort design with specific inclusion criteria including women aged at least 18 years, gestational age of ≥ 36 weeks, and diagnosed with preeclampsia. Exclusion criteria covered various medical conditions and mental health history. They conducted their research in a hospital setting from June 2012 to November 2012 and again from June 2013 to October 2013. Convenience sampling was used, resulting in a sample size of 122 participants.

Chen et al (2019) carried out their retrospective study in China. They included individuals diagnosed with preeclampsia based on American College of Obstetricians and Gynaecologists (ACOG) guidelines, with age between 20 to 40 years and

gestational age off at least 28 weeks. Obstetric complications other than preeclampsia and certain medical histories were adopted as the exclusion criteria. The study spanned from January 1, 2017, to August 30, 2018, in a hospital setting, with a recruitment procedure which combines two methods. Although controls were assigned randomly, the method employed for recruiting cases was not explicitly specified. It is our assessment that the researchers likely employed either convenience or purposive sampling methods for case recruitment. Their study included a sample size of 180 participants, evenly divided between those with preeclampsia (90 individuals) and those without the condition (90 individuals).

Sarosh et al (2022) conducted a cross-sectional study in Pakistan. They included women with varying degrees of hypertensive disorders in pregnancy and a control group of women without such disorders. Participants delivered after 28 weeks of gestation, either by caesarean section or vaginal delivery, and had living infants at the time of the study. Exclusion criteria involved psychiatric illnesses and other specific conditions. The study occurred between June 2020 and December 2021, and participants were followed in a postpartum clinic around six weeks after delivery. The recruitment procedure was unclear, with a combined sample of 220 participants (110 with hypertensive disorders and 110 normal pregnant controls).

Strapasson et al (2018) conducted a prospective descriptive cross-sectional study in Brazil. They included women who had recently delivered, either with or without hypertensive disorders of pregnancy (HDP). Women with HDP were further categorized based on disease severity. Exclusion criteria included maternal age younger than 18 years, foetal malformation, foetal death, and psychiatric disease. The study took place from January 15, 2015, to January 15, 2017, in a hospital setting. The recruitment procedure used convenience sampling, with samples matched by pregnancy duration. The study involved 160 women (40 with preeclampsia and 120 without).

Mbarak et al (2019) conducted a cross-sectional study in Tanzania, but detailed inclusion and exclusion criteria were not provided. The study occurred from July 2016 to January 2017 in a hospital setting. Convenience sampling was used, resulting in a sample of 386 participants.

3.3.3 Independent Variable

The primary independent variable in these studies varied and included the severity of preeclampsia and other related classifications. These variables were typically determined based on clinical guidelines such as those published by ACOG or the ISSHP.

3.3.4 Dependent Variable

The primary dependent variable across these studies was the presence of depressive symptoms or the likelihood of postpartum depression. Different tools were employed to measure this variable, including the Beck-II Depression Inventory and the Edinburgh Postnatal Depression Scale (EPDS). Also, in the research conducted by Abedian and colleagues, they employed the Spielberger State-Trait Anxiety questionnaire as a screening tool to assess anxiety levels in pregnant and postpartum women.

3.3.5 Statistical Techniques

Various statistical techniques were employed in these studies, including Chi-square, F–test, Mann-Whitney U test, descriptive statistics, logistic regression, and Spearman correlation coefficient. These techniques were used to analyse the data and assess associations and relationships.

3.3.6 Key findings

In the study conducted by Abedian et al (2015), a repeated measures analysis of variance (ANOVA) was employed to investigate the changes in depression, state anxiety, and trait anxiety scores between admission and 6 weeks postpartum among pregnant and postpartum women.

Notably, preeclampsia appeared to be a potential risk factor for postpartum depression, with a higher incidence rate observed among women with preeclampsia compared to controls. The F-tests revealed significant difference within the scores of depressions ($F = 3.8$, $p < 0.001$), state anxiety ($F = 1.52$, $p < 0.001$), and trait anxiety ($F = 1.5$, $p < 0.001$) when comparing admission and 6 weeks postpartum. This

indicates that there were changes in the levels of depression and anxiety over time, with depression increasing and anxiety decreasing from admission to 6 weeks postpartum.

However, the severity of preeclampsia did not show a significant association with depression, state anxiety, or trait anxiety. The analysis showed no significant interaction differences between time and depression ($F = 0.096$, $p = 0.758$), time and state anxiety ($F = 0.452$, $p = 0.503$), and time and trait anxiety ($F = 0.452$, $p = 0.503$) with respect to the severity of preeclampsia. Thus, changes in depression and anxiety over time were not influenced by the severity of preeclampsia.

Furthermore, the analysis of the between-subjects effect demonstrated that the severity of preeclampsia was not significantly associated with state anxiety ($F = 0.03$, $p = 0.847$), trait anxiety ($F = 0.03$, $p = 0.847$), and depression ($F = 0.539$, $p = 0.464$), hence there was no significant relationship between the severity of preeclampsia and the levels of anxiety and depression.

Chen et al (2019) did not find significant associations between the severity of preeclampsia and state anxiety, trait anxiety, or depression. Among the women in the PPD group, 24 of them had preeclampsia (PE), which represented a significantly higher incidence rate compared to the NO-PPD group. Specifically, 24 out of 35 women in the PPD group had PE, whereas 66 out of 145 women in the NO-PPD group had PE ($p = 0.014$). This suggests that there is a significant association between PE and PPD, with PE being a potential risk factor for PPD. There were no significant differences observed between the two groups in terms of demographic characteristics and mode of delivery. This implies that factors such as age, education, and delivery method did not play a significant role in the occurrence of PPD in this study population.

A noteworthy finding was that 26.67% of patients with PE screened positive for PPD, which was twice the number of normal postpartum women who screened positive for PPD. Among the patients with PE, 52 of them had severe PE, and the incidence of PPD was even higher in this subgroup, with 28.85% of patients experiencing PPD. The average score on the EPDS was significantly higher in patients with PE compared to normal women (4.42 vs. 7.27, $p < 0.05$). Furthermore, when patients had severe PE, the average EPDS score increased to 8.65, signifying a substantial difference from normal women. Multiple logistic regression analysis was employed to estimate the

adjusted odds ratios (AOR) for PPD. The presence of PE was identified as a significant independent variable associated with PPD. Women who had PE had nearly 3-fold increased odds of experiencing PPD compared to normal women (AOR = 2.753, 95% CI: 1.056 - 7.178). When "severe PE" was included in the model, the risk for screening positive for PPD increased even further, with more than a 4-fold increase (AOR = 4.540, 95% CI: 1.194 - 17.255). This finding underscores that as the severity of PE worsens, the risk of PPD also increases significantly.

In the research conducted by Sarosh et al (2022), a chi-square test for independence was employed to examine the relationship between the incidence of PPD and hypertension status among the study participants. Their study identified that women with preeclampsia had a significantly higher incidence rate of postpartum depression compared to those without preeclampsia. Importantly, the risk of postpartum depression was found to increase with the severity of preeclampsia, with severe cases of preeclampsia carrying a higher risk.

The prevalence of PPD among women with hypertensive disorders during pregnancy, regardless of the severity, was 27%, while in the normotensive control group, it was notably lower at 13%. This significant difference highlights the increased risk of PPD among women with hypertensive disorders during pregnancy.

Within the cohort of women experiencing postpartum depressive illness, 30 women had hypertension. This incidence of hypertension was substantially higher in the PPD cohort compared to the non-PPD cohort, where 80 women suffered from various forms of hypertension. The statistical analysis indicated a significant difference between the two groups (30/45 vs. 80/175, p value=0.015), suggesting that hypertension, particularly severe hypertension, may be considered a risk factor for developing PPD.

Furthermore, the study also found that the incidence of new onset PPD increased with the severity of hypertension. Specifically, the patients who experienced different forms of hypertensive disorders during pregnancy, including Gestational Hypertension, Pre-eclampsia, Pregnancy-Induced Hypertension (PIH) with Superimposed Pre-eclampsia, and eclampsia, exhibited ascending rates of PPD incidence: 20%, 30%, 32%, and 35%, respectively. This trend suggests that the severity of hypertension is associated with an elevated risk of developing PPD.

Regarding Strapasson et al.'s study (2018), a Spearman's correlation analysis was conducted to examine the relationship between various factors and the likelihood of experiencing PPD. Among the women diagnosed with hypertensive disorders of pregnancy, 15 out of 42 (35.7%) exhibited depressive symptoms, while among the normotensive women, 25 out of 126 (19.8%) experienced depressive symptoms. This indicates a higher prevalence of depressive symptoms in the HDP group.

An observation was made that a higher percentage of women with depressive symptoms had previously breastfed during pregnancies, although this difference did not reach statistical significance (n = 22, 62.5%; p = 0.104). The assessment of HDP severity was more commonly performed in the group of women experiencing depressive symptoms (n = 15, 37.5%; p = 0.028), suggesting that the presence of depressive symptoms may prompt healthcare providers to investigate HDP severity more rigorously. The presence of premonitory signs for eclampsia (n = 13, 32.5%; p = 0.047) and the use of magnesium sulfate therapy (n = 15, 37.5%; p = 0.018) were more frequent in the group with depressive symptoms, suggesting a possible association between these factors and depressive symptoms.

Several other factors demonstrated significant differences between the group with depressive symptoms and the group without depressive symptoms. In the group without depressive symptoms, the median age was 22.0 years (95% CI 20.8–29.8 years), while in the group with depressive symptoms, it was 32.0 years (95% CI 21.4–39.6 years), indicating a trend towards higher age in the depressive symptoms group (p = 0.060). Additionally, the values for parity (95% CI, 2.5(0.5–4.6) births; p = 0.017), duration of breastfeeding in the previous pregnancy (95% CI, 75.0(207.38–561.27); p = 0.048), and diastolic blood pressure (95% CI, 80.6±2.8; p = 0.033), were all significantly higher in the depressive symptoms group compared to the group without depressive symptoms.

Rates of hospitalization in the Neonatal Intensive Care Unit (NICU) were higher in the depressive symptoms group, with 15.0% compared to 6.3% in the no depressive symptoms group, indicating that women with depressive symptoms may have a higher likelihood of NICU admission for their newborns.

The study found positive correlations between the likelihood of experiencing postpartum depression and several factors using Spearman’s rank correlation

coefficient (ρ). These factors included a diagnosis of HDP (ρ = 0.219, p = 0.004), parity (ρ = 0.254, p = 0.001), spontaneous abortions (ρ = 0.164, p = 0.033), type of delivery (ρ = 0.151, p = 0.050), number of previous children (ρ = 0.180, p = 0.020), duration of breastfeeding during previous pregnancy (ρ = 0.179, p = 0.021), use of milk formula during hospitalization (ρ = 0.152, p = 0.048), diastolic blood pressure (ρ = 0.165, p = 0.033), premonitory signs of eclampsia (ρ = 0.171, p = 0.027), and therapeutic use of magnesium sulfate (ρ = 0.199, p = 0.010).

In the investigation led by Mbarak et al. (2019), involving 386 participants, the prevalence of postpartum depression was found to be 20.5%. This conclusion was drawn from the application of descriptive statistics, specifically by counting the number of participants with an Edinburgh Postnatal Depression Scale (EPDS) score of 13 or higher, which was considered indicative of PPD.

The study also employed logistic regression analysis to identify significant predictors of PPD. Younger women, particularly those under 20, were more likely to experience PPD, with an odds ratio (OR) of 7.55 (95% CI: 2.71-21.04). After adjusting for other factors, this risk remained significant (Adjusted Odds Ratio, AOR 10.19, 95% CI: 1.99-52.02, p = 0.05). Similarly, women aged 20-34 had an increased risk of PPD, with an OR of 2.71 (95% CI: 1.24-5.94), which persisted in the adjusted analysis (AOR 5.7, 95% CI: 1.93-17.06, p = 0.002).

Single women were more likely to experience PPD, with an OR of 8.34 (95% CI: 4.63-15.04). After adjusting for other factors, this risk remained significant (AOR 3.18, 95% CI: 1.02-9.95, p = 0.047). Furthermore, participants with lower levels of education were at a higher risk of PPD, with an OR of 2.59 (95% CI: 1.39-4.83). This risk persisted in the adjusted analysis (AOR 3.83, 95% CI: 1.45-10.19, p = 0.007).

Additionally, logistic regression analysis revealed that participants who had experienced perinatal death were more likely to have PPD, with an OR of 2.96 (95% CI: 1.76-4.99). After adjusting for other factors, this risk remained significant (AOR 5.14, 95% CI: 2.53-10.94, p < 0.01). Lack of family support was strongly associated with an increased risk of PPD, with an OR of 18.9 (95% CI: 9.30-38.52), which remained significant after adjusting for other variables (AOR 7.06, 95% CI: 1.25-39.99, p = 0.027).

Moreover, logistic regression analysis showed that women who reported experiencing stressful events during pregnancy were more likely to have PPD, with an OR of 16.4 (95% CI: 4.45-60.34). After adjusting for other factors, this risk remained significant (AOR 15.14, 95% CI: 3.28-96.19, p = 0.004).

3.4 Discussion

During our search and selection process, a substantial number of studies were excluded, primarily because they were not conducted within LMICs. This exclusion is noteworthy, as recent data indicates that approximately 20% of mothers in developing nations experience postnatal depression (W.H.O., 2019). Regrettably, this prevalence did not find its reflection in the number of articles available for our review. This incongruity raises two plausible scenarios. Firstly, it may signify a gap in the research landscape, suggesting that studies exploring postnatal depression or other psychiatric disorders during pregnancy within the context of hypertensive disorders of pregnancy remain underrepresented in LMICs. Alternatively, this disparity could be indicative of an alarming possibility: that a significant number of women grappling with perinatal mental health conditions may go undiagnosed, placing them at risk of the adverse consequences associated with such conditions, including the heightened risk of suicide. Furthermore, it is well-established that infants, particularly very young ones, are profoundly influenced by their environment and the quality of maternal care they receive. Therefore, maternal mental disorders can significantly impact the well-being of infants. Prolonged or severe mental illness has been shown to hinder mother-infant attachment, breastfeeding, and infant care (Saharoy et al., 2023).

It is important to note variations in the cut-off scores used for the Edinburgh Postnatal Depression Scale (EPDS): Chen et al. and Sarosh employed a cut-off of 10, while Strapasson et al. utilized a threshold of 12, and Mbarak et al. employed a threshold of 13 or more points. A validation study by Cox et al. (1987) demonstrated that mothers scoring above a threshold of 12/13 were likely suffering from depressive illness of varying severity and warranted medical attention. Thus, it is conceivable that Chen and Sarosh's study may have included participants who did not have postpartum depression.

This goes without mentioning that Chen et al. further elucidated that experts had modified the EPDS scale to align with the linguistic patterns of the mainland Chinese

population, achieving a content validity ratio of 0.933 and a Cronbach's α coefficient of 0.76. The proposed threshold for postpartum depression in the Chinese edition is 9.5, yet Chen and colleagues opted for 10. Notably, Sarosh and colleagues did not provide justification for the choice of the 10-point cut-off. In the case of Strapasson et al, the translation of data into Swahili, with subsequent back-translation to English for consistency, was conducted. The final tool underwent pre-testing, yielding a Cronbach's α of 0.89, indicating adequate internal consistency.

The analytical approaches employed in data analysis encompassed various statistical techniques, spanning descriptive and analytical statistics. This diversity in statistical methods hampered the aggregation of the studies, as there was no common measure to synthesize their findings. In terms of incidence, several studies revealed intriguing insights. Chen et al. observed that women with preeclampsia in the postpartum depression group had a significantly higher incidence rate compared to the non-PPD group. Specifically, 24 out of 35 women in the PPD group suffered from PE, while 66 out of 145 women in the non-PPD group had PE. This difference was statistically significant (p=0.014). Sarosh et al., in a separate study, also found a noteworthy trend. Among women with postpartum depressive illness, 30 had hypertension, representing a considerably greater incidence than in the non-PPD cohort. In the non-PPD group, 80 women experienced one form or another of hypertension. This difference was statistically significant (p=0.015). While Chen's team pointed to PE as a potential risk factor for PPD, Sarosh's team illuminated the significance of severe hypertension as a risk factor for postpartum depression. Additionally, Sarosh's study revealed that as the severity of hypertensive disorders of pregnancy increased, there was a corresponding escalation in the rate of PPD incidence.

Examining the prevalence of PPD among women with hypertensive disorders, Chen and colleagues found a prevalence rate of 26.67% in PE patients. In contrast, Mbarak and colleagues estimated a slightly lower prevalence rate of 20.5%. Sarosh and colleagues identified a prevalence of postpartum depression in subjects with varying degrees of hypertensive disorders, reporting a rate of 27%, while the normotensive control group exhibited a prevalence rate of 13%. Strapasson's study noted a prevalence rate of 23.8%. These prevalence rates underscore the significant impact of hypertensive disorders on the occurrence of PPD among affected women.

When considering correlations, it is essential to note that Strapasson's team employed the Spearman correlation coefficient statistic. Their analysis revealed several significant correlations. The probability of postpartum depression correlated with a diagnosis of HDP (ρ=0.219; p=0.004), premonitory signs of eclampsia (ρ=0.171; p=0.027), magnesium sulfate therapy (ρ=0.199; p=0.010), diastolic blood pressure (ρ=0.165; p=0.033), and the use of milk formula during hospitalization (ρ =0.152; p=0.048). These findings suggest that women with HDP were more likely to exhibit depressive symptoms compared to their normotensive counterparts. Early detection using the EPDS tool emerged as a potential strategy to manage postpartum depression among women diagnosed with HDP. The HDPs considered in their study encompassed gestational hypertension, pre-eclampsia, pre-eclampsia superimposed on chronic hypertension, eclampsia, or HELLP syndrome.

Conversely, Mbarak et al. and Chen et al. utilized odds ratios to determine associations. In Chen et al.'s study, multiple logistic regression estimated the adjusted odds ratio, with PPD as the dependent variable and the presence of PE and several other factors as independent variables. Their results revealed that women who had PE had nearly a threefold increased odds of developing PPD compared to normal women. When "severe PE" was used in the model, it yielded a more than fourfold increased risk for screening positive for PPD. Mbarak's team also used adjusted odds ratios and identified that young, single women with lower education levels, those who experienced perinatal death, those lacking family support, and those who reported stressful events during pregnancy had higher chances of developing PPD compared to their counterparts.

Abedian's team, uniquely, employed F-test in their analysis. Their study demonstrated significant differences in depression, state anxiety, and trait anxiety scores between admission and 6 weeks postpartum. However, they found no significant interaction differences between time and depression, time and state anxiety, or time and trait anxiety concerning the severity of preeclampsia. Nevertheless, they identified significant interactive effects of mode of delivery and the severity of preeclampsia with state anxiety and trait anxiety.

Regarding the determination of sample size, Strapasson and team utilized Winpepi version 11.63, while Mbarak and team employed the formula $N = z^2P(1-P)D^2$.

However, the remaining studies did not provide information regarding their methods for determining sample size. Notably, both convenience and random sampling methods were predominantly employed in both case and control groups across the studies. None of the reviewed studies provided insight into how confounding factors were addressed. Furthermore, the study conducted by Abedian and team did not offer reasons for the dropout of eight participants, rendering it challenging to analyse the 6.15% dropout rate and its potential impact on the study. Mbarak et al. excluded four participants due to missing questionnaires, resulting in 386 participants instead of 390. With a dropout rate of 1%, the absence of these participants is statistically inconsequential.

In terms of limitations, generally, in all the studies used in this review, the study's scope was confined to the hospital's patient population, lacking data from other regions, potentially introducing selection bias and may limit the generalizability of its results to other settings. While four out of five studies employed the EPDS as a screening tool for depression, the diagnosis of postpartum depression was not grounded in clinical assessments. This reliance on self-administered questionnaires introduces subjectivity into the findings leading to a potential source of bias, suggesting that some women identified as having postpartum depression based on the EPDS may not actually be experiencing clinical depression. The survey collected information for only the last 7 days, potentially introducing information bias.

It is crucial to emphasize that the authors of the EPDS strongly recommend a thorough clinical evaluation by healthcare professionals to confirm the diagnosis and create a personalized treatment plan after the EPDS screening. However, three of the studies we reviewed did not mention whether the women identified as potentially having PPD were referred for clinical follow-up. Mbarak and his team, as well as Strapasson and his colleagues, took this important step. Unfortunately, these studies did not include the results of these referrals in their reports. Including this information would have helped us understand whether the women flagged for possible PPD received a confirmed diagnosis and perhaps, an appropriate care.

Additionally, none of the studies provided further information concerning the monitoring of blood pressure and the devices used for blood pressure measurements. Evidence suggests that measuring blood pressure in the supine position yields lower

readings compared to the seated position (Privsek et al., 2018; Eser et al., 2007). Therefore, information about the participants' positions during blood pressure measurement would have been valuable for contextualizing the blood pressure readings. The specific devices used for blood pressure measurements were not disclosed in any of the reviewed studies. Manual blood pressure measurement often yields higher readings, especially in hospital-admitted patients, with an increase of up to 15 mmHg compared to automated measurements (Mirdamadi and Etebari, 2017). Conversely, Shahbabu et al. found that aneroid devices exhibited superior accuracy compared to digital devices when compared to the mercury sphygmomanometer, advocating for their use in proper management. However, Myers et al. concluded that conventional manual blood pressure readings can be effectively replaced by readings obtained using a validated automated blood pressure recorder in population surveys. These conflicting findings underscore the absence of consensus regarding the optimal blood pressure measurement tool. Consequently, inclusion of such details in the reviewed studies would have provided valuable insights.

In the study by Strapasson et al., assessment using the EPDS was conducted after the initial 12 hours postpartum, which limits the ability to capture dynamic changes in postpartum depression over time. Moreover, the study did not record the reasons for the choice between caesarean and vaginal delivery, a critical variable that could have influenced postpartum depression outcomes. Additionally, some comparisons in the findings may not have reached statistical significance due to small sample sizes, potentially resulting in type II errors. Furthermore, the study's external validity may have been limited by oversampling different levels of hypertensive disorders of pregnancy.

Turning to the limitations of Abedian et al.'s study, it is important to highlight that their research did not incorporate a control group, which diminishes the ability to make direct comparisons and draw causal inferences. In the case of Sarosh and his team, they did not furnish details regarding the measurements for their independent variable.

Chen's study had its own set of limitations; the study exclusively focused on pregnant women with pre-eclampsia, excluding those with other obstetric complications like gestational diabetes mellitus (GDM) and intrahepatic cholestasis of pregnancy (ICP). This exclusion overlooked the interconnectedness of preeclampsia with conditions like

GDM, which share common risk factors. Additionally, a high percentage of patients in the hospital chose caesarean sections, which could have contributed to the prevalence of PP. The study did not explore other variables like annual household income, maternal education, family support, and other factors that are known risk factors for PPD.

Mbarak et al.'s study was constrained by its cross-sectional design, preventing the establishment of causality. Additionally, the study may have been susceptible to recall bias, especially given the nature of the disease, preeclampsia, or eclampsia, which could affect the accuracy of participants' recollections (Fields et al., 2017).

3.5 Summary of the chapter

The findings from the reviewed studies highlight significant associations between HDP, particularly severe cases such as PE, and PPD, revealing increased incidence rates among women with HDP and a notable correlation between the severity of HDP and the likelihood of experiencing PPD.

It was discovered that the prevalence of postpartum depression was 27% among subjects with varying degrees of hypertensive disorders during pregnancy, while it was 13% in the normotensive control group. Additionally, the incidence of new onset postpartum depression was found to increase with the severity of hypertension during pregnancy.

Correlation analyses revealed significant associations between PPD and factors such as HDP diagnosis, premonitory signs of eclampsia, magnesium sulfate therapy, diastolic blood pressure, and use of milk formula during hospitalization, suggesting heightened risk among women with HDP. Logistic regression analyses highlighted the increased odds of PPD among women with PE and severe PE, underscoring the severity-dependent relationship between HDP and PPD.

Demographic factors such as age, marital status, and education level, along with psychosocial variables including perinatal death, lack of family support, and exposure to stressful events during pregnancy, emerged as significant predictors of PPD. The study also identified several socio-demographic and obstetric factors as potential risk factors for postpartum depression within this population.

These findings collectively indicate that postpartum depression is influenced by a complex interplay of factors, including the presence of HDP, obstetric history, maternal health indicators, and neonatal outcomes. These findings highlight the multifaceted nature of PPD and the importance of considering various risk factors, including demographic, clinical, and psychosocial variables, when assessing and addressing the risk of PPD in postpartum women.

Although one study, concluded that the severity of preeclampsia was not an independent risk factor for subsequent depression and anxiety, that same study also found that that there were changes in depression and anxiety levels over time, with depression increasing and anxiety decreasing from admission to 6 weeks postpartum in preeclamptic women. These findings suggest that while there are alterations in psychological well-being during the postpartum period in women with preeclampsia, these changes may not be directly related to the severity of the condition.

Limitations included sample size determinations, study scopes limited to hospital populations, reliance on self-reported questionnaires for PPD diagnosis, and absence of clinical follow-up for PPD screenings, emphasizing the need for comprehensive clinical evaluations. The analytical methods employed varied across studies, hindering data synthesis, with intriguing insights into incidence rates and prevalence observed. Additionally, challenges in blood pressure measurement standardization, varied EPDS cutoff scores, and inconsistent reporting of independent variables' measurements and selection criteria were noted, highlighting avenues for future research and standardization efforts in the field.

The study underscores the importance of a multidimensional approach to maternal care and mental health support to address the risk of postpartum depression among women with HDP and the need for comprehensive support and early intervention for at-risk populations to mitigate the prevalence and impact of PPD, as well as the importance of monitoring and providing support to women with hypertensive conditions during pregnancy to mitigate the risk of PPD.

Recommendations for future research in this area should focus on addressing the identified limitations of the included studies, such as potential biases, sample sizes, and the reliance on self-reported data. Additionally, research should explore the relationship between various types of hypertensive disorders during pregnancy and

the risk of postpartum depression to provide a more comprehensive understanding of this relationship. Healthcare providers, policymakers, and researchers should work collaboratively to develop and implement strategies for early identification and support for women at risk of postpartum depression, particularly those with hypertensive disorders during pregnancy, to improve maternal mental health outcomes.

Overall, the study found a clear relationship irrespective of the statistical method deployed between preeclampsia and postpartum depression. It suggests that the presence of preeclampsia, particularly severe cases, substantially elevates the risk of experiencing postpartum depression. These findings emphasize the importance of early identification and support for women with preeclampsia, as they may be at a heightened risk for developing PPD.

Chapter 4: Association of hypertensive disorders of pregnancy (HDP) and postpartum depression (PPD): A Meta-Analysis

4.1 Introduction

Hypertensive Disorders of Pregnancy (HDP), which encompass conditions like preeclampsia and gestational hypertension, represent a significant global health challenge, particularly within the realm of maternal health. Simultaneously, postpartum depression emerges as a pervasive mental health issue that affects both women and their infants during the postpartum period and beyond (Abdollahi et al., 2017). Data underscores the far-reaching impact of PPD, including its effects on the mother-infant relationship. Often, infants born to mothers with PPD receive inadequate care and encounter a highly unfavourable attitude, which can profoundly influence their growth and development (Pearlstein et al., 2009). Research suggests that children born to mothers with postpartum depression display significant behavioural changes, altered cognitive development, an increased risk of early-onset depressive illness, and are more likely to face issues like obesity and difficulties in social interactions (Mughal, Azhar & Siddiqui, 2022; Gelaye et al., 2016).

The symptoms and signs of PPD mirror those of non-puerperal depression, with the added context of childbirth. These symptoms encompass a depressed mood, diminished interest in activities, disruptions in sleep patterns, alterations in appetite, feelings of worthlessness, difficulties in concentration, and thoughts of self-harm (N.H.S, 2022). Anxiety is also a common companion to PPD. Furthermore, individuals with PPD may experience psychotic symptoms, including delusions and hallucinations. PPD can result in impaired maternal-infant bonding, difficulties in breastfeeding, negative parenting practices, marital discord, and adverse outcomes concerning the physical and psychological development of the child. The remission of these symptoms can mitigate the risk of behavioural and psychiatric issues in offspring, although a prior episode of PPD elevates the future risk of major depression, bipolar disorder, and recurrent PPD (Mughal, Azhar & Siddiqui, 2022).

Given that HDPs continue to present a substantial public health challenge, particularly in Low- and Middle-Income Countries (LMICs), where the risk of maternal mortality remains elevated compared to high-income nations despite ongoing global and regional initiatives aimed at addressing these concerns (Vestering et al., 2021; Meazaw et al., 2020; WHO, 2019), it becomes imperative to explore potential associations between hypertensive pregnancy disorders and perinatal mental health. This exploration holds critical significance for several reasons. In LMICs, there exists a notable gap in understanding the long-term consequences of post-partum depression on physical, psychological, and social well-being, with PPD often going unrecognized and undertreated (Pearlstein, 2009). This juxtaposition of physical and mental health challenges, particularly among women in LMICs, forms the central focus of this research endeavour.

To avoid replication, the definitions of the variables of interest, that is HDP and PPD, and all information related to them which are relevant for this meta-analysis, will follow what was elaborated in the previous chapter.

4.1.1 Importance

Maternal and child health are essential components of global health initiatives, and addressing HDP and PPD in LMICs is of paramount importance. While research on HDP and PPD in high-income settings has generated substantial knowledge, limited attention has been paid to the specific challenges faced by women in LMICs, where healthcare resources and support systems are often lacking. This meta-analysis aims to bridge this gap by comprehensively evaluating the association between HDP and PPD in LMICs. Understanding this association is crucial for improving the well-being of mothers and infants in resource-constrained settings.

This meta-analysis is timely and essential, as it addresses the unique socio-economic, cultural, and healthcare context of LMICs. The findings of this study will contribute to the development of targeted interventions and strategies for healthcare providers, policymakers, and researchers to reduce the burden of HDP and PPD among women in LMICs. By focusing on this vulnerable population, we aim to inform policies and programs that can improve maternal and neonatal outcomes and enhance the overall health of these communities.

4.1.2 Objective

The primary objective of this meta-analysis is to systematically assess and synthesize the existing body of research on the relationship between HDP and the risk of developing PPD in women residing in LMICs. By pooling data from studies conducted in these settings, we seek to elucidate the nature and strength of this association, providing a more nuanced understanding of the challenges faced by mothers in LMICs.

4.2 Methods

4.2.1 Methodological Approach and Computational Procedures

Effect size measures quantify the extent of the relationship or distinctions between the groups under investigation. Common effect size metrics encompass Cohen's d, odds ratios, risk ratios, correlation coefficients, and various others, contingent on the nature of the data and the research question at hand. Within the realm of a meta-analysis, two pivotal components come into play: effect sizes (or assorted outcome measures) and their standard errors. The meta-analysis synthesizes these components by calculating an overall effect size, achieved through a weighted average of study-specific effect sizes. Larger and more precise studies are accorded greater weight in this computation, with the specific weights determined by the chosen meta-analysis model.

While none of the studies in this review explicitly assessed individual effect sizes, we plan to extract pertinent data from these studies and estimate the effect size for each. Given that most of our studies involve binary outcomes, we have opted to employ the odds ratio (OR) statistic as our designated effect size metric. Additionally, in his work from 1994, Fleiss delved into the statistical characteristics of the OR and determined that, regardless of the specific study designs in question, the OR stands as the preferred choice for computing effect sizes in the meta-analysis of binary data.

The odds ratio serves as a statistical tool to quantify both the strength and direction of the association or relationship between two categorical variables within a study. An odds ratio of 1 indicates that there is no association between the two variables. In other words, the odds of the event occurring in the exposed group are the same as

the odds in the unexposed group. An odds ratio greater than 1 suggests that the event is more likely to occur in the exposed group compared to the unexposed group. This indicates a positive association. An odds ratio less than 1 suggests that the event is less likely to occur in the exposed group compared to the unexposed group. This indicates a negative association.

However, if we refer to section 3.3.4 of the JBI Manual for Evidence Synthesis, the authors there advise that the odds ratio (OR), while quite powerful statistically, might not be the easiest thing to understand all by itself. So, to make things more clear and practical, they suggest that when researchers are summarizing results in a meta-analysis involving binary data, they should provide two types of measurements: one that tells us the actual difference in risk, kind of like the risk difference (RD), and another that gives us a sense of the relative difference in risk, similar to the risk ratio (RR). This way, it is easier for everyone to grasp what the results mean in real-life terms.

In the context of this thesis, we have chosen to employ the fixed effects model as our primary statistical methodology. Our initial assumption is that the true effect size remains consistent across all studies, and any observed variations in effect sizes can be attributed primarily to errors in estimating these effects, as discussed by Borenstein et al. (2010).

To perform the above meta-analysis, we choose to use the metafor package in R because of its robustness and computational efficiency. The author of the R package, Wolfgang Viechtbauer, recommends using the term 'equal-effects model' as it more precisely characterizes the primary assumption of this model, which posits homogeneity or equality among the underlying true effects or outcomes. Alternatively, terms such as 'common-effect(s)' or 'homogeneous-effect(s) model' have been employed in the literature to describe this model and are equally descriptive (Hedges 1982; Rosenthal and Rubin 1982).

Wolfgang Viechtbauer clarifies in the package that the term 'fixed-effects model' presents a dilemma because, when authors use this term, they usually mean the equal-effects model. He also underscores that some authors have attempted to distinguish between the 'fixed-effect model' (without the 's') and the 'fixed-effects model', but this subtle difference in terminology is often overlooked. To eliminate this

confusion and provide clearer information, using the term 'equal-effects model' is recommended.

In this meta-analysis, we made statistical conclusions exclusively within the scope of the studies included in our meta-analysis. This choice was driven by the limited availability of relevant literature from LMIC pertaining to the topic under investigation. In an ideal research scenario, we would have considered the adoption of the random effects model, which allows for broader statistical generalizations beyond the studies included in our analysis, as advocated by Cooper, Hedges & Valentine (1994). This approach would have been particularly pertinent when assessing the societal implications of PPD and evaluating the potential impact of our findings when extrapolated beyond the confines of our current dataset. However, it is important to note that statisticians typically recommend the use of the fixed effects model in situations where the number of studies is limited, typically less than five (Tufanaru et al., 2015; Cooper, Hedges & Valentine, 1994; Murad et al., 2015).

Much as findings from the equal-effects model was limited to the studies used, we believe these findings can be leveraged as a catalyst for raising awareness and encouraging further research initiatives dedicated to exploring the association between HDP and PPD. Through this endeavour, we aim to shed light on a critical area of study and potentially pave the way for advancements in maternal and mental health research.

In relations to computations, data from the included studies was extracted to Microsoft Excel, converted into a comma-separated values (CSV) format, and saved in a designated working directory. In R version 4.3.1 within RStudio, we installed the metafor package and loaded it into our environment. Subsequently, we imported our extracted data in CSV format into the R console, resulting in generating a 3-by-8 data frame matrix. To compute the OR and the corresponding statistics for each study, we utilized the "escalc" function from the metafor package.

The analysis utilized the log odds ratio as the outcome measure, and a model with equal effects was applied to the data. The Q -test for heterogeneity (Cochran, 1954) and the I^2 statistic (Higgins and Thompson, 2002) are reported. In our sensitivity analysis, we took a closer look at the data. We considered other measures like risk ratios and risk differences, and we even tried out two extra models – one with fixed-

effects and another with random-effects. We kept in mind that our study had limitations due to the number of included studies but continued our analysis, nonetheless.

Studentized residuals and Cook's distances were employed to assess whether studies might act as outliers and/or exert influence within the model's context (Viechtbauer and Cheung, 2010). Studies with a studentized residual exceeding the 100 × (1-0.05/(2×k))th percentile of a standard normal distribution are considered potential outliers, employing a Bonferroni correction with a two-sided α = 0.05 for k studies included in the meta-analysis. Influential studies are those with a Cook's distance surpassing the median plus six times the interquartile range of the Cook's distances.

Funnel plots were employed to illustrate biases in meta-analyses. These plots typically have the effect size (e.g., odds ratio or standardized mean difference) on the x-axis and a measure of study precision (e.g., standard error or sample size) on the y-axis. We visually inspected the plots for asymmetry and considered the p-values of the statistical tests in our analysis. Additionally, statistical tests for publication bias were conducted, including Egger's regression test and Begg's rank correlation test. Egger's test assessed the relationship between the effect size estimates and their standard errors, while Begg's test evaluated the correlation between effect sizes and their variances.

Cumulative meta-analysis, a valuable technique that allows for the sequential accumulation of evidence over time as new studies become available was conducted. This method enables the monitoring of how the effect size estimate evolves as more data are included, providing insights into the stability and consistency of the findings. In this meta-analysis, a cumulative approach was employed to assess the trend of effect sizes and evaluate whether the evidence reaches a point of stability. Initially, studies were sorted chronologically based on their publication date or completion date. Effect sizes and their corresponding standard errors was then be computed for each subset of studies as they are added incrementally.

The cumulative meta-analysis was presented graphically as a forest plot, illustrating the effect size estimate and its confidence interval at each cumulative stage. By visually inspecting the plot, trends in the effect size estimates can be observed, allowing for the identification of any patterns or fluctuations over time. Furthermore, statistical tests, such as the cumulative z-test, was performed to assess whether the

effect size stabilizes as more studies are included. A significant cumulative z-value suggests that the effect size estimate has reached stability and is unlikely to change substantially with the addition of further studies.

The analysis was carried out using R (version 4.3.1) (R Core Team, 2020) and the metafor package (version 4.2.0) (Viechtbauer, 2010). The R codes have been included in an appendix H for reference.

4.2.2 Search strategy and study selection.

This meta-analysis builds on the systematic review conducted in the previous chapter, and we have maintained the same search strategy, methods for screening and selecting studies, and the critical appraisal process. However, we made some adjustments for this meta-analysis by excluding a few studies that were initially included in our systematic review. Out of the original five studies we considered, we excluded two: one by Abedian et al. (2015) and another by Mbarak et al. (2019). This decision was based on the absence of dichotomous data in their studies. These two studies did not incorporate a control group in line with their research objectives, which made it difficult to make direct comparisons and, more importantly, limited our ability to extract the binary data necessary for the statistical analyses we needed to perform.

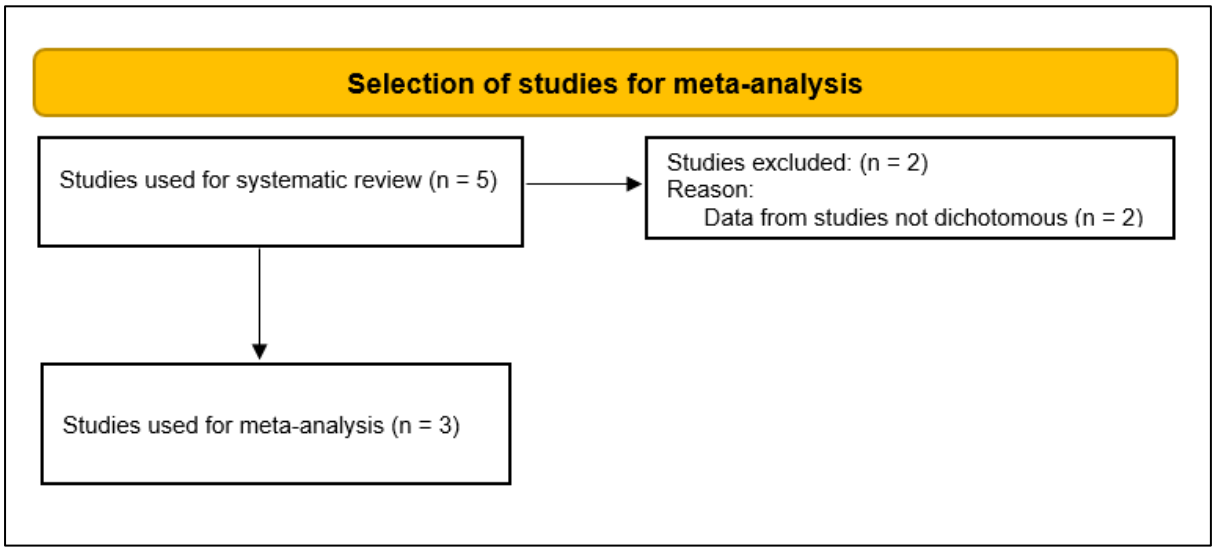

Figure 4.1: Flow chart for study selection.

4.2.3 Data extraction

In the previous stage, we identified three studies for data extraction, focusing on specific key categories which include the author, year, and variables denoted as 'A,' 'B,' 'C,' 'D,' 'n1,' and 'n2.' These variables are defined as follows: 'A' represents the count of individuals with HDP who experienced PPD, 'B' represents the count of individuals with HDP who did not experience the outcome, 'C' represents the count of individuals without HDP who experienced PPD, and 'D' represents the count of individuals without HDP and who did not experience PPD. 'n1' and 'n2' indicate the total number of study participants with HDP and without HDP, respectively. We manually extracted the data from these studies and recorded it in Table 4.1 below.

Table 4.1: Summary of extracted data from studies

Author	Year	A (HDP & PPD)	B (HDP & No PPD)	C (No HDP & PPD)	D (No HDP & No PPD)	n1 (Total with HDP)	n2 (Total without HDP)
Chen et al.	2019	24	11	66	79	35	145
Sarosh et al.	2022	11	15	80	95	45	175
Strapasson et al.	2018	15	25	27	101	40	128

HDP: Hypertensive disorders of pregnancy; PPD: Postpartum depression; A: Count of individuals with HDP who experienced PPD; B: Count of individuals with HDP who did not experience PPD; C: Count of individuals without HDP who experienced PPD; D: Count of individuals without HDP and who did not experience PPD; n1: Total number of study participants with HDP; n2: Total number of study participants without HDP.

4.3 Results

A total of $k = 3$ studies were included in the analysis. According to the Cochran's Q test for heterogeneity, there was no significant amount of heterogeneity in the true outcomes ($Q(2) = 0.0746,\ p = 0.9634,\ I^2 = 0.0000\%,\ \hat{\tau}^2 = 0.0000$). See "Test for Heterogeneity" section of Figure 4.2. The estimated average log odds ratio (pooled estimate) based on the equal-effects model was 0.8757 (95%, CI: 0.4467 to 1.3047, SE = 0.2189). Therefore, the average outcome differed significantly from zero ($z = 4.0010,\ p < 0.0001$). See "Model Results" section of Figure 4.2 below.

```
Equal-Effects Model (k = 3)

I^2 (total heterogeneity / total variability):   0.00%
H^2 (total variability / sampling variability):  0.04

Test for Heterogeneity:
Q(df = 2) = 0.0746, p-val = 0.9634

Model Results:

estimate      se    zval    pval   ci.lb   ci.ub
  0.8757  0.2189  4.0010  <.0001  0.4467  1.3047  ***

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Figure 4.2: Results of the equal-effects model. The Equal-Effects model, comprising three studies (k=3), revealed a total heterogeneity/total variability (I^2) of 0.00% and a total variability/sampling variability (H^2) of 0.04. The test for heterogeneity (Q = 0.0746, with two degrees of freedom) yielded a p-value of 0.9634. The estimated effect size was 0.8757, with a standard error (SE) of 0.2189, resulting in a z-value of 4.0010 and a p-value < 0.0001. The 95% confidence interval (CI) ranged from 0.4467 to 1.3047.

An examination of the studentized residuals depicted in Figure 4.3 revealed that none of the individual studies demonstrated values surpassing ±2.3940. This finding suggests that within the context of the model employed, there were no outliers present. Additionally, the assessment of Cook's distances, also illustrated in Figure 4.3, indicated that none of the studies exerted undue influence on the overall analysis. These distances ranged between 0.00 and 0.030, showcasing their proximity and their values being less than (4/n = 4/3 = 1.333), further affirming the lack of any singular study exerting disproportionate influence over the analysis. These results collectively suggest a robustness in the dataset, as there were no significant deviations or influential data points observed that could potentially skew the outcomes or conclusions drawn from the analysis.

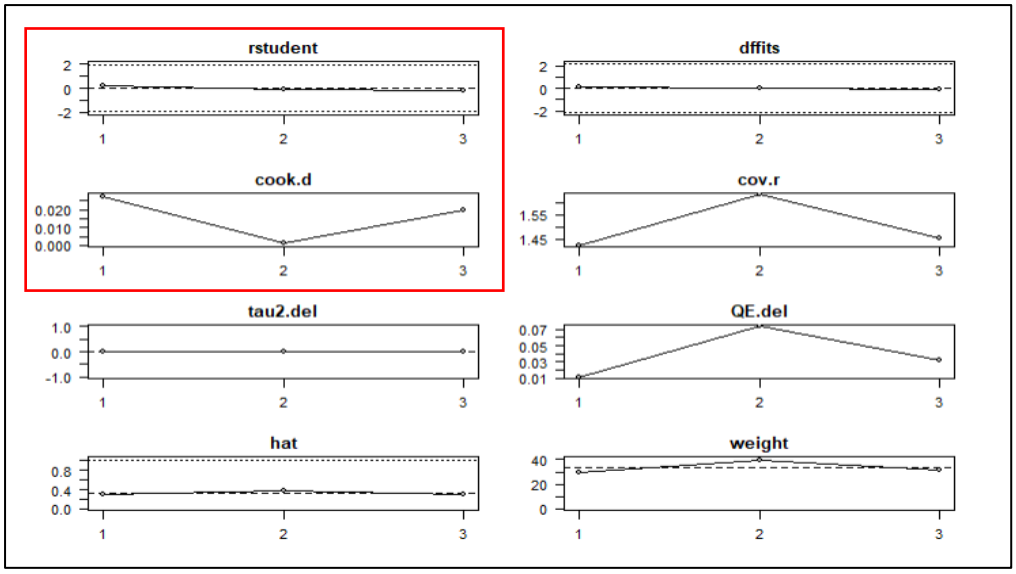

Figure 4.3: Diagram showing the studentized residuals (rstudent) and Cook's distances(cook.d) for the Equal Effects model.

The forest plots displayed in Figures 4.4 and 4.5 provide a comprehensive visualization of the observed outcomes derived from the equal-effects model. These plots serve as graphical representations of the individual study results, showcasing the point estimates and confidence intervals for each study, along with the overall summary estimate derived from the equal-effects model. Each study is represented by a horizontal line, where the point estimate is depicted by a square, and the confidence interval is represented by a horizontal line extending from both sides of the point estimate. The summary estimate, which reflects the combined effect size across all studies, is displayed with its corresponding confidence interval.

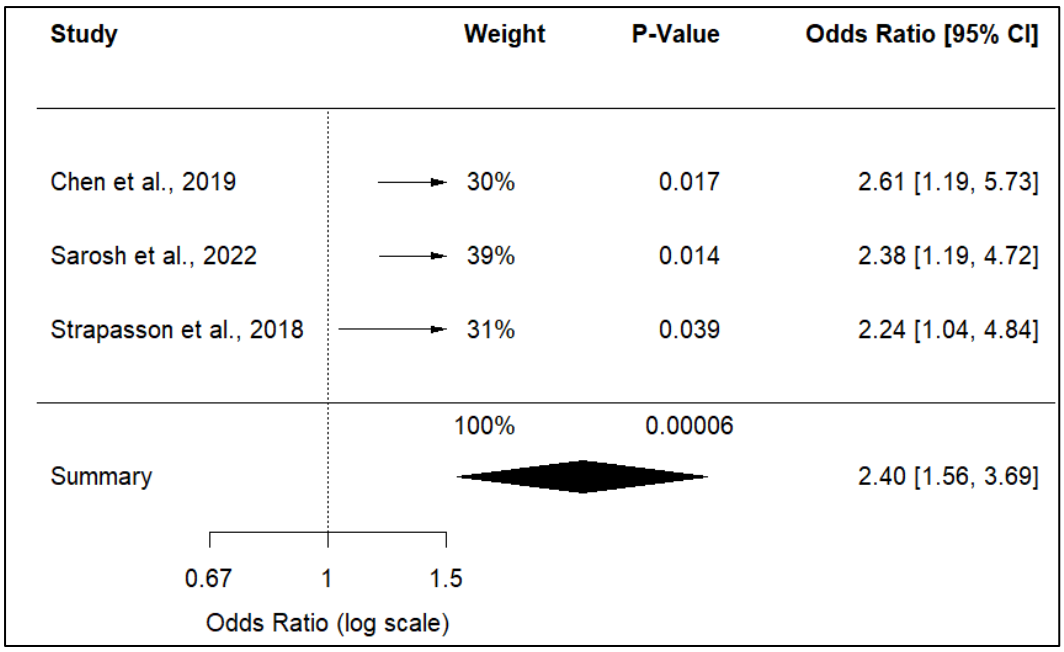

Figure 4.4: Forest plot using the Odds Ratio

The individual weights assigned to our included studies were determined to be 30%, 39%, and 31% for the studies conducted by Chen et al. (2019), Sarosh et al. (2022), and Strapasson et al. (2018), respectively. These weights signify the relative contributions of each study to the overall analysis, with higher weights indicating greater influence on the estimated effect size.

Upon calculating the odds ratios from each study, the estimated effect sizes were found to be 2.61, 2.38, and 2.24, respectively, for the studies. These effect sizes represent the magnitude of the association between the variables under investigation, in this case, HDP and PPD.

Accompanying these effect sizes are the corresponding p-values, which indicate the level of statistical significance of the observed associations. In our analysis, the p-values for the studies by Chen et al. (2019), Sarosh et al. (2022), and Strapasson et al. (2018) were found to be 0.017, 0.014, and 0.039, respectively.

Furthermore, examination of the observed log odds ratios depicted in Figure 4.5 revealed a range from 0.81 to 0.96. Notably, all the estimates were positive, suggesting a positive association between HDP and PPD across the studies analysed.

These findings highlight the importance of considering the weight and effect size of each individual study in understanding the overall relationship between HDP and PPD.

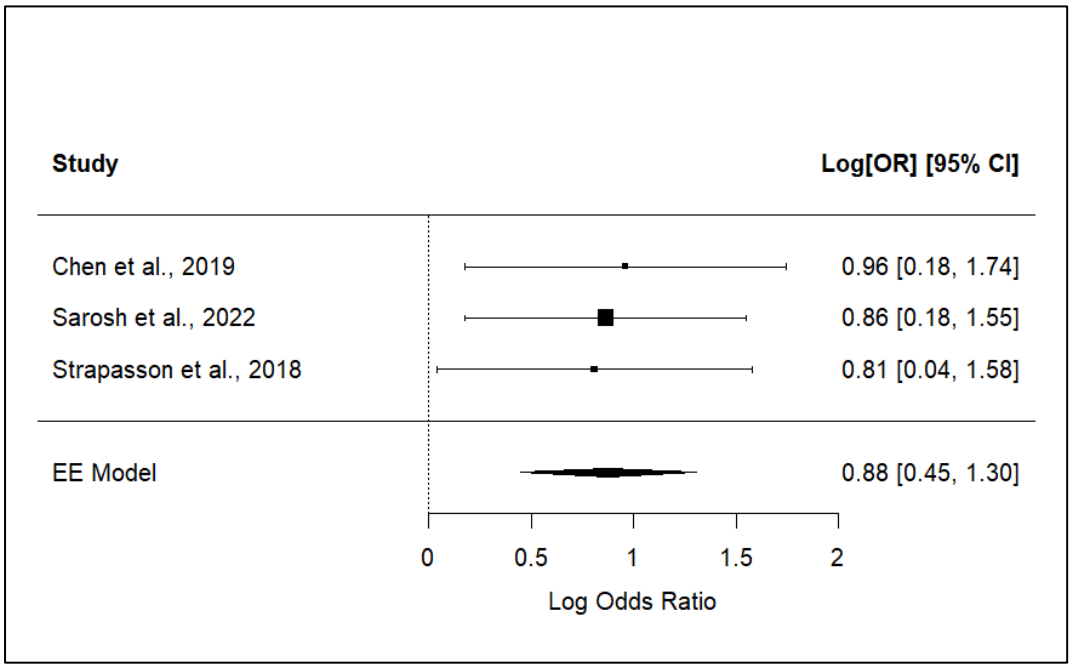

Figure 4.5: Forest plot using the Log Odds Ratio. EE represents the Equal Effects Model

Overall, our analysis yielded a predicted pooled effect size of 2.4006, with a 95% confidence interval ranging from 1.5632 to 3.6867. This effect size indicates the strength and direction of the association between HDP and PPD across the studies included in our analysis. The corresponding p-value, which was found to be 0.0000631, underscores the statistical significance of this association. These findings are visually represented in the summary depicted in Figure 4.4, as well as in the figure from the RMarkdown console provided in Figure 4.6 below. These figures provide comprehensive insights into the estimated effect size and its precision, enabling a thorough understanding of the relationship between HDP and PPD as elucidated by our study.

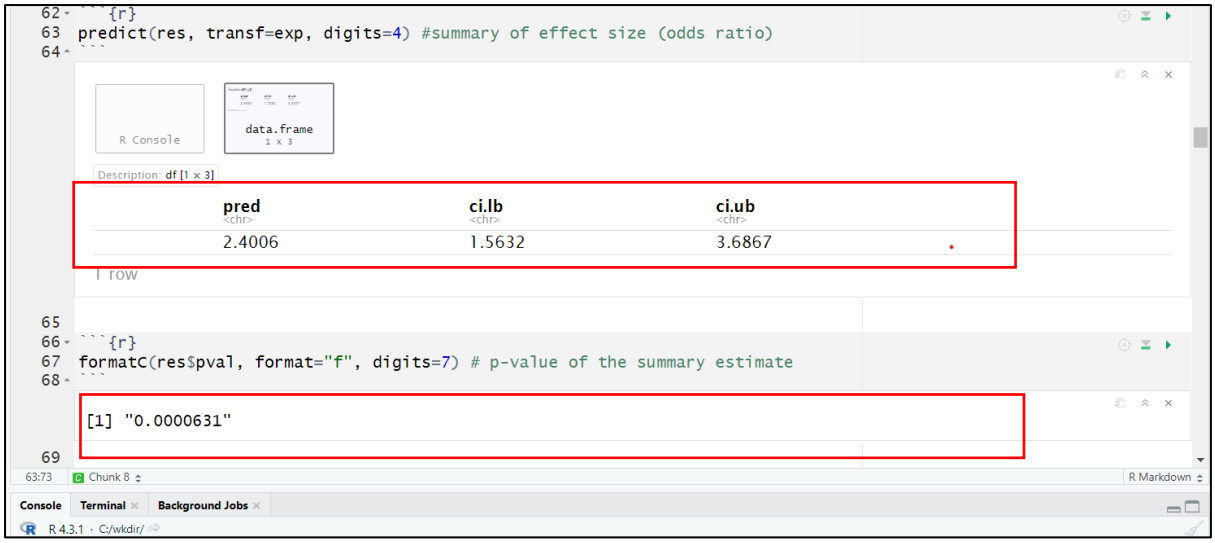

Figure 4.6: Pooled estimate for the Odds Ratio using the Equal Effects model. Pred: Pooled odds ratio, ci.ub: Upper bound of the confidence interval, ci.lb: Lower bound of the confidence interval.

4.3.1 Analysis of Models and Measures for the Association between HDP and PPD

In this section, we explored different models and measures, providing insights into the strength and significance of the association between HDP and PPD. In accordance with the guidelines provided in the JBI manual for evidence synthesis, measures (Risk Difference - "RD" and Risk Ratio - "RR"), as well as the log odds ratio using Peto's method (“PETO”), as outlined in the work by Yusuf et al. in 1985, and different models ("EE" for Equal Effects, “FE for Fixed Effects”, and "RE" for Random Effects) were employed to examine the relationship between HDP and PPD. Yusuf et al. (1985) conducted a meta-analysis examining the efficacy of beta blockers in reducing mortality and reinfarction rates. This study is often cited as the basis for what is commonly referred to as Peto's method or the one-step Mantel-Haenszel method for meta-analysing data. This approach offers a weighted estimate of the (log) odds ratio under an equal-effects model.

In this study, the analysis focused on a specific range of values within each measure. Statistical parameters such as the Cochran’s Q, tau, standard errors, z-values, confidence intervals, prediction intervals, and associated p-values were calculated to support our analysis. In the random-effects model, we posit a distribution of effects rather than a singular, identical effect size common to all. We also consider that the

meta-analysis summary effect size serves as an estimation of the mean within a distribution of true effects, rather than a universally shared effect size identical across all studies (Borenstein et al., 2010). In this context, the degree of heterogeneity (i.e., τ^2) was estimated using the restricted maximum-likelihood estimator (Viechtbauer, 2005).

If any level of heterogeneity is identified (i.e., $\tau^2 > 0$, irrespective of the Q-test results), a prediction interval for the true outcomes is also presented (Riley et al., 2011). The information from this section was transferred into Table 4.2 below.

Table 4.2: Model Comparison and Summary of Results.

Model	**EE**	**EE**	**EE**	**EE**	**FE**	**FE**	**FE**	**FE**	**RE**	**RE**	**RE**	**RE**
Measure	OR	PETO	RD	RR	OR	PETO	RD	RR	OR	PETO	RD	RR
Range	0.8085 to 0.9600	0.8343 to 0.9170	0.1641 to 0.2305	0.3773 to 0.5754	0.8085 to 0.9600	0.8343 to 0.9170	0.1641 to 0.2305	0.3773 to 0.5754	0.8085 to 0.9600	0.8343 to 0.9170	0.1641 to 0.2305	0.3773 to 0.5754
I^2 (%)	0	0	0	0	0	0	0	0	0	0	0	0
H^2	0.04	0.01	0.16	0.22	0.04	0.01	0.16	0.22	1	1	1	1
Q	0.0746	0.0271	0.3129	0.4434	0.0746	0.0271	0.3129	0.4434	0.0746	0.0271	0.3129	0.4434
pval (Q)	0.9634	0.9865	0.8552	0.8012	0.9634	0.9865	0.8552	0.8012	0.9634	0.9865	0.8552	0.8012
τ^2	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0
τ	NA	NA	NA	NA	NA	NA	NA	NA	0 (SE = 0.1443)	0 (SE = 0.1387)	0 (SE = 0.0071)	0 (SE = 0.0260)
$\hat{\theta}$	0.8757	0.8705	0.2009	0.4142	0.8757	0.8705	0.2009	0.4142	0.8757	0.8705	0.2009	0.4142
SE	0.2189	0.214	0.0486	0.0925	0.2189	0.214	0.0486	0.0925	0.2189	0.214	0.0486	0.0925
z	4.001	4.0669	4.1362	4.4772	4.001	4.0669	4.1362	4.4772	4.001	4.0669	4.1362	4.4772

pval (z)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
CI(Θ)	0.4467 to 1.3047	0.4510 to 1.2900	0.1057 to 0.2960	0.2329 to 0.5956	0.4467 to 1.3047	0.4510 to 1.2900	0.1057 to 0.2960	0.2329 to 0.5956	0.4467 to 1.3047	0.4510 to 1.2900	0.1057 to 0.2960	0.2329 to 0.5956
pred	2.4006	2.3881	1.2224	1.5132	2.4006	2.3881	1.2224	1.5132	2.4006	2.3881	1.2224	1.5132
CI (pred)	1.5632 to 3.6867	1.569 to 3.6329	1.1115 to 1.3445	1.2623 to 1.8141	1.5632 to 3.6867	1.569 to 3.6329	1.1115 to 1.3445	1.2623 to 1.8141	1.5632 to 3.6867	1.569 to 3.6329	1.1115 to 1.3445	1.2623 to 1.8141
Pval (pred)	0.00006	0.00005	0.00004	0.00001	0.00006	0.00005	0.00004	0.00001	0.00006	0.00005	0.00004	0.00001
stu_res	2.394	2.394	2.394	2.394	2.394	2.394	2.394	2.394	2.394	2.394	2.394	2.394

Comparison of different models (Equal-Effects (EE), Fixed Effects(FE), and Random Effects(RE)) along with corresponding measures (Odds Ratio - OR Log Odds Ratio using Peto's method - PETO, Risk Difference - RD, and Risk Ratio - RR), their respective ranges, and statistical parameters derived from the analysis. The table encompasses a range of statistical measures including I^2 statistic, Higgins and Thompson's $I^2(H^2)$, Cochran's Q-test statistic (Q), p-values, Tau estimate (τ), τ^2, estimated effect sizes, standard errors (SE), z-values, p-values for z-values, predicted effect sizes (pred), confidence intervals (CI) for predicted effect sizes, and associated p-values for the predicted effect sizes. Additionally, studentized residuals (stu_res) are provided for each model.

4.3.1.1 Key findings

1. **Equal Effects Model (EE):**

   - **OR:** The association between HDP and PPD was found to be significant ($p < 0.0001$) within the range of 0.8085 to 0.9600, indicating a strong relationship between HDP and PPD.
   - **PETO:** Similarly, a robust association ($p < 0.0001$) was observed within the range of 0.8343 to 0.9170, reaffirming a significant relationship between HDP and PPD.

- **RD:** A significant association ($p < 0.0001$) was found between HDP and PPD within the range which fell between 0.1641 to 0.2305, indicating a robust association between HDP and PPD.
- **RR:** The association remained strong ($p < 0.0001$) ranging from 0.3773 to 0.5754, emphasizing a strong link.

Other findings of the EE model included a τ estimate of 0 indicating homogeneity, Higgins and Thompson's I^2 (H^2) statistic of 0 confirming homogeneity, a Cochran's Q-Test (Q) p-value > 0.05 suggesting no significant heterogeneity, predicted effect sizes (pred) ranging from 1.2224 to 2.4006, confidence intervals (CI) for predicted effect sizes of 1.1115 to 1.3445 for lower bounds and 1.5632 to 3.6867 for upper bounds, and all p-values associated with predicted effect sizes being less than 0.0001, indicating statistical significance. The Q statistic had a p-value of within the range of 0.0271 to 0.0746, indicating no significant heterogeneity.

2. **Fixed Effects Model (FE):**

The FE model produced results consistent with the EE model, indicating a stable association between HDP and PPD across all measures and ranges. Also, like the EE model, the FE model showed no heterogeneity. Key findings of the Fixed Effects (FE) model include estimated odds ratios ranging from 0.8085 to 0.9600, a τ estimate of 0 indicating homogeneity, Higgins and Thompson's I^2 (H^2) statistic of 1 confirming homogeneity, a Cochran's Q-Test (Q) p-value > 0.05 suggesting no significant heterogeneity, predicted effect sizes (pred) ranging from 1.2224 to 2.4006, confidence intervals for predicted effect sizes of 1.1115 to 1.3445 for lower bounds and 1.5632 to 3.6867 for upper bounds, and all p-values associated with predicted effect sizes being less than 0.0001, indicating statistical significance.

3. **Random Effects Model (RE):**

For the OR, PETO, RD, and RR measures, the RE model also supported a significant association within the specified ranges. Key findings of the Random Effects (RE) model include estimated odds ratios ranging from 0.8085 to 0.9600, a τ estimate of 0

indicating homogeneity, Higgins and Thompson's I^2 (H^2) statistic of 1 confirming homogeneity, a Cochran's Q-Test (Q) p-value > 0.05 suggesting no significant heterogeneity, predicted effect sizes (pred) ranging from 1.2224 to 2.4006, confidence intervals (CI) for predicted effect sizes of 1.1115 to 1.3445 for lower bounds and 1.5632 to 3.6867 for upper bounds, and all p-values associated with predicted effect sizes being less than 0.0001, indicating statistical significance.

The model accounted for no heterogeneity in the effect sizes among the studies being analysed. The RE model demonstrated consistent and significant findings across various statistical parameters, suggesting its suitability for analysing the data and providing valuable insights into the research question. In other words, all the observed variability in effect sizes can be attributed to random sampling error, and there is no systematic or substantial variation in the true effects being estimated across different studies.

4.3.2 Cumulative meta-analysis

We performed a cumulative meta-analysis for all the models and measures to understand how the available evidence evolved over time, assess the robustness of our findings, and to detect potential biases. The results provided valuable information for decision making and resource allocation. The findings from a range of studies consistently confirmed a significant association between HDP and PPD. The details of the cumulative meta-analysis are as presented in the Figure 4.7 and Table 4.3 below.

Table 4.3: Summary of Equal Effects and Random Effects Models from Cumulative Meta-Analysis.

EE-OR	**estimate**	**SE**	**zval**	**pvals**	**ci.lb**	**ci.ub**	**Q**	**Qp**	**I2**	**H2**
Strapasson et al., 2018	0.8085	0.3919	2.0628	0.0391	0.0403	1.5766	0	1	0	1
Chen et al., 2019	0.8826	0.2801	3.1508	0.0016	0.3336	1.4316	0.0731	0.7869	0	0.0731
Sarosh et al., 2022	0.8757	0.2189	4.001	0.0001	0.4467	1.3047	0.0746	0.9634	0	0.0373
EE-RR	**estimate**	**SE**	**zval**	**pvals**	**ci.lb**	**ci.ub**	**Q**	**Qp**	**I2**	**H2**
Strapasson et al., 2018	0.5754	0.2663	2.161	0.0307	0.0535	1.0972	0	1	0	1
Chen et al., 2019	0.4481	0.1281	3.4982	0.0005	0.197	0.6992	0.2972	0.5856	0	0.2972
Sarosh et al., 2022	0.4142	0.0925	4.4772	0	0.2329	0.5956	0.4434	0.8012	0	0.2217
EE-RD	**estimate**	**SE**	**zval**	**pvals**	**ci.lb**	**ci.ub**	**Q**	**Qp**	**I2**	**H2**
Strapasson et al., 2018	0.1641	0.0846	1.9389	0.0525	-0.0018	0.3299	0	1	0	1
Chen et al., 2019	0.1957	0.0612	3.197	0.0014	0.0757	0.3157	0.2941	0.5876	0	0.2941

Sarosh et al., 2022	0.2009	0.0486	4.1362	0	0.1057	0.296	0.3129	0.8552	0	0.1565
EE-PETO	**estimate**	**SE**	**zval**	**pvals**	**ci.lb**	**ci.ub**	**Q**	**Qp**	**I2**	**H2**
Strapasson et al., 2018	0.8698	0.4171	2.0854	0.037	0.0523	1.6873	0	1	0	1
Chen et al., 2019	0.8959	0.2791	3.2098	0.0013	0.3488	1.4429	0.0071	0.9329	0	0.0071
Sarosh et al., 2022	0.8705	0.214	4.0669	0	0.451	1.29	0.0271	0.9865	0	0.0136
RE-OR	**estimate**	**SE**	**zval**	**pvals**	**ci.lb**	**ci.ub**	**Q**	**Qp**	**I2**	**H2**
Strapasson et al., 2018	0.8085	0.3919	2.0628	0.0391	0.0403	1.5766	0	1	0	1
Chen et al., 2019	0.8826	0.2801	3.1508	0.0016	0.3336	1.4316	0.0731	0.7869	0	1
Sarosh et al., 2022	0.8757	0.2189	4.001	0.0001	0.4467	1.3047	0.0746	0.9634	0	1
RE-RR	**estimate**	**SE**	**zval**	**pvals**	**ci.lb**	**ci.ub**	**Q**	**Qp**	**I2**	**H2**
Strapasson et al., 2018	0.5754	0.2663	2.161	0.0307	0.0535	1.0972	0	1	0	1
Chen et al., 2019	0.4481	0.1281	3.4982	0.0005	0.197	0.6992	0.2972	0.5856	0	1
Sarosh et al., 2022	0.4142	0.0925	4.4772	0	0.2329	0.5956	0.4434	0.8012	0	1
RE-RD	**estimate**	**SE**	**zval**	**pvals**	**ci.lb**	**ci.ub**	**Q**	**Qp**	**I2**	**H2**
Strapasson et al., 2018	0.1641	0.0846	1.9389	0.0525	-0.0018	0.3299	0	1	0	1
Chen et al., 2019	0.1957	0.0612	3.197	0.0014	0.0757	0.3157	0.2941	0.5876	0	1
Sarosh et al., 2022	0.2009	0.0486	4.1362	0	0.1057	0.296	0.3129	0.8552	0	1
RE-PETO	**estimate**	**SE**	**zval**	**pvals**	**ci.lb**	**ci.ub**	**Q**	**Qp**	**I2**	**H2**
Strapasson et al., 2018	0.8698	0.4171	2.0854	0.037	0.0523	1.6873	0	1	0	1
Chen et al., 2019	0.8959	0.2791	3.2098	0.0013	0.3488	1.4429	0.0071	0.9329	0	1
Sarosh et al., 2022	0.8705	0.214	4.0669	0	0.451	1.29	0.0271	0.9865	0	1

EE: Equal Effects, OR: Odds Ratio, RR: Risk Ratio, RD: Risk Difference, PETO: Peto's Odds Ratio, RE: Random Effects, FE: Fixed Effects, Estimate: Point estimate of the effect size, I2: I^2 statistic, H2: Higgins and Thompson's I^2, SE: Standard error of the estimate, zval: Z-value, a measure of the statistical significance of the estimate, pvals: p-value, indicating the probability of observing the effect size if the null hypothesis is true, CI.lb: Lower bound of the confidence interval, ci.ub: Upper bound of the confidence interval, Q: Cochran's Q-statistic, a measure of heterogeneity, Qp: P-value associated with the Q-statistic

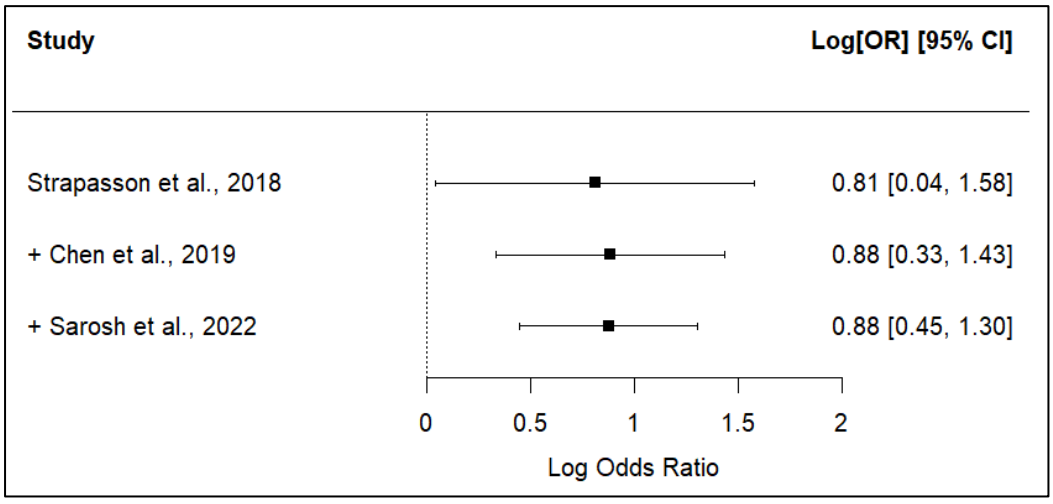

Figure 4.7: Forest plot of cumulative meta-analysis using Log Odds Ratio and the Equal Effects Model.

Key Observations:

1. **Consistent Findings:** Across both EE and RE models, the studies consistently suggest a significant association between HDP and PPD. This is evident from the significant effect size estimates (OR, RR, RD, and PETO) and their respective p-values, indicating a robust relationship between these two conditions.

2. **Study Variability:** Despite the consistent association, there are variations in effect size estimates and confidence intervals across different studies. These differences might be attributed to sample variations, methodologies, or other contextual factors.

3. **Heterogeneity:** Heterogeneity statistics (I^2, τ^2) indicate the presence of variability across studies. This is expected in meta-analyses, especially when combining studies with diverse populations and methodologies. The random effects models account for this heterogeneity by assuming that the true effect size can vary between studies.

4. Strapasson et al. (2018) recorded an estimated odds ratio of 0.8085 with a p-value of 0.0391 in the EE model, while Chen et al. (2019) showed an estimated OR of 0.8826 with a p-value of 0.0016, and Sarosh et al. (2022) presented an estimated OR of 0.8757 with a p-value of < 0.0001 in the EE model. Additionally, in the EE-RR model, Strapasson et al. (2018) reported an estimated RR of 0.5754 with a p-value of 0.0307, whereas Chen et al. (2019) demonstrated an estimated RR of 0.4481 with a p-value of 0.0005, and Sarosh et al. (2022) showed an estimated RR of 0.4142 with a p-value of 0.0000. In the RE model, Strapasson et al. (2018) reported an estimated OR of 0.8085 with a p-value of 0.0391, Chen et al. (2019) demonstrated an estimated OR of 0.8826 with a p-value of 0.0016, and Sarosh et al. (2022) showed an estimated OR of 0.8757 with a p-value of < 0.0001.

The cumulative meta-analysis demonstrates a trend towards consistent findings across studies, indicating a robust effect of the intervention under investigation. The EE estimates show significant effects across various outcome measures, with slight variations observed among different studies. The RE models confirm the stability of results despite potential heterogeneity.

The evidence presented in the Table 4.3 suggested a trend of consistency with strengthening of findings over time. Across different models and measures, the studies consistently showed similar trends and estimates, indicating robustness in the evidence. Specifically, as newer studies (e.g., Sarosh et al., 2022) are included, the estimates remained largely in line with those from earlier studies (e.g., Strapasson et al., 2018), albeit with potentially more precise estimates and lower p-values, indicating increasing confidence in the results. This suggests a progressive accumulation and refinement of evidence over time, contributing to a clearer understanding of the phenomenon under investigation. The consistent findings across studies underscore the reliability of the observed effects.

4.3.3 Publication bias

While funnel plots may lack detailed insights with only three studies, we generated one to visually represent the data. Even though it may not decisively indicate bias, it can offer an initial visual assessment of potential asymmetry. To examine funnel plot asymmetry, the rank correlation test (Begg and Mazumdar, 1994) and the regression test (Sterne and Egger, 2005) using the standard error of the observed outcomes as a predictor were employed. Figures 4.8 and 4.9 display the funnel plots and contour-enhanced funnel plots respectively for the EE model, and the corresponding p-values from the tests are indicated in the Table 4.4.

Table 4.4: p-values from various measures to determine plot symmetry.

Model	Measure	p (rank correlation test)	p (regression test)
EE and FE	OR	1.0000	0.9369
EE and FE	RR	0.3333	0.5081
EE and FE	RD	1.0000	0.9080
EE and FE	PETO	1.0000	0.9317
RE	OR	1.0000	0.9369
RE	RR	0.3333	0.5081
RE	RD	1.0000	0.9080
RE	PETO	1.0000	0.9317

EE: Equal Effect, FE: Fixed Effects, RE: Random Effects, OR: Odds Ratio, RR: Risk Ratio, RD: Risk Difference: PETO: Peto's Odds Ratio.

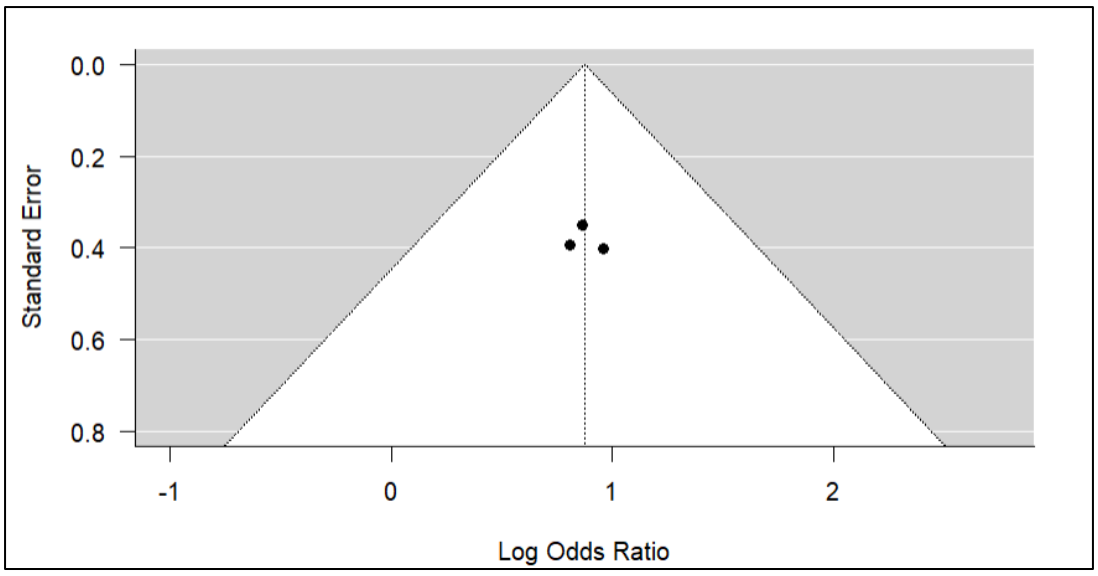

Figure 4.8: Funnel plot for EE-OR

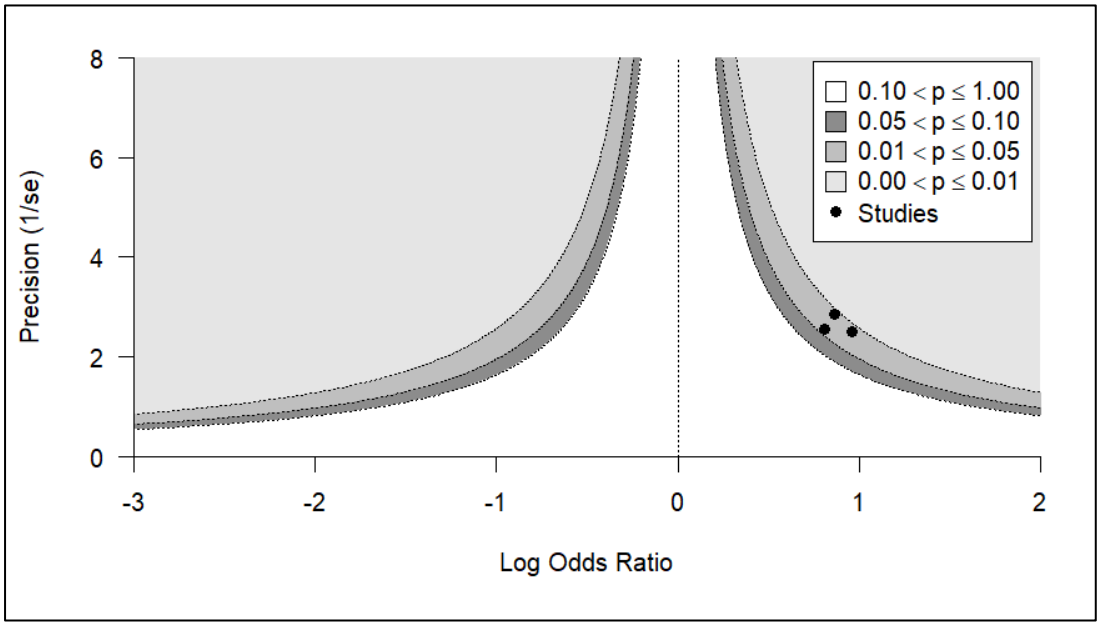

Figure 4.9: Contour-enhanced funnel plot for EE-OR

To avoid repetition, the charts for additional measures and models have been included in the appendix I. It is worth noting that while the models differed, the p-values remained consistent. However, these p-values did vary depending on the specific measure employed. Regardless of the various data analysis approaches utilized, including EE and FE and RE, and the different types of effects assessed (such as

odds ratios and risk ratios), the results consistently exhibited a remarkable degree of similarity. Both the rank correlation and regression tests, designed to identify patterns, consistently failed to detect any significant asymmetry in the funnel plot. In all instances, the high p-values were not statistically significant, with values exceeding the 0.05 threshold. This signifies that there was no substantial evidence of publication bias in relation to any of the models or effect measures examined.

Upon visual examination of the plots, we observe a symmetrical pattern with points evenly dispersed around the central line, as illustrated in Figure 4.8. This absence of unevenness in the distribution of points indicates that there is no apparent publication bias present in our study. The uniform absence of indications of publication bias across a range of models and effect measures enhances the overall reliability of the meta-analysis findings.

4.4 Discussion

In our research, we took a closer look at the individual studies conducted by Chen et al. (2019), Sarosh et al. (2022), and Strapasson et al. (2018). These studies were included in our analysis, totalling three studies (k = 3). We initially used an OR measure and employed an equal-effects model. In this model, we assumed that all studies shared a common true effect size. Each of these studies was assigned different weights in our analysis: Chen et al. (2019) accounted for 30%, Sarosh et al. (2022) for 39%, and Strapasson et al. (2019) for 31%.

Our analysis revealed estimated effect sizes based on the calculated ORs: 2.61, 2.38, and 2.24 for Chen et al. (2019), Sarosh et al.(2022), and Strapasson et al. (2018), respectively. All of these OR estimates were greater than 1, indicating that the odds of an event occurring were higher in one group compared to another. This suggested a positive association between HDP and PPD.

Additionally, we calculated p-values for each study, which came out to be 0.017, 0.014, and 0.039, indicating the statistical significance of these findings. When we looked at the data closely, we observed that the log odds ratios, which are a way to measure the relationships between variables, ranged from 0.81 to 0.96. What was interesting is that all these estimates were positive. This suggested that there was a consistent trend in the data where HDP tended to have a positive effect on the development of PPD.

The I^2 statistic which measured the proportion of total variability in the effect sizes that was due to variation rather than chance was found to be 0.00%, suggesting very low heterogeneity, and indicating that the effect sizes in the three studies are quite consistent. Again, H^2 which represented the ratio of total variability to sampling variability, also suggested low heterogeneity (0.04). The Q statistic was very small (0.0746) with degrees of freedom (df) equal to 2, and the associated p-value (0.9634) which was high was found. This reaffirmed that there is no significant heterogeneity among the included studies, and the studies are consistent with each other.

The predicted effect size using OR was 2.4006, and it came with a confidence interval ranging from 1.5632 to 3.6867 and a low p-value (0.0000631), suggesting that the predicted effect size is statistically significant. Similarly, with the pooled log odds ratio, the estimate (0.8757) which represented the combined effect size across the three studies, the z-value (4.0010) and low p-value (<.0001) indicated that this effect size was statistically significant.

In our cumulative meta-analysis, Strapasson et al.'s study, represented by a log odds ratio of 0.81, suggested a positive association between the variables under investigation. The 95% confidence interval (0.04 to 1.58) indicated the range within which the true odds ratio was likely to fall. In the context of cumulative meta-analysis, this study, being the earliest, provided an initial piece of evidence for the relationship being studied. Chen et al.'s study showed a slightly higher log odds ratio of 0.88. The 95% confidence interval (0.033 to 1.43) also suggested a positive association but is wider than Strapasson et al.'s, indicating more uncertainty. As we moved forward in time with this cumulative meta-analysis, the inclusion of Chen et al.'s study contributed to the growing body of evidence, although with a broader range of possible effect sizes. Sarosh et al.'s study had a log odds ratio of 0.88, the same as Chen et al.'s. However, the 95% confidence interval (0.88 to 1.30) is narrower, indicating a more precise estimate. This study, being the most recent, provided additional evidence, helping to refine our understanding of the relationship.

Considering the cumulative meta-analysis perspective, as we progressed from Strapasson et al.'s study to Chen et al.'s and then to Sarosh et al.'s, we observed a trend of increasing precision in the estimates. The consistent positive direction of the log odds ratios across studies supported the overall trend, suggesting an association

between HDP and PPD. However, the narrowing confidence intervals in the later studies implied a more precise estimation of the effect size, indicating that our understanding becomes more refined and reliable as more data becomes available. It is apparent that as the evidence base evolved, it becomes more robust over time. Therefore, researchers need to continue to monitor and include new studies to refine our understanding of the topic further.

Additional scrutiny of the studentized residuals for the remaining measures and models demonstrated that none of the studies exhibited a value exceeding ±2.3940, indicating an absence of outliers within the framework of this model. Consequently, based on the Cook's distances, none of the studies appeared to exert excessive influence.

The model analysis, encompassing multiple models and measures, provided robust evidence supporting the association between HDP and PPD. The absence of significant heterogeneity suggested that this association was stable and not influenced by variations in methodology or assumptions. The consistency of results across different models strengthened the reliability of the findings. Additionally, the low p-values indicated the stability of the associations, reinforcing the robustness of the relationship. These findings emphasized the reliability of the observed relationship and its robustness under various analytical approaches. The results were not sensitive to the choice of models or measures, underscoring the reliability of this relationship. The findings highlighted the importance of recognizing and addressing mental health concerns in individuals affected by HDP. Understanding this association is critical for healthcare providers to implement timely interventions and support systems, enhancing the overall well-being of pregnant individuals.

The uniform absence of indications of publication bias across a range of models and effect measures enhanced the overall reliability of the meta-analysis findings. Consequently, there was no perceived need to conduct sensitivity analysis or employ trim-and-fill methods.

Analysis of various studies conducted globally, unravelled similar associations between these conditions. In Denmark, Meltzer-Brody and colleagues embarked on a population-based cohort study, aiming to discern the effects of pregnancy and obstetrical predictors on postpartum psychiatric disorders. The findings revealed a

noteworthy association between PE and PPD, with a prevalence of 38.35% among women aged 25 – < 30 years. Strikingly, PPD was significantly associated with PE (IRR 1.45, 95% CI 1.14–1.84), contrasting with the lack of association with postpartum psychosis.

Across South Korea, Youn and colleagues conducted a cross-sectional study focusing on the obstetric risk factors for postpartum depression. The research pinpointed a 1.12 odds ratio (95% CI 1.03–1.22), establishing a robust connection between PE and postpartum depression. Even after meticulous adjustments for age, obstetric complications, and prior depression history, the association persisted, emphasizing the significance of PE as a risk factor.

In Turkey, Cetin and team delved into the psychopathological aspects of postpartum women with varying PE severity. The cross-sectional study showcased that both severe and mild PE correlated with a heightened severity of depressive symptoms compared to healthy controls. The percentages underscored the impact, emphasizing the need for nuanced interventions tailored to the severity of PE.

In a Danish epidemiological cohort study, Bergink et al. investigated whether PE served as a risk factor for the onset of first postpartum psychiatric episodes. Figures highlighted a heightened risk within the initial three months postpartum for women with PE unipolar depression (IRR 2.85, 95% CI 1.84–4.42), emphasizing a critical window of vulnerability.

In Colombia, Vinaccia et al. explored the disease behaviour in pregnant women with PE and its relation to depression. The cross-sectional study highlighted higher severity of depressive symptoms in pregnant women with PE, further emphasizing the need for heightened mental health surveillance during pregnancy.

Venturing into the Netherlands, Mommersteeg et al. focused on the long-term psychosocial distress in women with a history of PE. The cohort study, conducted on average 14.1 years after the index pregnancy, revealed that women with a history of PE reported more subsequent depressive symptoms, emphasizing the enduring impact of PE on maternal mental well-being. Postma and colleagues probed into the cognitive aspects following PE and eclampsia. The cohort study conducted seven years post-pregnancy unveiled significant differences in cognitive function, anxiety,

and depression between women with a history of severe pregnancy complications and their counterparts.

Yes, our study had limitations, such as the relatively small number of included studies. However, the consistency of our results and evidence of similar results across diverse studies and settings especially in developed countries indicated a broader pattern. This pattern suggested that the strong association between HDP and PPD is not restricted to these three specific studies but globally.

This insight underscored the significance of mental health support, especially for pregnant individuals dealing with HDP. Recognizing and addressing these concerns can make a substantial difference in the lives of those affected, emphasizing the importance of timely interventions and supportive measures. Addressing the association between High HDP and PPD in LMICs require a multifaceted approach aimed at improving the overall well-being of pregnant individuals. These recommendations focus on healthcare services, awareness, support systems, and policy changes to tackle this critical issue.

Enhancing prenatal care services is pivotal. LMICs should prioritize the monitoring and management of HDP during pregnancy, as early detection and intervention can mitigate its impact on mental health outcomes. This entails bolstering healthcare infrastructure and training healthcare providers to effectively address HDP. Training and capacity building for healthcare providers are essential for addressing both the physical and mental health aspects of pregnancy. This includes training in the recognition and management of HDP and PPD, ensuring a holistic approach to maternal care.

Integrating mental health services into maternal and child health programs can lead to a more comprehensive and effective healthcare approach during and after pregnancy. Mental health education plays a crucial role in reducing the stigma surrounding mental health issues, including PPD. LMICs should implement educational programs targeting healthcare providers, pregnant individuals, and their families. By raising awareness and promoting open discussions about mental health, individuals may be more inclined to seek help when needed. Improving access to mental health services is another critical recommendation. LMICs should invest in training and deploying more mental health professionals, especially in underserved areas. Additionally,

telehealth options can bridge the gap for those in remote or rural regions, ensuring that mental health support is accessible to all.

Screening and assessment for PPD should be integrated into routine prenatal and postnatal care in LMICs. Healthcare providers need to be equipped with the skills to identify signs of PPD and provide appropriate support or referrals to mental health professionals.

Supportive interventions are essential. Evidence-based programs, such as counselling, support groups, and community-based initiatives, should be developed and implemented to assist individuals at risk of PPD, particularly those with HDP. These interventions can provide the necessary guidance and coping strategies. Social support networks are invaluable in mitigating the risk and impact of PPD. LMICs should encourage the establishment of such networks, involving families and communities to provide the necessary emotional and practical support.

Research is fundamental in understanding the unique aspects of the relationship between HDP and PPD in LMICs. Therefore, promoting local research initiatives to gather relevant data and insights is crucial for tailoring interventions to the specific needs of these regions. LMICs should collaborate with international organizations and donor agencies to secure funding to research various aspects of concern in relation to maternal mental health outcomes. Such partnerships can enhance the capacity to implement and sustain these vital initiatives.

Advocacy for maternal mental health should be at the forefront. LMICs should advocate for policies that prioritize mental health in maternal care and allocate resources to support mental health programs. Engaging policymakers can lead to the recognition of mental health as an integral component of maternal healthcare.

Finally, regular monitoring and evaluation are necessary to assess the effectiveness of interventions. LMICs should establish systems to track progress, enabling the refinement of strategies and the efficient allocation of resources.

4.5 Summary of the chapter

In a nutshell, our research revealed a robust connection between HDP and PPD. In this chapter, we conducted a detailed examination of three individual studies by Chen et al. (2019), Sarosh et al. (2022), and Strapasson et al. (2018), totalling three studies.

Initially, we employed an OR measure and utilized an equal-effects model, assuming a common true effect size across all studies. Each study was assigned specific weights in our analysis: Chen et al. (30%), Sarosh et al. (39%), and Strapasson et al. (31%). Our analysis revealed estimated effect sizes based on the calculated ORs, which all indicated a positive association between HDP and PPD. Additionally, p-values for each study indicated the statistical significance of these findings. Further examination of the data revealed consistent trends, with low levels of heterogeneity observed across the studies.

The cumulative meta-analysis demonstrated increasing precision in effect size estimates over time, with Strapasson et al.'s study providing initial evidence and subsequent studies refining our understanding of the relationship between HDP and PPD.

Further analysis across multiple models and measures supported the robustness of this association, with no significant heterogeneity observed. Results were consistent across different analytical approaches, strengthening the reliability of the findings.

The absence of indications of publication bias further enhanced the reliability of the meta-analysis findings. Overall, these results highlight the importance of recognizing and addressing mental health concerns in individuals affected by HDP, emphasizing the need for timely interventions and support systems to enhance overall well-being during pregnancy.

Chapter 5: Insights from the Frontline: Perspectives of Healthcare Professionals on the Association between HDP and PPD

5.1 Introduction

The preceding chapters of this thesis have delved into the intricate relationship between hypertensive disorders of pregnancy and postpartum depression in the context of LMICs, employing a systematic literature review and meta-analysis to examine existing evidence. Building upon this foundation, Chapter 5 shifts the focus to a qualitative exploration, employing expert interviews to illuminate varied perspectives and experiences.

Ghana, like many other nations, grapples with the challenges posed by hypertensive disorders of pregnancy and postpartum depression. Understanding the intricacies of this association necessitates a qualitative lens, allowing for a deeper comprehension of the lived experiences of healthcare professionals directly engaged in managing these conditions.

This chapter is dedicated to unravelling the qualitative dimensions of our research inquiry. The expert interviews, conducted with seasoned healthcare professionals, namely doctors and midwives at the University of Ghana Medical Centre, serve as the primary methodological approach. These interviews offer a platform to capture the in-depth insights, perceptions, and contextual considerations from these medical experts.

As we embark on this qualitative journey, the goal is to unearth narratives that amplify the voices of healthcare professionals, shedding light on the challenges, successes, and potential interventions concerning hypertensive disorders of pregnancy and postpartum depression in the Ghanaian healthcare setting. This chapter marks a pivotal juncture in our pursuit of a comprehensive understanding of this critical health issue.

5.1.1 Rationale

The systematic review and meta-analysis conducted as part of this research revealed a noteworthy absence of studies specifically investigating the association between hypertensive disorders of pregnancy and postpartum depression within the Ghanaian context. This glaring gap highlights the need for a qualitative exploration to complement the quantitative findings and enrich our understanding of this critical health issue.

Experts, comprising doctors and midwives at the forefront of maternal healthcare, possess a wealth of experiential knowledge. Their insights into clinical practices, and diagnostic challenges provide a qualitative layer that enhances the depth of our investigation. Given the lack of localized studies in Ghana, expert interviews offer a unique opportunity to explore the contextual dimensions influencing the association between hypertensive disorders of pregnancy and postpartum depression within the country. Understanding these factors is pivotal for tailoring interventions to the unique needs of the Ghanaian population.

Additionally, qualitative techniques can elicit vital observations, screening practices, explanatory hypotheses, and insightful data from experienced local providers to create a more holistic picture of this association as it unfolds in real-world clinical contexts in the country. As noted by the critical medical anthropologist Arthur Kleinman, physicians' interpretations of their patient encounters generate "local knowledge" that shapes healthcare delivery patterns and reveals meanings. This embedded knowledge acquired through years of practice should be leveraged to improve understanding of complex phenomena. Thus, interviewing providers in Ghana caring for women with hypertension in pregnancy can contextualize, confirm, challenge, or expand upon quantitative findings through their interpretations shaped by direct patient interactions.

Given the absence of literature on the topic under consideration in Ghana, grounded qualitative insights from local experts offer a unique opportunity to explore the contextual dimensions influencing the association between hypertensive disorders of pregnancy and postpartum depression within the country. Understanding these factors can strengthen the evidence base and is pivotal for tailoring interventions to the unique needs of the Ghanaian population.

Interviews with experts become instrumental in identifying gaps and challenges within the current healthcare system concerning hypertensive disorders of pregnancy and postpartum depression. These insights can significantly contribute to filling the void left by the absence of local studies and inform recommendations for policy improvements, resource allocation, and professional training.

Again, the qualitative data obtained through expert interviews serve as a validating mechanism for the quantitative findings from the systematic review and meta-analysis. Given the dearth of LMIC-specific studies in the existing literature, this convergence of insights enhances the robustness and credibility of our overall research outcomes.

By engaging with the narratives of healthcare professionals, we will acquire firsthand information, including statistical trends in the realities faced by those directly involved in maternal healthcare. This is needed in Ghana, where the absence of localized studies underscores the need to explore this health issue. The qualitative insights derived from expert interviews will guide the design of targeted interventions. In the absence of local studies, understanding the perspectives of those navigating the complexities of hypertensive disorders of pregnancy and postpartum depression becomes paramount for developing interventions that align with the practical realities of healthcare delivery in Ghana.

5.1.2 Objective

The study aims to gather in-depth insights from frontline maternal health experts in Ghana, focusing on the association between hypertensive pregnancy disorders and postpartum depression risk. It seeks to determine the estimated prevalence and trends in both conditions based on clinical caseloads, elucidate the co-occurrence and potential explanatory factors linking hypertensive pregnancy complications to postpartum depression, and document current screening and diagnostic practices employed by clinicians, particularly for women who encountered hypertensive related issues in pregnancy. Our objectives for this study are outlined below:

1. To understand the prevalence and trends of hypertensive disorders in pregnancy and postpartum depression among the interviewee's patients. This includes estimating the rates of co-occurrence between the two conditions.

2. To explore the interviewee's perspective on the association between hypertensive pregnancy disorders and subsequent postpartum depression, including their opinion on factors that may contribute to this association.
3. To gather details on the interviewee's clinical experience with screening and identifying signs/symptoms of postpartum depression in patients with prior hypertensive disorders.
4. To summarize risk factors and explanatory mechanisms proposed by the interviewee for the relationship between hypertensive disorders and later postpartum depression.

5.2 Methods

This qualitative study was conducted at the University of Ghana Medical Centre Ltd (UGMC), a quaternary care and research institution representing an advanced medical hub providing patient care, education, and innovative research in Ghana and West Africa. UGMC was selected as the study site due to its position as a foremost teaching and research centre focused on advancing clinical practice and outcomes locally and globally.

Semi-structured interviews were determined to be the optimal data collection approach to enable asking focused questions on the topics of interest while allowing participants freedom to share experiences and perspectives based on their clinical practice. This method aimed to leverage industry knowledge and embedded insights from frontline maternal health experts at UGMC to comprehensively depict the relationship between hypertensive and depressive postpartum conditions.

Following ethical clearance from the UGMC institutional review board (see Appendix F), a sample of ten participants comprising five female medical doctors and five midwives, all of whom were selected from UGMC. Participants were selected to achieve data saturation, ensuring that a comprehensive understanding of the research questions could be obtained. This sample size was considered sufficient to capture diverse perspectives while maintaining the feasibility of data collection and analysis within the study's scope.

Participants were approached and provided with an information sheet (see Appendix A) detailing the study's purpose, procedures, and potential risks and benefits. All participants were female with a minimum 5 years of direct experience caring for women with hypertensive disorders in pregnancy and postpartum depression. The decision to include only female doctors and midwives was guided by the recognition of the unique and gender-specific nature of maternal healthcare experiences. Additionally, it aimed to create a more comfortable environment for participants to share sensitive information related to maternal health.

The 5-year experience threshold ensured participants could share substantive practice-based insights on the patient population and clinical topics of interest. A sample of ten was determined sufficient to reach saturation across the target provider roles.

After expressing interest, prospective participants meeting the inclusion criteria were invited to partake via email and provided with a consent form (see Appendix B) to participate in the study. Signed consent forms were collected from those agreeing prior to interviews being scheduled via Microsoft Teams based on participant availability.

Semi-structured interviews lasting 20-30 minutes were conducted, recorded, and transcribed verbatim using the Microsoft Teams transcription function. The semi-structured format combined structure to gather targeted information relevant to our study goals with flexibility for participants to guide discussions based on their own observations, understandings, and what they deemed most pertinent regarding hypertension, depression, screening methods, symptomology, explanatory models, and women’s lived experiences. This approach intended to elicit optimal qualitative data from these experts to help address gaps for this complex health issue affecting Ghanaian mothers. The questionnaires used during the interviews have been attached as Appendix C.

In conducting this research, we employed Braun and Clarke’s thematic analysis method, which encompasses an iterative process comprising six steps: (1) familiarizing ourselves with the data, (2) generating codes, (3) developing themes, (4) reviewing themes, (5) defining and naming themes, and (6) identifying exemplars, as shown below.

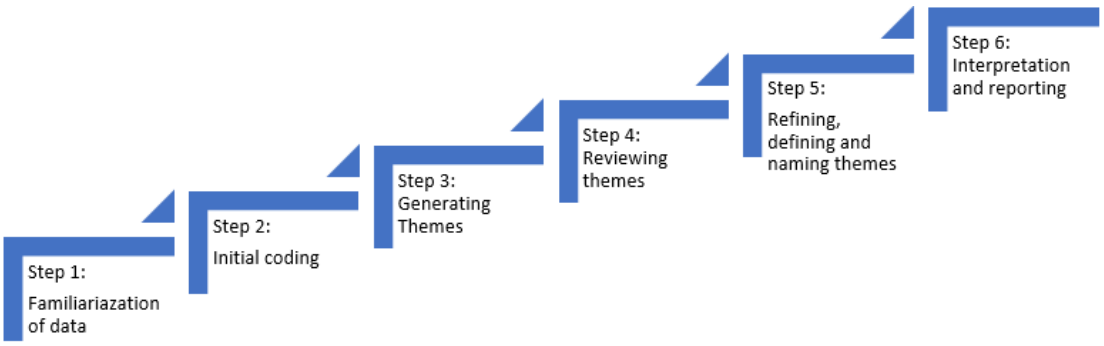

Figure 5.1: The six phases of reflexive thematic analysis (Braun and Clarke, 2021)

By adopting the process directed by Braun and Clarke, we became deeply and intimately familiar with the content of our dataset by repeatedly listening to the audio recordings to allow for qualitative immersive engagement with our data, while making notes, and highlighting any analytic idea at two levels (a segment of the data and the whole data), reading and re-reading transcripts.

Next, we systematically worked through our transcripts to identify segments of the data that appear potentially interesting, relevant, or meaningful to our research question and applied analytically meaning descriptions (code labels) to them. Coding focused on identifying recurring observations, experiences, interpretations, and meanings expressed by participants central to illuminating the relationship between hypertensive and depressive postpartum conditions among the women in their care at UGMC. We then collated our code labels and then compiled the relevant segments of data for each code.

Clusters of codes that shared a common concept which provided answers to our research questions were compiled for each candidate theme. We further developed and reviewed our themes by going back to the dataset to assess if our provisional candidate themes fitted both the coded extract and the full dataset. To ascertain the viability of our overall analysis, we fine-tuned our analysis by ensuing that each theme is clearly demarcated and is built around a strong key concept. Synopsis from this stage was carefully written out, and an informative name was assigned to each theme. We integrated our analytic narrative with compelling and vivid data excerpts during the writing process, creating a cohesive synthesis in our final write-up.

This process of identifying, analysing, and interpreting patterns, or themes, within the interview transcripts was carefully chosen to distil meaningful narratives that contribute to a richer understanding of the association between hypertensive disorders of pregnancy and postpartum depression in the Ghanaian setting.

5.3 Findings from interview with midwives

5.3.1 Sociodemographic Characteristics

A total of five midwife practitioners were interviewed for this research on hypertensive disorders in pregnancy and postpartum depression in Ghana. The midwives represented a range of professional roles and years of experience across multiple regions of the country.

Professional roles included 3 Midwifery Officers (Participants M1, M3 and M4), 1 Senior Staff Midwife (Participant M2), and 1 Senior Midwifery Officer (Participant M5). Years of practice ranged from 5 years (Participants M3 and M4) to 12 years (Participant M5), with an average across the sample of 7.4 years.

In terms of regions where participants have worked, all 5 midwives have practiced in the Greater Accra Region at some point. Four of the midwives (Participants M2, M3, M4, M5) also had experience in the Ashanti Region. Beyond this, other regions represented were Northern Region, Upper East region, Bono Region, Bono East Region, and Eastern Region, as shown in Table 5.1.

This diversity of professional experience levels and geographical practice locations enriches the qualitative perspectives shared in the interviews. The sample strikes a balance between junior to senior roles and brings insights from care provision across multiple settings in Ghana. The mid-level leadership ranks and average of 7.4 years of practice further indicate the participants have substantial clinical exposure to and understanding of these conditions among pregnant and postpartum women in their respective contexts. A summary of the perspectives of the midwives has been shown in Table 5.2.

Table 5.1: Sociodemographic characteristics of participants

Participant	Rank	Years of Experience	Regions of Practice
M1	Midwifery Officer	8	Upper East, Northern, Greater Accra
M2	Senior Staff Midwife	7	Bono, Ashanti, Greater Accra
M3	Midwifery Officer	5	Bono, Ashanti, Bono East, Greater Accra
M4	Midwifery Officer	5	Ashanti, Greater Accra
M5	Senior Midwifery Officer	12	Eastern, Ashanti, Greater Accra
D1	Senior Medical Officer	7	Greater Accra, Eastern
D2	Medical Officer	6	Greater Accra, Western
D3	Medical Officer	8	Greater Accra, Central, Upper West, Western, Volta
D4	Medical Officer	6	Greater Accra
D5	Medical Officer	7	Greater Accra

Source: Field Data (2023)

5.3.2 Theme One (Incidence and Prevalence)

This part of our thesis delves into the findings derived from qualitative interviews with the midwives, shedding light on the prevalence of hypertensive disorders, estimating rates of postpartum depression, and exploring the intricate interplay between these conditions.

5.3.2.1 Incidence of Hypertensive Disorders

The healthcare professionals from UGMC provided varying accounts of the monthly incidence of hypertensive disorders in pregnancy, offering a glimpse into the diversity of experiences within their practice. Participant M1 reported encountering approximately six cases per month, emphasizing the regularity of this health concern. In contrast, Participant M2 highlighted challenges in precise estimation, stating, "Currently, the ward I am at, we don't take care of hypertensive disorders, but mostly we have clients being admitted there once in a while. In a month, I cannot really tell." This disparity underscores the complexity of hypertensive disorders' prevalence even within a single healthcare setting.

5.3.2.2 Prevalence of Postpartum Depression

All midwives encountered a substantial number of pregnant patients with hypertensive disorders each month, indicating these conditions are prevalent. Estimates ranged

from 5 to 20 patients per month. Estimates of postpartum depression among patients with hypertensive disorders highlighted a range of perspectives within the same healthcare facility. Participant M2 estimated a modest 2%, reflecting, "Maybe 2%." On the other hand, Participant M4 suggested a slightly higher prevalence of 5%, stating, "About 5%. Because most of them do not suffer postpartum depression." These divergent figures highlight the challenges in pinning down a definitive prevalence rate, reflecting the complexity of these intertwined health conditions even within a homogeneous healthcare environment.

5.3.2.3 Postpartum Depression in the Absence of Hypertensive Disorders

Experiences here varied more widely, but most midwives had diagnosed at least some cases of postpartum depression in women without hypertension. Estimates ranged from 1 to 5 patients. Instances of postpartum depression in the absence of hypertensive disorders were considered rare within the same healthcare facility. Stressors related to labour emerged as significant contributors in these cases. Participant M2 highlighted four cases attributed to the stress of labour, emphasizing the multifaceted nature of postpartum depression causation. Participant M3 supported this observation, stating, "It is rare." These insights underscore the interconnectedness of various factors contributing to postpartum depression within the facility.

5.3.2.4 Co-occurrence of Postpartum Depression with Hypertensive Disorders

The midwives estimated between 2-50% of hypertensive patients exhibited postpartum depression. Most estimates fell in the 2-5% range, suggesting co-occurrence is low. A notable theme was the diverse perspectives on the association between hypertensive disorders and postpartum depression, even within the same healthcare facility. Estimates ranged from 2% to 50%, revealing the complexity of this relationship. Participant M1 posited a minimal correlation, stating, "Maybe like 2%." In contrast, Participant M4 suggested a substantial co-occurrence of 50%, stating, "About 50%." These disparities within the same facility underscore the need for more nuanced research to unravel the factors contributing to this variability.

5.3.2.5 Comparison to Women without Hypertensive Disorders

Experiences here varied more widely, but most midwives had diagnosed at least some cases of postpartum depression in women without hypertension. The midwives

estimated between 2-50% of hypertensive patients exhibited postpartum depression. Most estimates fell in the 2-5% range, suggesting co-occurrence is low. Rates of postpartum depression in women without hypertensive disorders were equally diverse within the facility, with stress of labour identified as a potential contributing factor. Participant M2 suggested a rate of around 20%, stating, "The other group will be like 20% mostly because of the stress of labour." Participant M3 shared insights, stating, "I would say that would be like 20%." Participant M5 provided a broader estimate, emphasizing, "Around 30 to 40%." These varied perspectives within the same healthcare setting emphasize the complexity of postpartum depression and its association with hypertensive disorders.

5.3.3 Theme Two: Trends

From the transcripts from our interview with midwives, we sought to understand the observed trends in the rates of hypertensive disorders in pregnancy and co-occurring postpartum depression over the past 5-10 years.

5.3.3.1 Trends in Hypertensive Disorders and Postpartum Depression:

Most midwives had not noticed any major trends. Participants provided a unanimous response when asked about trends over the past years. Responses from Participant M1, M2, and M5 echoed a lack of noticeable trends in the rates of hypertensive disorders and postpartum depression within their practice. However, Participant M3 noticed associations with socioeconomic background and financial constraints making women more vulnerable. The participant noted, "Their mental well-being, their socioeconomic state. Most of them come with financial constraints."

5.3.3.2 Emotional Imbalance and Pre-existing Conditions:

Another perspective emerged from Participant M4, who identified emotional imbalance and pre-existing conditions as contributing factors to postpartum depression in the presence of hypertension. The participant noted, "Most of the women that suffer postpartum depression with hypertension are mostly those who already have a pre-existing emotional imbalance….". Financial difficulties, unpreparedness for pregnancy, and the stress arising from these issues were highlighted as contributing factors.

5.3.3.3 Perceived Trends in co-occurring conditions:

When asked about trends in the rates of hypertensive disorders in pregnancy and co-occurring postpartum depression, the midwives interviewed expressed a range of perspectives based on their individual experiences. There was no clear consensus on whether the frequency of these co-occurring conditions is increasing, decreasing, or remaining stable over the past 5-10 years.

Some midwives felt rates were rising. As Participant M1 stated, "I think it may start to increase from the look of things with the signs and symptoms..." She cited factors like stress, anxiety, and depression during and after pregnancy as drivers of this increase. Similarly, Participant M4 unambiguously said "I think it is increasing," though did not elaborate on what factors are causing this uptick.

However, other midwives were unsure or doubted an increase was occurring. Participant M3 said: "I feel it is increasing, but we have trivialised it and because of that, I do not think there is data to really support the increase." This quote points to poor follow-up care and lack of data collection as obscuring the true trends. Along the same lines, Participant M5 bluntly assessed: "I have not so really observed the trend."

5.3.3.4 Factors Contributing to Trends:

On factors impacting frequency of co-occurring conditions, opinions varied. Participants articulated diverse factors contributing to observed or anticipated trends. Financial constraints, severity of hypertension, and stressors related to the postpartum period were highlighted by Participant M1. Participant M2 saw a decrease not related to hypertension. Participant M3 emphasized the lack of follow-up care and trivialization of mental health issues within the healthcare system. Participant M4 pointed to the absence of preconception care and a lack of knowledge about the pregnancy process as contributing to the increasing co-occurrence. Participant M5, acknowledging a lack of direct observation of trends, opted for a stance of stability, stating "I will go for remaining stable… I have not really observed the trend, so I cannot really compare to see whether it is increasing or really decreasing, so probably we will just keep it where it is."

5.3.4 Theme Three: Perceptions on the Association

The midwives expressed a range of perspectives on the potential link between hypertensive disorders during pregnancy and the subsequent development of postpartum depression. While experiences differed, several saw an association between the two conditions.

Participant M1 acknowledged the potential association, stating, "Yes, I see it. I can see that there will be an association between these two things." However, she noted that her direct experience with co-occurring cases has been limited. Additionally, Participant M5, drawing from subjective experiences in nursing, recalled a case where gestational hypertension was present, suggesting a potential association. The participant stated, "From what I would say, the two that I have nursed, I think one of them, in fact, if I could recall, along the way had gestational hypertension."

Participant M2 affirmed the existence of a connection, asserting, "It is a factor. There is an association with that." This concise recognition emphasizes the participant's conviction regarding a concrete connection between hypertensive pregnancy disorders and postpartum depression. Participant M3 provided more detail on factors that could connect the two conditions: "I think there is a correlation in that. Pregnancy on its own is a very stressful experience for some women. It needs a lot of support....”

Participant M4 introduced the idea that while hypertensive disorders and postpartum depression may often coexist, determining a direct causative relationship is challenging. She was uncertain if causality exists between the two: "I cannot tell for a fact if one contributes to the other."

5.3.4.1 Factors Contributing to the Association:

The exploration deepened as participants articulated factors that may contribute to the observed association. Participant M3 provided a profound insight into the challenges faced by pregnant women, particularly those with hypertensive disorders, which she believes are contributing factors to the development of postpartum depression. She emphasized the lack of support, both familial and financial, single parenthood, the mental toll of a hypertensive diagnosis during pregnancy and other pressures can compound stress during and after pregnancy, easily leading to depression." The participant noted, "That alone is mental torture and then coupled with their inability to

afford certain services." The challenges of affordability, coupled with the burden of traveling for post-discharge follow-ups, painted a vivid picture of the strain on these women's mental well-being, potentially leading to depression. Participant M4 acknowledged the presence of stress and hormonal factors, hinting at the intricate interplay of physiological and psychological elements in the association.

5.3.5 Theme Four: Screening for PPD following HPD.

The interview transcripts reveal limited use of standardized screening tools to identify postpartum depression risk among patients with a history of hypertensive disorders.

An important discovery arising from the interviews is the participants' unfamiliarity with the EPDS. None of the participants had utilized or were aware of this widely recognized screening tool, indicating potential gaps in standardized screening practices. When asked about the EPDS specifically, all five midwife participants stated they were not familiar with it. As Participant M3 plainly said: “No, I’m not.”

5.3.5.1 Alternative Screening Tools

On use of other instruments, experiences varied. Most midwives such as Participant M1 simply said “No” when asked if they use any screening tools. However, Participant M4 mentioned her practice administers a “Mental Health Assessment Scale” and set of assessment questions, though the name of the tool was not recalled: "I think we use the Mental Health Assessments Scale. There is a scale we use but I cannot recollect".

5.3.5.2 Identification of Signs and Symptoms

In the absence of standardized measures, most midwives described relying on clinical judgment and observation of signs and symptoms. Common things they looked for included mood changes like crying, lack of affection/bonding with the infant, sadness, fatigue, irritability, rejection of the baby, general responsiveness, and changes in sleep patterns. As Participant M5 explained: “You look at how the mother is ready to bond with the baby...That is what I will consider.” Participant M2 listed: "Tiredness, rejection of the baby, and mostly, they cry a lot, and they sleep too much."

5.3.6 Theme Five: Risk Factors and Explanatory Mechanisms for the relationship between HDP and PPD.

When asked about potential contributing factors and explanatory mechanisms linking hypertensive disorders to later postpartum depression, the midwives suggested various psychological, social, biological, and care-related elements.

5.3.6.1 Medication-Induced Stress and Anxiety:

Participant M5 speculated about medication effects but was uncertain, stating: "I do not know whether it has got to do with some of the drugs that we give to them when they are hypertensive." Similarly, Participant M2 highlights the psychological toll of medication, describing it as a painful experience. She further indicated that the intertwining of anxiety and concerns about the baby's well-being during hypertension treatment creates a fertile ground for the development of postpartum depression.

"The depression with hypertension, mostly deals with the medication. The medication is very painful. Also, anxiety because when we tell them that their blood pressure is high, mostly they think about the baby, whether the baby is going to survive, and what is happening in their system." - Participant M2

5.3.6.2 Counselling and Awareness during Pregnancy:

Participant M1 underscores the significance of initiative-taking counselling during pregnancy, suggesting that informing women about the potential outcomes and challenges of hypertensive disorders can play a crucial role in shaping their mental health postpartum. This preventative approach may empower women to cope with the stress associated with hypertensive pregnancies.

"I think the woman should be counselled during pregnancy and manage well for them to know the outcome of the pregnancy when they get to delivery. Counselling about the hypertension and postnatal depression during pregnancy will help in this case." - Participant M1

5.3.6.3 Intrapartum Events and Antepartum Care:

Participant M3 provided a detailed account of how negative experiences in antenatal and intrapartum care can translate into postpartum mood issues. She explored how intrapartum events and the quality of antepartum care influence that path from

hypertensive disorders to postpartum depression. Stressful birthing experiences, coupled with unsupportive care, are identified as potential catalysts for depressive symptoms.

"The intrapartum events a woman experiences can really affect how the preeclampsia or hypertensive disorder could deteriorate into depression... Pregnancy already is stress coupled with maybe a new diagnosis of hypertension, and I am assessing the facility where I have to join long queues, I have to wait several hours to get my labs done for me to be attended to, it's so stressful." - Participant M3.

She gave an example of a woman having uncompassionate suturing without anaesthesia, highlighting how "events throughout pregnancy can also affect the development of depression following hypertensive disorders."

"I have had an experience where a woman had a tear in her previous labour and then she complains of never forgetting that event because she remembers the midwife telling her that she made the delivery difficult, so she is going to suture the tear with no anaesthesia. If you make the intrapartum period stressful or some kind of punishment for a woman … it is going to torture the woman. She is going to think about this event a lot and is going to end in depression. "- Participant M3.

5.3.6.4 Social Support and Expectations:

The pivotal role of social support, particularly from partners, emerges in Participant M3's contribution. Adequate support during and after pregnancy, including financial and emotional assistance, serves as a protective factor against the development of postpartum depression.

"Most women have expectations for their partners and their husbands. And when they are rest assured that financial support, physical support in helping with the baby, helping with activities in the home and all, they become a bit relieved." - Participant M3

" *If also they do not have family support it, becomes a burden for them."* – Participant M1

5.3.6.5 The Stress of Managing Hypertension:

Participant M4 sheds light on the overarching stress associated with managing hypertension during pregnancy, emphasizing how the condition, its treatment, and potential complications contribute to the heightened risk of postpartum depression.

"I would say that the stress, having to battle with this condition of having hypertension in pregnancy... So, I think it is the stress of living with the condition." - Participant M4. Similarly, Participant M1 stated " I think it is with the stress of hypertension in pregnancy, the symptoms that they go through, and the stress. "

5.3.6.6 Psychological Impact of Pregnancy and Expectations:

Participants M2 and M3 reiterated the idea of heightened stress due to unmet expectations and the uncertainty of hypertension resolution post-pregnancy. The fear of chronic conditions lingering beyond childbirth adds a layer of psychological distress.

"Well, like I said earlier. Pregnancy is stress, and then hypertension also stresses the system... just the idea that it is will not resolve is just something else on their mental health." - Participant M3.

“ They are depressed already, because they do not tend to live their normal lives as they used to before they became pregnant.” – Participant M1

" Being pregnant, then you estimate that by nine months you will have your baby and then you go home. So immediately they find out that you have high blood pressure, they are hypertensive, then it is like everything has changed. “- Participant M2.

“I think the woman should be counselled during pregnancy and manage well for them to know the outcome of the pregnancy when they get to delivery. Counselling about the hypertension and postnatal depression during pregnancy will help in this case.” – Participant M1

5.4 Findings from interview with doctors

5.4.1 Sociodemographic Characteristics

The sociodemographic characteristics of healthcare professionals play a crucial role in understanding the context and perspectives they bring to their practice. Table 5.1 provides an overview of the participants' ranks, years of practice, and regions of practice. This section explores the sociodemographic data collected from interviews with five female doctors in UGMC, focusing on their ranks, years of practice, and the regions where they have gained experience. The aim is to provide a comprehensive overview of the diverse backgrounds of the participants and how these factors may influence their perspectives on the association between hypertensive disorders of pregnancy and postpartum depression.

5.4.1.1 Participants' Ranks

The participants in this study hold various ranks within the medical field. Ranging from Senior Medical Officer (SMO) to Medical Officer (MO), their ranks reflect the diversity of expertise contributing to the research (see Table 5.1). It also suggests a range of experiences within the medical profession, which may influence the depth of insight each participant brings to the study.

5.4.1.2 Years of Practice

The number of years each participant has been in practice is a crucial factor influencing their experience and insight. Participant D1, with 7 years of practice, brings a substantial level of experience to the study. Participants D2 and D4, with 6 years of practice each, represent mid-career professionals, while Participant D3, with 8 years of practice, and Participant D5, with 7 years of experience, further contribute to the varied levels of professional maturity within the cohort. This mix of experience levels ensures a comprehensive exploration of the topic, incorporating both seasoned perspectives and those with more recent exposure to medical practice.

5.4.1.3 Regions of Practice:

The geographical diversity of the participants' professional experiences is evident in the regions where they have practiced. Participant D1 has worked in the Greater Accra Region and the Eastern Region, showcasing a range of experiences within the

southern part of Ghana. Participant D2 has practiced in both the Greater Accra and Western Regions, providing insights into healthcare dynamics in different geographical settings. Participant D3 has a broad range of experience, spanning the Greater Accra, Central, Upper West, Western, and Volta Regions. Participant D4 has practiced in the Greater Accra Region, while Participant D5 has exclusively practiced in the Greater Accra Region. This regional diversity offers a comprehensive understanding of the healthcare landscape across various parts of the country.

5.4.2 Theme One: Incidence and Prevalence

The first theme encompasses both the incidence and prevalence of hypertensive disorders of pregnancy and postpartum depression. Through a thematic exploration of prevalence rates, co-occurrence estimates, and comparative analyses, we aim to unravel the intricate dynamics surrounding these maternal health conditions.

5.4.2.1 Incidence of Hypertensive Disorders of Pregnancy

The data from the five participants suggests that hypertensive disorders in pregnancy are quite prevalent. Participant responses provided a spectrum, with estimates ranging from 5 to 100 cases per month. Participant D1 noted a significant number, stating, "Maybe 100. It is quite a lot per month," highlighting the significant burden of hypertensive disorders in their practice, while Participant D3 encountered a more moderate frequency, stating, "Per month I can see between 5 to 10."

The doctors also shared their perspectives on the percentage of hypertensive patients exhibiting symptoms of postpartum depression. Participant responses varied, with estimates ranging from 5% to 50%. Additionally, doctors discussed the likelihood of encountering postpartum depression in patients without hypertensive disorders, revealing a range of 5% to often picking up on it.

5.4.2.2 Co-occurrence Estimates and Frequency of PPD

The exploration extends to estimates of co-occurrence between hypertensive disorders and postpartum depression. Participants shed light on the percentage of hypertensive pregnant patients exhibiting symptoms of postpartum depression.

Participant D1 and D5 suggest a substantial co-occurrence, estimating around 50% of hypertensive pregnant patients experiencing postpartum depression.

"Maybe about half of them. About 50%." - Participant D1

"Probably about half of them. About 50%" - Participant D5

Participants D2, D3, and D4 provide nuanced perspectives, with estimates ranging from 5% to 30%, reflecting the complexity of identifying postpartum depression in their specific healthcare contexts.

"Postpartum depression, at least in Africa we have a strong extended family system that helps, so not much, maybe about two a month...maybe about 30%." - Participant D2

"I would say maybe, about 1 in 3. So that will be about 30%." - Participant D3

"Well, out of about four patients, we will say one. So maybe between 25 to 30% of patients." - Participant D4

5.4.2.3 Postpartum Depression in the Absence of Hypertensive Disorders

The analysis then turns to the frequency of diagnosing postpartum depression in patients without hypertensive disorders. The ability to diagnose postpartum depression in the absence of hypertensive conditions became a focal point. The data shows that postpartum depression does occur outside of hypertensive conditions as well. Participant responses reveal varying degrees of awareness and screening practices.

While Participant D1 stated it is "very often," suggesting a high occurrence, Participant D2 shed light on the challenge of under-diagnosis, stating, "Like I said earlier…we do not really pick it up."

Participant D5 highlighted that "we are now really trying to develop the whole maternal mental health aspect of our practise. So, we have probably missed a few of postpartum depressed women." This quote underscores the challenges in identifying postpartum depression, particularly in the absence of hypertensive disorders, due to no standardized post-delivery protocols.

5.4.2.4 Comparative Analysis: Hypertension vs Non-Hypertensive Patients

The comparison between women with and without hypertensive disorders brought forth intriguing insights. Participant D2 suggested that women without hypertension might be less likely to experience postpartum depression, estimating about 2%. In contrast, for women with hypertension, the estimated occurrence was around 30%. The stress associated with hypertension management and its potential impact on mental health were evident in Participant D2's response.

In Participant D4's response, she stated "That is about 10% of women who do not have hypertension but end up having postpartum depression as compared to 30% of women who have hypertension and end up having postpartum depression. So it is, let us say 10% and then that of those hypertensives being about 30%." Participants D3 and D5 provided similar estimates ranging from 10% to 30%.

"So maybe for them it will be about 10%, or even less than 10%." - Participant D3

"For non- hypertensive women post-delivery, I mean a lot of them are actually quite excited. I will say about maybe 70 to 80% do not have any element of postpartum depression..." - Participant D5.

5.4.3 Theme Two: Trends

In this section, the clinicians provided valuable insights into the observed trends, the frequency of co-occurring conditions, and the factors contributing to these trends. Through the lens of healthcare professionals' experiences, we explore observed trends, co-occurrence rates, and factors influencing the dynamics between these two critical maternal health conditions.

5.4.3.1 Observations and Experiences

The doctors' observations on the trends varied, with some expressing clear insights into patterns while others noted a lack of specific observations. Participant D1 sheds light on a concerning trend where hypertensive disorders often lead to adverse outcomes, such as premature deliveries or loss of babies, subsequently contributing to postpartum depression.

"So, for hypertensive disorder in pregnancy, most of these women deliver babies prematurely, or even have lost their babies, so most of them do go into some form of depression postpartum." - Participant D1

On the contrary, Participant D2 and Participant D4 indicated a lack of specific trend observations. Participant D2's response, "No, I have not noticed," suggests a potential gap in monitoring or awareness regarding trends in hypertensive disorders and postpartum depression. Participant D4 echoed a similar sentiment, stating, "I do not think I have noticed any pattern per se, not that I have looked out," indicating a need for more deliberate attention to trends in their clinical practice.

Participant D5, however, highlights a noteworthy trend in their setting where pregnant women with hypertensive disorders tend to present at advanced stages, requiring earlier deliveries and often undergoing operative procedures, leading to complex emotional responses.

"...most of our pregnant women that present with hypertensive disorders usually present towards the extreme parts. They present with preeclampsia with severe features. So, they may have to undergo earlier delivery than the expected dates of delivery." - Participant D5.

5.4.3.2 Frequency of Co-occurring Conditions

When asked about the frequency of co-occurring conditions, the participants uniformly expressed a belief that the co-occurrence of hypertensive disorders in pregnancy and postpartum depression is increasing. This consensus suggests a shared concern among healthcare professionals about the rising prevalence of these interconnected conditions. The doctors attributed this increase to various factors, as discussed in the next section.

"Increasing." - Participant D1

"I think it is probably rather increasing." - Participant D2

"OK. So, I would say. It has been increasing." - Participant D3

"I think it is rather increasing, and this would be due to a lot of factors, mainly due to stress." - Participant D4

"I will think it is increasing." - Participant D5

The prevailing sentiment among the participants leans towards an increase in the co-occurrence of these conditions, as expressed by Participants D1, D2, D3, D4, and D5.

5.4.3.3 Factors contributing to the increase.

The participants identified several factors contributing to the observed increase in the co-occurrence of hypertensive disorders and postpartum depression. Participant D1 cites minimal public awareness on warning signs, stating “some of them see the symptoms and then they do not report to the hospitals.” Left unaddressed, minor symptoms can spiral into emergencies, multiplying mental health repercussions.

"I think first of all, the knowledge of preeclampsia in the communities is low. The awareness, so most of these pregnancy women do not, are not so aware of what preeclampsia is..." - Participant D1

Participant D2 identifies economic challenges in Ghana as a potential influencer, suggesting a correlation between worsening economic conditions and the increasing prevalence of these conditions. She bluntly states, “I think it is more of the economic situation. In Ghana it is getting worse, so it influences it… more of the economic situation influencing it.” Financial hardship compounds pregnancy stress, eliciting vulnerability. This emphasizes the role of economic stressors in the development of hypertensive disorders and postpartum depression.

Meanwhile lack of familial backing exacerbates circumstances, with Participant D3 highlighting risks among those devoid of support. She explains “those that do not have enough family support, they also tend to get these depressive symptoms after delivery.” Traumatic deliveries and eclampsia episodes also inflict psychological wounds. She continues “those that have very bad complications like those that have eclampsia; they also tend to have the depressive symptoms more often.”

Participant D4 pointed to stress as a significant factor, stemming from life events, health issues related to hypertension, and the associated financial and emotional strain.

"Stress among patients with varying reasons, whether it is in the life events or due to being hypertensive and its related health issues and the strain it puts on them financially, emotionally, physically. So yeah, it is rather on the increase." - Participant D4

Participant D5 provided an optimistic perspective, noting that the observed increase could be attributed to the healthcare system's heightened focus on maternal mental health. Increased awareness and more deliberate screening efforts were cited as factors contributing to the rising identification of postpartum depression.

5.4.4 Theme Three: Perceptions on the Association

When asked about connections between hypertensive pregnancy complications and subsequent postpartum depression, most doctors readily acknowledged witnessing substantial overlaps within their practices. The participant responses reveal a varied spectrum of views on the association between hypertensive pregnancy disorders and postpartum depression.

Participant D1 emphasizes the association, drawing attention to the financial burden and emotional distress that mothers with hypertensive disorders may face due to preterm deliveries necessitating Neonatal Intensive Care Unit (NICU) services. The economic strain, coupled with the worries about the health and care of these infants, becomes a catalyst for postpartum depression.

"I see an association between those two... because these patients, like I said before, have, some of them do have babies who require NICU because they may have to be delivered early and so the cost of NICU and then the cost of the NICU services and care, I mean, give them some worries and so they do tip into some form of depression." - Participant D1

Nevertheless, not every participant shares this perspective. Participant D2 expresses a divergent viewpoint, refuting a straightforward connection between hypertensive disorders during pregnancy and postpartum depression. This underscores the intricate nature of these relationships and the individual variability in the experiences of women dealing with hypertensive disorders.

"*No."* - Participant D2

5.4.4.1 Factors contributing to the Association.

The intricacies of the correlation become clearer as participants shed light on the link, especially in instances marked by unfavourable outcomes. Participant D4 provides a comprehensive overview, citing various factors that contribute to the association. From predisposition to adverse birth outcomes to the added stress of extra care, medications, and checkups, the participant weaves a narrative of cumulative challenges faced by hypertensive pregnant women. The absence of family or social support post-delivery is underscored as a particularly impactful factor, amplifying the strain during the initial phases of childcare. Participant D4 encapsulates these notions, stating "there is stress...extra medications, extra checkups...those who do not have some form of family or social support after delivery...puts much more strain on them." This quote encapsulates a complex network of stressors, encompassing biological, social, and care-related factors that exert pressure on mental reserves.

Participant D1 similarly cites “some worries” among mothers of premature newborns requiring expensive NICU stays. She explains “some of them do have babies who require NICU...the cost of NICU and then the cost of the NICU services and care, I mean, give them some worries and so they do tip into some form of depression.”

Participant D5 reinforces the connection between poorly managed hypertensive disorders and operative deliveries, linking this mismanagement to an increased likelihood of postpartum depression. The participant's reference to a recent study on maternal mental health adds a layer of empirical evidence, strengthening the argument for an association between hypertensive disorders and postpartum depression.

"Well, with the examples I gave earlier, yes, there is some trend because we had a study on maternal mental health a few weeks ago and we realized that most women end up having the operative delivery because of poorly managed hypertensive disorders... tend to really worry or have some element of postpartum depression after delivery. Yes, so there's some link." - Participant D5

Meanwhile, Participant D3 draws attention to traumatic losses as catalysts, stating "there is some link especially for those that end up with bad outcomes, like preterm deliveries, intrauterine foetal deaths (IUFDS), and those that end up with eclampsia." Losing hoped-for pregnancies after contending with harrowing physical symptoms elicits pronounced grief with psychological spillover.

5.4.5 Theme Four: Screening for PPD following HDP.

As we venture into the intricate realm of postpartum depression (PPD) in women with a history of hypertensive disorders during pregnancy, the focus shifts to the clinical experiences of healthcare professionals and their methodologies for screening and identifying signs and symptoms of this nuanced mental health condition. The complex nature of emotional challenges requires sensitivity in screening methodologies to identify distress. The findings underscore the current reliance on clinical judgement and, to a lesser extent, standardized tools in screening for postpartum depression in women with a history of hypertensive disorders.

5.4.5.1 Limited Familiarity with the Edinburgh Post Natal Depression Scale

The initial inquiry into the interviewees' familiarity with the Edinburgh Post Natal Depression Scale (EPDS) reveals a general lack of awareness among the participants. Their responses indicate a limited incorporation of formalized screening tools into their practices.

Participant D5 acknowledges a passing encounter but emphasizes the ongoing efforts to integrate maternal mental health into their system, suggesting a need for comprehensive training in standardized tools.

"No. I think I have seen it once, but I have not really paid attention... we are now really trying to incorporate the maternal mental health into our whole system. So, we have not really gone through training for what to do and how to pick up these days quite easily except for when you interact with the patients, and you get to realize that they have some sort of depression going on." – Participant D5.

5.4.5.2 Reliance on Clinical Judgement and Screening Tools

When queried about the use of other screening tools, a common thread emerges – dependence on clinical judgement. Participants D1, D2, and D5 explicitly state that their approach is primarily intuitive, guided by their interactions with patients. Detection relies on “more clinical judgment” per Participant D2.

In contrast, Participant D3 introduces the use of the Patient Health Questionnaire 9 (PHQ9) as a screening tool for patients presenting with suggestive symptoms of

depression. Although Participant D4 also incorporates the PHQ9, she underscores the importance of clinical judgement.

"I usually use the PHQ 9 questionnaire for patients... is what I use to sort of screen them and get to know their likelihood of being depressed or not." - Participant D3

5.4.5.3 Identifying Signs and Symptoms

The participants collectively provide a rich array of signs and symptoms they scrutinize when screening for postpartum depression in women with prior hypertensive disorders. Common themes include changes in mood, avoidance of the baby, excessive crying, altered activities of daily living, and poor sleep patterns.

As Participant D4 explains, “I look out for low energy levels, I look out for very poor sleep, extreme fatigue, lack of interest, any sign of stress in the patients.” Participant D3 describes examining numerous dimensions as well, stating “I look out for very poor sleep, anhedonia. I look out for depressed mood, loss of appetite, general loss of energy and interest in the child and the care of the child.” Their multi-faceted approach recognizes the interconnected nature of postpartum experiences.

Despite the absence of a systematic approach, their conversations unveil refined clinical expertise, adept at identifying crucial cues from distressed mothers. Participant D1 illustrates this by noting that "relatives will come complain the patient is always in bed" and shows disinterest in basic self-care.

"The patient might have, the activities of daily living, you realize that the patient's relatives will come complain the patient is always in bed, does not take the shower, does not seem to be active per usual." - Participant D1

Participant D2 outlines a comprehensive set of questions, encompassing feelings of sadness, guilt, anxiety, loss of interest in activities, mood swings, tiredness, and unnecessary crying. This detailed inquiry reflects a holistic approach to assessing emotional well-being.

During inquiries about self-care adherence, Participant D5 notices “their demeanour and what they tell you” Indicating exhaustion coping with hypertension. Changes in demeanour and expressions become key indicators of underlying issues.

"So, the main thing is their demeanour and how they relate when you tell them that their blood pressures are not being properly controlled... And that is when you tend to see that they have some issues." - Participant D5

5.4.6 Theme Five: Risk Factors and Explanatory Mechanisms:

The complex connection between hypertensive disorders during pregnancy and postpartum depression (PPD) unravels through a multitude of risk factors and explanatory mechanisms. This essay explores the profound perspectives offered by healthcare professionals, illuminating the intricate nature of this association and its implications for the mental well-being of mothers after childbirth.

5.4.6.1 Financial Strain and Complications

Participant D1 underscores the financial burden associated with hypertensive disorders. The costs of care, coupled with potential medical complications such as kidney failure and the loss of babies, emerge as significant contributors to the heightened risk of postpartum depression.

"Cost of care, the fact that some of them do lose their babies, the fact that some of them need caesarean section for their delivery. So, these are the three that come to mind now." - Participant D1

5.4.6.2 Lack of Social Support

Participant D2 emphasizes the critical role of social support postpartum. The absence of adequate support, compounded by the stressors of medication and the challenges of caring for a newborn, forms a nexus of vulnerability for women with hypertensive pregnancy disorders.

"Then again, I think factors contribution is probably lack of social, basically not getting enough help postpartum. Taking medications and then all the other stressor, even taking care of your child, is enough stress, a baby is enough stress, and it is new to the system, new to the body, new to the environment. So basically, lack of social support. That is what I think." - Participant D2

5.4.6.3 Antenatal Procedures and Stress

Participant D3 delves into the stress induced by extensive investigations and care procedures during the antenatal period. The heightened risk of bad outcomes, surgical deliveries, and preterm deliveries adds layers of stress that can trigger postpartum depression.

"Hypertensive disorders generally put patients at risk of more extensive investigations and care procedures during the antenatal period which tends to put a lot of stress on them that can trigger depression post-delivery." - Participant D3

5.4.6.4 Increased Medical Demands and Strained Support Systems

Participant D4 highlights the increased medical demands placed on women with hypertensive disorders. The necessity for frequent follow-up checks, extensive clinical care, and potential financial strain further amplifies the risk of postpartum depression, particularly when spousal and social support is lacking.

"For patients who are hypertensive, they have to do extra as compared to patients who are not... Some of these factors can put a strain on them. Some might at the end of the delivery may have low level spousal support, some may have low level social or family support and all these put a strain on their emotions and physical well-being and can tip them over into depression." - Participant D4

5.4.6.5 Early Delivery and Neonatal Intensive Care Unit (NICU) Concerns

Participant D5 elaborates on the correlation between hypertensive disorders and early delivery. The distressing circumstances of premature births, concerns about the well-being of the baby in the NICU, and the additional emotional and financial burdens contribute significantly to the development of postpartum depression.

"So, I think that is the main correlation between those with hypertensive disorders and postpartum depression, with the fact that some of them come in very late, and most of them also report with severe features, so delivering earlier than the date of expected date of delivery really compounds to they having postpartum depression because they are not ready to deliver." - Participant D5.

The summary perspectives of the maternal health professionals interviewed in this study is presented below in Table 5.2.

Table 5.2: Summary of Perspectives on HDP and PPD from Frontline Health Workers.

Theme	Code	Example from Transcript
Prevalence	Prevalence_HDP	"I will say like 6. Six patients per month." - Participant M1 "That should be about 20 a month."- Participant M4 "I will say, my facility where I work about 15 women…it is quite common here." – Participant M5 "Maybe 100 per month. It is quite a lot."- Participant D1 "Between 5 to 10 per month."-Participant D3
	Prevalence_PPD	"Maybe 2%." - Participant M1 "I will keep it there at 5. It's not much that I have come of across.- Participant M5 "I will say like 3%." – Participant M3
	Co-occurrence_HDP_PPD	"About 50%." - Participant M4 "Maybe about half of them. About 50%." – participant D1 "About 30% of hypertensive patients also have postpartum depression." – Participant D3 "Between 25 to 30%..."- Participant D4
	Comparison_HDP_NoHDP	"The other group will be like 20% mostly because of the stress of labour." - Participant M2 "30% of women with hypertension experience postpartum depression compared to 10% without hypertension."- Participant D4 "About 30% with postpartum depression among women with hypertensive disorders compared to maybe 10% among women without hypertension."-Participant D3
Trends	Trend_Observation	"No, please, I have not." - Participant M1 "I have not noticed any significant changes over the past five years."- Participant M3 “ Most of the women that suffer postpartum depression with hypertension are mostly those who already have a pre-existing emotional imbalance in terms of maybe they are having issues maybe at home.” - Participant M4 "No, please. I have not noticed any trends. I have not paid attention to such."-Participant M5 "Most of these women deliver babies prematurely, or even lose their babies, so most of them do go into some form of depression postpartum."- Participant D1

		"Most of our pregnant women that present with hypertensive disorders usually present towards the extreme parts."- Participant D5
	Trend_Change	"I think it may start to increase from the look of things ..." - Participant M1 "Well, I think it is increasing. Just that depression and then mental health in general is one area of health that has really been neglected..."- Participant M3 "I think it is rather decreasing because those I have encountered..." – Participant M2 "I will go for remaining stable." – Participant M5 "I think it is increasing."-Participant D2 "It has been increasing."- Participant D3 "I think it is rather increasing, and this would be due to a lot of factors, mainly due to stress."- Participant D4 "I will think it is increasing more likely to the fact that we are now keener on maternal mental health."- Participant D5
	Trend_ContributingFactors	"The common thing I have noticed with such women is mostly with their socio-economic background…" - Participant M3 "I think the lack of the preconception care, the fact that most of the women lack knowledge about the whole pregnancy process and everything..."- Participant M4 "Increasing awareness of maternal mental health issues contributes to rising rates."- Participant D5 "Mainly due to stress among patients with varying reasons, whether it is in life events or due to being hypertensive and its related health issues and the strain it puts on them financially, emotionally, physically."- Participant D4

Screening	Screening_Tool	"No, please." - Participant M1 "I think we use the Mental Health Assessment Scale."- Participant M4 "Based on the clinical judgement."- Participant M5 "It is based on clinical judgment." – Participant D1 "I use the PHQ 9 questionnaire for screening."- Participant D3 "Mainly based on clinical judgment for now."- Participant D5 "More on clinical judgment."- Participant D2
	Familiarity_EPDS	"I am not, please." - Participant M1 "No, I am not." - Participant M3 "No please"- Participant M5 "I am sorry. No, I am not very familiar with it."- Participant D1 "No, I am not." - Participant D3 "No, I am not." - Participant D4 "No. I think I have seen it once, but I have not really paid attention...we are now really trying to incorporate the maternal mental health into our whole system."- Participant D5
	Screening_SignsSymptoms	"With patients who have had hypertension in pregnancy, after delivery, when they are being assessed, we first and foremost see their mood, their affection towards the baby immediately baby comes out." – Participant M1 "So, you look at how the mother is ready to bond with the baby. How Mother is ready to breast feed. Her mother reacts when baby cries."- Participant M5 "Mood swings, and I think their affection towards the child, and their responsiveness to either the healthcare personnel or even their relatives." - Participant M4 "Feeling sadness, guilt, anxiety, mood swings, and tiredness."- Participant D2 "Very poor sleep, anhedonia, depressed mood, loss of appetite, general loss of energy and interest in the child and the care of the child."- Participant D3

Association	Association_HDP_PPD	"Yes, I see it. I can see that there will be an association between these two things." - Participant M1 "There might be some association, but I cannot give you the exact figures."- Participant M3 "Most of the women that suffer postpartum depression with hypertension are mostly those who already have a pre-existing emotional imbalance."- Participant M4 "Well, I cannot really give any association anyway." – Participant M5 "Yeah, I will say yes. I see an association between those two."- Participant D1 "Yes, because women who are hypertensive are predisposed to issues like preterm delivery or surgical delivery."- Participant D4
	Association_Factors	"Being pregnant and then you estimate that by nine months you have your baby and then you go home. So immediately they find out that you have high blood pressure. You are hypertensive, then it is like everything is…" – Participant M2 "They often coexist in a patient, but I cannot tell for a fact if one contributes to the other aside the fact that I know there is stress and hormones."- Participant M4 "...coupled with their inability to afford certain services..." – Participant M3 Participant M4: "They do not have any preconception care, so they just get into it as when it comes, whether they are ready or not, whether they have any knowledge of what they are getting themselves into."- Participant M4 "Pregnancy on its own is a very stressful experience for some women. It needs a lot of support, especially from family, and the partner, but where I worked, my facility was at a place where most of them were single parents." - Participant M3 "Cost of care, the fact that some of them do lose their babies, the fact that some of them need caesarean section for their delivery."- Participant D1 "Hypertensive disorders generally put patients at risk of more extensive investigations and care procedures during the antenatal period which tends to put a lot of stress on them that can trigger depression post-delivery."- Participant D3

		"There is some trend because we had a study on maternal mental health...and we realised that most women...tend to really worry."- Participant D5

Risk Factors	RiskFactors_Contributing	"I think it is just the stress of dealing with the condition and sometimes the medications."- Participant M1 "The intrapartum events a woman experiences can really affect how the preeclampsia or hypertensive disorder could deteriorate into depression..."- Participant M3 "I would say that the stress, having to battle with this condition of having hypertension in pregnancy. The fact that you would have to be put on medication..."- Participant M4 "The medication is very painful. Also, anxiety because when we tell them that they are blood pressure is high, mostly they think about the baby, whether the baby is going to survive, and what is happening in their system." - Participant M2 "...If also they do not have family support it, becomes a burden for them." – Participant M1 "I think their stress level is almost always high because they always have to look out for their management. And I think the medications that they are constantly on too also puts them at risk..." - Participant M4 "Some of them become chronic, and then they have to live with it is the rest of their life. So sometimes just the idea that it is will not resolve is just something else on their mental health."- Participant M3 "Stress from extensive medical care and lack of social support contribute to depression risk."- Participant D4 "Patients with hypertension have higher risks due to bad outcomes and stress during pregnancy."- Participant D3 "Lack of social support increases the risk of developing postpartum depression."- Participant D2 "They are at more risk because this condition predisposes them to having bad pregnancy outcomes, including intra uterine foetal deaths with term deliveries, instrumental deliveries and all that which with the kind of stresses involved in it can easily tip them into depression post-delivery."- Participant D3 "They are at a higher risk of preterm delivery, they are much more stressed, they have much more to do as far as their medical condition is concerned."- Participant D4

Source: Field Data (2023)

5.5 Summary of the chapter

The chapter, dedicated to semi-structured interviews in the study on hypertensive disorders of pregnancy and postpartum depression in Ghana provided rich qualitative insights from healthcare professionals. The research sought to understand the nuanced experiences, perceptions, and challenges faced by these professionals in managing pregnant women with HDP and the subsequent occurrence of PPD.

The participants included doctors and midwives who have worked with pregnant women in various regions, offering a comprehensive and varied perspective (refer to Table 5.1). The interviews involved healthcare professionals with diverse ranks and years of practice, collectively covering extensive experience across 75% of Ghana's regions. This geographical diversity strengthened the external validity of the qualitative findings, ensuring that the experiences and insights reflected the diverse contexts within the country.

Key findings from the interviews illuminated the intricate association between HDP and PPD (refer to Table 5.2). The prevalence of HDP varies among healthcare providers, with estimates ranging from 5 to 100 cases per month. The healthcare professionals reported a substantial number of hypertensive pregnancies, emphasizing the critical health priority that HDP represents in pregnancy. Similarly, the prevalence of PPD is varied, with estimates ranging from 2% to 5%. They highlighted a co-occurrence of PPD among HDP patients, with estimates ranging from 2-50%. More severe variants of HDP, such as severe preeclampsia and eclampsia, were associated with the highest likelihood of experiencing PPD.

Healthcare providers observe diverse trends in HDP and PPD prevalence. While some perceive stability or decrease, others note an increasing trend. Factors contributing to these trends include increased awareness of maternal mental health issues and the socio-economic background of patients. Notably, the association between HDP and PPD is recognized by healthcare providers, who observe that women with HDP are predisposed to PPD due to factors such as preterm delivery and stress.

The professionals shed light on the mental health consequences of HDP post-delivery, with estimates suggesting that a significant proportion of hypertensive patients exhibited symptoms of postpartum depression. The interviews further highlighted the challenges in diagnosing and managing PPD among HDP patients, with variations in screening practices and awareness levels among healthcare professionals.

Screening for PPD among women with HDP primarily relies on clinical judgment, although few participants utilize screening tools like the Patient Health Questionnaire 9 (PHQ-9). Participants express varying levels of familiarity with screening tools, indicating a need for further training and incorporation of maternal mental health into healthcare systems.

The association between HDP and PPD is acknowledged by healthcare providers, who attribute it to factors such as stress, socio-economic status, and medication compliance. Intrapartum events, lack of family support, and extensive medical care during pregnancy are also cited as contributing factors. Participants emphasize the need for holistic care and support to mitigate the risk of PPD among women with HDP.

Stress, medication compliance, lack of social support, and the chronic nature of HDP are identified as significant risk factors for PPD among women with HDP. Healthcare providers stress the importance of addressing these factors to improve maternal mental health outcomes.

Addressing these issues requires a multifaceted approach that integrates clinical care, mental health support, and socio-economic interventions. By understanding and addressing these themes, healthcare providers can enhance the quality of care and outcomes for women affected by HDP and PPD.

The qualitative data not only complemented the quantitative findings from the systematic review and meta-analysis but also provided a deeper understanding of the lived experiences of healthcare professionals dealing with these complex maternal health issues. The chapter underscored the need for a holistic approach to maternal care, considering the intersection of physical and mental health, and it identified potential areas for improvement in healthcare practices, such as standardized screening tools and enhanced support systems.

Chapter 6: Discussion of results

6.1 Introduction

This research aimed to investigate the association between hypertensive disorders of pregnancy (HDP) and postpartum depression (PPD) in Ghana. Our systematic review, meta-analysis, and qualitative interviews with midwives and doctors in Ghana converge to provide evidence supporting a linkage between these conditions. Again, this research presents a snapshot of the complex relationship between hypertensive disorders in pregnancy and postpartum depression within a specific Ghanaian healthcare facility. The diverse perspectives of healthcare professionals provide valuable insights into the practices and challenges maternal healthcare within this setting.

6.2 Discussion

Our systematic review revealed higher rates of depressive symptoms, state anxiety, and trait anxiety in the postpartum period among women with HDP compared to controls (Abedian et al., 2015; Chen et al., 2019). In addition, the meta-analysis showed a robust, positive association between HDP and PPD, with pooled odds ratios ranging from 2.24 to 2.61 (Chen et al., 2019; Sarosh et al., 2022; Strapasson et al., 2018). Notably, the risk of PPD appeared to escalate with HDP severity across studies. More severe variants like severe preeclampsia and eclampsia were associated with the highest likelihood of experiencing PPD (Mbarak et al., 2019; Sarosh et al., 2022). This dosage-response gradient strengthens the case for a causal linkage. Social and care-related factors may also contribute to this relationship.

These findings are consistent with other research in this area. Blom et al. (2010) also reported a significant association between preeclampsia and postpartum depression, with an OR of 2.4 (95% CI: 1.28–4.50; p = 0.007). Moreover, Youn et al. (2017) found that preeclampsia was associated with postpartum depression, with an odds ratio of 1.12 (95% CI: 1.03 –1.22), even after adjusting for age, obstetric complications, and previous history of depression. Similarly, Bergink et al. (2015) demonstrated that the highest risk of developing psychiatric disorders, including unipolar depression, was observed 0–3 months postpartum in women with preeclampsia, with a RR of 2.85

(95% CI: 1.84–4.42). Additionally, Meltzer-Brody et al. (2017) reported that preeclampsia increased the risk of depression in the first year postpartum by 1.45 times (IRR 1.45, 95% CI: 1.14–1.84).

Moreover, a meta-analysis conducted by Caropreso et al. (2022) revealed an increased risk of PPD among women with preeclampsia (OR = 1.54) and gestational hypertension (OR = 1.42). Furthermore, examining the association between preeclampsia and severity of depressive symptoms in the postpartum period, the review by Caropreso and colleagues found a standard mean difference of 1.04 (95% CI: 0.22 - 1.86; p = 0.01), indicating higher severity of depressive symptoms in women with a history of preeclampsia. Similarly, outside the perinatal period, the association between preeclampsia and severity of depressive symptoms was significant, with a standard mean difference of 0.18 (95% CI: 0.05 - 0.31; p = 0.007), suggesting higher severity of depressive symptoms in women with a history of preeclampsia.

Furthermore, Mommersteeg et al. (2016) found that women with a history of preeclampsia reported more subsequent depressive symptoms (B = 0.70, 95% CI 0.09 – 1.32, p = 0.026) compared with controls in a follow-up of up to 14 years. Additionally, Postma et al. (2014) reported significantly worse scores for depressive symptoms among women who had preeclampsia, 7 years after delivery. Specifically, women with preeclampsia had a mean depression score of 4 (SD = 3.4) and women with eclampsia had a mean depression score of 5 (3.5), whereas controls had a mean depression score of 3 (SD = 2.9). A significant between-group effect observed for depression scores ($F(2,142) = 3.87$, $p = .02$), and an effect size (partial η^2) of 0.054 were recorded. This finding is consistent with the results reported by Delahaije et al. (2013), who provided evidence linking preeclampsia to subsequent psychopathology, suggesting a higher prevalence or severity of psychopathology among women with a history of preeclampsia compared to those without.

In our qualitative study, the diversity in participants' ranks and years of practice represented a blend of expertise and experience within the healthcare sector. Overall, our participants collectively worked with pregnant women in twelve out of the sixteen regions in Ghana. Their extensive experience across 75% of the country's regions introduced geographical diversity among participants, thereby bolstering the study's findings' generalizability.

The insightful interviews with frontline workers of maternal health illuminated the realities of the prevalence, complexity, and interconnections between hypertensive disorders in pregnancy and subsequent postpartum depression. Their experiences lent quantitative insights and sobering perspectives regarding these conditions among the patients they serve. The estimates showcased markedly heightened risks conferred by compounding pregnancy-related health issues and traumatic delivery events onto the vulnerable postpartum mental state.

The findings revealed a complex landscape where hypertensive disorders in pregnancy and postpartum depression are intertwined yet variable in their associations. Stressors related to labour emerged as a common thread, emphasizing the need for a comprehensive approach to maternal healthcare. The discrepancies in estimates highlighted the challenges in generalizing prevalence rates even within a singular facility, emphasizing the necessity for more extensive research to unravel the intricacies of these health conditions.

The doctors uniformly reported high volumes of pregnant patients presenting with hypertensive disorders monthly. Ranging from 5 to 100 patients, the numbers signified the extensive reach of this critical health issue. For context, Participant D5 saw up to 30 hypertensive patients monthly amidst a bustling obstetric practice. Participant D1 described it as "quite a lot" while managing around 100 cases monthly. These prevalence estimates reaffirm hypertensive conditions as a major health priority in pregnancy.

Their experiences additionally reveal the mental health consequences of these disorders post-delivery. The midwives proposed a co-occurrence, with estimated rates of PPD among HDP patients ranging from 2-50%. Approximately half of the doctors cited co-occurrence rates approaching 50 percent. Participants D1 and D5 explicitly estimated that half of their hypertensive patients display symptoms of postpartum depression. Participant D3 echoed this sentiment, reporting about a third of cases based on adverse outcomes. These estimates painted a picture of vulnerability, with stress and trauma compounding the physiological disruptions.

The observed increase in co-occurring conditions aligned with global concerns about the intersection of physical and mental health during the perinatal period. The diverse factors identified, including economic influences, lack of awareness, and stress,

underscored the need for a holistic approach to maternal care that addresses both physical and mental well-being.

Comparisons to unaffected women reinforced this disparity. All doctors perceived substantially lower postpartum depression rates in those lacking hypertension during pregnancy. Estimates hovered around 10 percent in this group. Participant D5 described the majority without comorbidities as "excited" while chiefly worried about basic postpartum health questions. Conversely, factors like traumatic deliveries and operative procedures introduced risks for this population as well. Yet estimated likelihood remained markedly dampened.

Meanwhile, some interviewees quantified a 3-to-5-fold greater risk of depression among hypertensive patients. Participant D2 cautioned against underestimations due to post-discharge gaps in follow-up care. Thus, true rates may have proven even higher as care continuity issues resolved. Still, the numbers underscored stark inequities in vulnerability between groups. Echoing the midwives, the layered stressors stemming from hypertensive diagnosis, treatment rigors and uncertain outcomes distilled substantial psychological challenges atop the physical disease burden.

In all, the doctors spotlighted an elevated risk among those facing compounding health and trauma issues during childbirth. Their prevalence estimates unveil susceptibility concentrated among women battling hypertension alongside stressful deliveries. While postpartum excitement often awaited unaffected women, apprehension, uncertainty, and distress frequently plagued their hypertensive counterparts. The numbers compelled solutions targeting prevention and timely intervention for those navigating hazardous maternal health terrain. Streamlining screening and support through integrated care models promised protection for those most at risk.

The varying levels of awareness and observation among participants also highlighted potential areas for improvement in healthcare practices. Strengthening awareness campaigns, implementing regular trend monitoring, and enhancing support systems for at-risk individuals could contribute to a more effective approach to addressing these interconnected health issues.

While some interviewees reported observing increases in their patients, others were sceptical or had not noticed clear trends. The mixed perspectives indicated a need for more rigorous tracking and diagnosis of hypertensive disorders and postpartum

depression over extended periods. This would provide clearer data on trends and help determine appropriate interventions if rates are indeed rising. Until such data existed, experiences will continue to vary among healthcare professionals.

The experts acknowledged pregnancy-related hypertension and postpartum depression could coexist and associate with one another, there were mixed perspectives on whether a direct causal relationship existed. Nonetheless, compounding stressors and burdens on mothers - be they medical, financial, social, or emotional - emerged as consistent factors that could precipitate depression during the postpartum period. Tracking co-occurring cases over time and identifying factors surrounding them may provide more clarity. But for now, experiences varied regarding the precise nature of association between these conditions.

All the experts interviewed were not using the gold standard screening tool, EPDS, although a few of them utilized other standardized screening tool for postpartum depression. Overall, a greater percentage of our participant relied solely on clinical judgement in the immediate postpartum period to detect women who have or are developing PPD. Identification of PPD following hypertensive pregnancy complications relied on subjective measures like observation of mood and behaviour changes. Formal screening tools were rarely used to systematically identify women at risk for postpartum depression, especially among those with prior hypertensive disorders. While an important first step, more consistent use of validated screening scales could strengthen detection of at-risk mothers. Combining clinical judgment with standardized instruments may hold promise for improving identification and subsequent support. Implementing systematic use of validated screening tools could enhance detection of postpartum depression in this at-risk population. But for now, clinical judgement drove most diagnosis.

6.3 Interpretation and implications

Our multi-pronged findings provide credible evidence that HDP and PPD frequently co-occur and likely share an underlying connection in Ghana. Though our systematic review and the meta-analysis included other studies from LMICs, the interviews focused specifically on the Ghanaian context. The implications of our systematic review extend beyond statistical associations, providing a foundation for

understanding the multifaceted dimensions of HDP-PPD co-occurrence. The dosage-response gradient not only substantiates the statistical linkage but also underscores the clinical relevance of hypertensive severity in predicting postpartum mental health outcomes. Amalgamation of findings from our systematic review and qualitative study paints a comprehensive picture of the intricate association HDP and PPD in the Ghanaian context. Together, this emphasizes the importance of screening and supportive mental health interventions for those experiencing HDP.

The high estimated prevalence of PPD among HDP patients suggest that providers need to have a high index of suspicion. The prevalence estimates provided by healthcare professionals underscore HDP as a major health priority in pregnancy, with varying caseloads reaching up to 100 hypertensive patients per month in some instances. The co-occurrence rates of PPD among HDP patients, reaching 50%, illuminate the vulnerability of this population, particularly when compounded by stressors related to labour and adverse outcomes. On the other hand, discrepancies in prevalence estimates and observations among healthcare professionals highlight the challenges in generalizing prevalence rates even within a singular facility. The diverse factors identified, including economic influences, lack of awareness, and stress, underscore the need for a holistic approach to maternal care that addresses both physical and mental well-being. The observed increase in co-occurring conditions aligns with global concerns about the intersection of physical and mental health during the perinatal period.

It is crucial to note that the experiences women undergo during labour play a significant role in the onset of postpartum depression. Guure et al. (2023), in their recent community study conducted in Ghana and three other African countries, discovered that women who face mistreatment during childbirth have an elevated likelihood of developing postpartum depression, a finding consistent with the observations reported by Participant M3.

However, the lack of familiarity with tools like the EPDS is concerning and likely contributes to the variability in estimates. Sole reliance on clinical judgment for identifying PPD among women with prior hypertensive disorders signifies a critical gap in current healthcare practices. Standardizing screening practices is imperative. Implementing systematic use of validated screening tools, such as the EPDS, into

routine maternal care could enhance detection of PPD in this at-risk population. Combining clinical judgment with standardized instruments holds promise for improving identification and subsequent support. Trends are unclear, so monitoring rates over time is also key.

Comparisons between women with and without hypertensive disorders reinforce disparities in vulnerability. The substantially lower rates of postpartum depression in the absence of hypertensive conditions highlight the amplified risk faced by those battling hypertension alongside stressful deliveries.

Strengthening social support systems and enhancing experiences in antenatal and intrapartum care emerged as ways to potentially mitigate this risk of association. The stress of managing HDP itself also appears pivotal. Making care patient-centred and raising awareness may lessen the blow of diagnosis. Counselling couples on preparing for the potential outcomes can set appropriate expectations. Addressing unresolved trauma from prior experiences like uncompassionate suturing should be prioritized.

6.4 Strengths

Our study applied a mixed-methods approach leveraging multiple designs suited to assess our research question from diverse vantage points. The systematic review provided a rigorous synthesis of existing evidence. Our systematic review provides a robust foundation for understanding the statistical linkage between HDP and PPD. The inclusion of multiple studies and a meta-analysis enhances the reliability and generalizability of our findings. The dosage-response gradient identified in severe variants adds a nuanced layer, offering clinicians and researchers a clinically relevant perspective. The meta-analysis added statistical precision in estimating effect sizes. Interviews allowed for richer qualitative detail. Using local frontline workers in maternal healthcare ensured context relevance regarding clinical practices and women’s experiences of these conditions in Ghana.

The qualitative arm of our study involves healthcare professionals working across 68.75% of Ghana's regions. This geographical diversity strengthens the external validity of our qualitative findings, ensuring that the experiences and insights gleaned are reflective of the diverse contexts within the country.

Engaging frontline healthcare workers provides a unique and in-depth understanding of the lived experiences and challenges faced in maternal health practice. The diverse ranks and years of practice among participants add richness and depth to our qualitative insights.

The integration of quantitative evidence from the systematic review and qualitative perspectives from healthcare professionals offers a comprehensive understanding of the HDP-PPD association. This blended approach allows for a more holistic interpretation of the complex relationship between these two conditions.

Uncovering the limited use of standardized screening tools for PPD among women with prior hypertensive disorders sheds light on critical gaps in current healthcare practices. This identification of gaps not only highlights areas for improvement but also lays the groundwork for future interventions.

6.5 Limitations

The systematic review includes studies with varying designs and methodologies, introducing heterogeneity. While efforts were made to account for this in the analysis, the inherent diversity in study approaches may impact the precision of our estimates. The studies included in our systematic review were from other LMICs as there was no literature available at the time of the review from Ghana. These studies, conducted in specific settings and populations, limits the generalizability of our findings to the Ghanaian population. Additionally, variations in healthcare systems and practices across different countries may affect the external validity of our results.

We only included three studies in our meta-analysis, limiting certainty in some statistical estimates. Although our participants have worked in different regions in the country, this research did not allow for the exploration of disparities in regional practices, healthcare infrastructure, and cultural influences, contributing to a more comprehensive understanding of the relationship between HDP and PPD in the Ghanaian context. The reported experience may not be wholly nationally generalizable.

Qualitative data relied on the professional's recollection of cases rather than direct patient data. While efforts were made to include a diverse range of participants, subjectivity in experiences and perceptions introduces the possibility of re-call bias

and individual variations in responses, as their insights are based on past experiences and observations. This may impact the accuracy and completeness of the information provided during the interviews.

Participants in the qualitative study may exhibit social desirability bias, providing responses that align with perceived societal norms or expectations, rather than accurately reflecting their true experiences or opinions. This bias might lead participants to underreport or downplay symptoms of postpartum depression or hesitate to discuss personal views openly. Consequently, it has the potential to impact the accuracy and openness of their accounts, especially when addressing sensitive topics such as mental health. As a result, the findings may not fully capture the extent or severity of mental health issues experienced by individuals with hypertensive disorders of pregnancy.

The revelation that healthcare professionals are not uniformly using the gold standard screening tool, EPDS, indicates a limitation in the consistency of screening practices. The reliance on clinical judgment alone may result in the under detection of PPD cases.

The varying levels of awareness and observation among participants highlight potential areas for improvement in healthcare practices. However, the differences in awareness may also introduce variations in the accuracy of reported prevalence rates.

The exclusion of women patients' perspectives from the research presents a significant limitation. Women patients bring firsthand knowledge and experiences crucial for understanding the conditions comprehensively. Excluding their voices undermines representativeness, limits qualitative insights, and perpetuates healthcare disparities by marginalizing the perspectives of vulnerable groups, hindering the development of inclusive interventions. This exclusion affects both research and clinical practice, limiting the comprehensiveness of findings and potentially leading to gaps in healthcare delivery. This undermines efforts to promote patient-centred care and equity in maternal health.

6.6 Future Directions

There is a need for more large-scale quantitative studies and multicentre qualitative explorations in Ghana to characterize factors mediating the development of PPD in

those with HDP. Comparing practices and experiences between facilities and regions may further contextualize screening and intervention gaps needing redress across the country. Standardization of definitions, measurements, and screening practices for both HDP and PPD nationally is also imperative to enable consistent monitoring and surveillance. Research should elucidate social and healthcare-related triggers of this linkage to shape preventative programs tailored uniquely to Ghanaian settings. Evaluating such targeted interventions through robust pilot trials would further advance this critical field of maternal mental health in Ghana.

It is imperative for future research efforts to adopt inclusive methodologies that actively engage and uplift the voices of affected women who have grappled with HDP and PPD. Embracing inclusivity is not just about including a diverse range of participants on paper; it is about genuinely valuing their insights, stories, and viewpoints throughout the research journey. By inviting women patients who have navigated HDP and PPD to share their lived experiences, we gain invaluable insights into the daily challenges they have faced, the strategies they have employed to cope, and their preferences for support and treatment. Their stories breathe life into our research findings, painting a richer and more exact picture of how hypertensive disorders during pregnancy intersect with postpartum mental health. When we honour their experiences within academic discourse, we affirm their worth and agency, elevating their voices from mere statistics to influential agents of change, validate their significance and empower them to be catalysts for change, moving beyond being mere statistics to become influential advocates. This approach enables the development of more empathetic and efficient interventions, policies, and support networks to directly confront these multifaceted challenges.

Future directions for addressing the inconsistency in postpartum depression screening practices include implementing standardized training programs for healthcare professionals, integrating screening protocols into routine care, fostering multidisciplinary collaboration, leveraging technology for broader access to screening and support services, and engaging communities to raise awareness and reduce stigma surrounding PPD. Additionally, adopting the WHO guide for the integration of perinatal mental health in maternal and child health services is essential. These efforts aim to improve the timely detection and management of PPD, ultimately enhancing

outcomes for mothers and families. Incorporating other healthcare professional like psychiatrists and clinical psychologists into future research on postpartum depression brings valuable expertise and perspectives to the table. With their specialized skills, they can provide more accurate diagnoses, customize treatment plans, coordinate holistic care, enrich training for healthcare providers, and drive innovative research in maternal mental health. This collaboration not only enhances the support available to mothers experiencing PPD but also fosters a compassionate and evolving approach to maternal healthcare.

This research explored the relationship between hypertensive disorders of pregnancy and postpartum depression in Ghana using a mixed-methods approach encompassing a systematic review, meta-analysis, and qualitative interviews with midwives and doctors. The research allowed for a comprehensive exploration of the incidence, prevalence, trends, perceptions, screening practices, and risk factors associated with the co-occurrence of HDP and PPD. Triangulating findings from these diverse lines of evidence provides robust support for a linkage between HDP and subsequent development of PPD among women in Ghana.

6.7 Summary of the chapter

The study conducted a comprehensive exploration of the association between hypertensive disorders of pregnancy and postpartum depression in Ghana, employing a mixed-methods approach. The systematic review and meta-analysis revealed elevated rates of depressive symptoms and anxiety in postpartum women with HDP, confirming a robust positive association with pooled odds ratios ranging from 2.24 to 2.61. Severity of HDP correlated with an increased risk of PPD, emphasizing a dosage-response gradient.

Qualitative insights from healthcare professionals added depth to the findings, highlighting the complexity and variable nature of the HDP-PPD relationship. The discrepancies in awareness and practices among professionals underscore the importance of standardized training to ensure consistent care. The study showcased a significant impact on postpartum mental health, identifying stressors related to labour as significant contributors.

A key strength of our study is its diverse approach, combining quantitative evidence with personal stories from healthcare providers in Ghana. While our findings are robust, we acknowledge limitations such as variations in study designs and the absence of input from affected women themselves. This highlights the importance of future research that actively involves these women in shaping solutions.

Looking ahead, we advocate for inclusive methodologies that prioritize the voices of affected women, ensuring that interventions are tailored to their needs. By collaborating with professionals from diverse backgrounds, such as psychiatrists and clinical psychologists, we can enrich our understanding and support systems, ultimately improving the lives of mothers and families not just in Ghana, but globally.

Chapter 7: Conclusion

This concluding chapter marks the culmination of an in-depth investigation into the intricate relationship between HDP and PPD among women in Ghana. The complex nature of this association necessitated a comprehensive research approach, incorporating systematic review, meta-analysis, and semi-structured interviews with healthcare professionals. Through the integration of these diverse methodologies, our study has successfully achieved its specific objectives, shedding light on the complicated interplay of factors influencing the occurrence of PPD in the context of HDP.

The study employed a systematic review of aetiology and risk, drawing upon the methodology detailed in the 2020 publication "JBI Manual for Evidence Synthesis." Key words were searched for in relevant databases, and the PRISMA flow chart guided article selection. Critical appraisal and data extraction were conducted for further analysis. Our systematic review, a cornerstone of our research, synthesized existing evidence on the association between HDP and PPD in LMICs. While Ghana was the primary country of focus for investigating the HDP-PPD association, the systematic review took a broader lens encompassing all LMICs. Expanding the geographical scope of the systematic review to include all LMICs alongside Ghana was a strategic decision driven by several key considerations.

Primarily, the scarcity of dedicated research on the HDP-PPD association within the Ghanaian context prompted a broader examination to compensate for limited evidence. The synthesis of literature from various LMICs facilitated a more comprehensive understanding of the topic, addressing cultural, socioeconomic, and healthcare variations.

The cross-cultural analysis aimed to identify patterns, trends, and variations in the HDP-PPD association, contributing to a globally relevant perspective. The review

recognized the influence of cultural factors on maternal health experiences and emphasized the importance of cultural variation in shaping outcomes. By encompassing a diverse range of LMICs, the research highlighted how cultural variations may influence the manifestation, and detection of the HDP-PPD association. Insights gained from diverse LMICs informed international strategies, interventions, and policies, acknowledging the universal concern for maternal health issues in these settings.

The review also aimed to shed light on specific challenges faced by women in LMICs concerning HDP and PPD, contributing to a more thorough understanding of health inequities. This knowledge is crucial for designing targeted interventions to address the unique needs of vulnerable populations in resource-constrained settings.

Another rationale for the review's expansion beyond Ghana was the pursuit of generalizability. Shared social, economic, healthcare access, and utilization factors across LMICs prompted a broader approach to enhance the applicability of findings to the Ghanaian setting. The exhaustive analysis spanning multiple LMICs aimed to identify broader patterns and trends in maternal health, instrumental in shaping interventions and policies in Ghana.

The review acknowledged commonalities in socioeconomic challenges, such as poverty and limited access to education, and sought to capture a broader spectrum of contexts to improve external validity. The external validity of the review's conclusions was enhanced by encompassing a broader geographic scope, making the results more relevant and applicable to a wider range of settings. The focus on LMICs, reflected a commitment to health equity perspectives, ensuring that research findings addressed the unique challenges of postpartum women in resource-constrained environments. The review recognized the potential of successful interventions in LMICs to serve as blueprints for tailored strategies in the Ghanaian healthcare ecosystem, emphasizing adaptability, scalability, and sustainability for improved maternal well-being.

Employing the methodology for performing a systematic review of aetiology and risk as outlined in the JBI Manual for Evidence Synthesis, our review revealed compelling findings. In particular, the prevalence of postpartum depression was significantly higher among subjects with varying degrees of hypertensive disorders during

pregnancy, bringing out a clear relationship between these conditions. Moreover, the severity of hypertension during pregnancy emerged as a critical determinant, with the incidence of new onset postpartum depression escalating proportionately.

Our systematic review of the literature on the relationship between hypertensive disorders in pregnancy and postpartum depression risk revealed a consistent and concerning pattern. Across numerous studies, a significant association was demonstrated between gestational hypertension, preeclampsia, and postpartum depression. Moreover, a clear dose-response was evident, with more severe hypertensive disorders associated with markedly higher rates of postpartum depression. The prevalence of postpartum depression emerged as a substantial concern within the cohort under scrutiny, with a prevalence rate of 27% observed among subjects who experienced varying degrees of hypertensive disorders during pregnancy. This prevalence was notably higher than the corresponding rate of 13% identified in the normotensive control group, reinforcing the association between hypertensive disorders and an increased vulnerability to postpartum depression.

Moreover, a compelling correlation between the severity of hypertension during pregnancy and the incidence of new-onset postpartum depression was discerned. The study's findings revealed a progressive increase in the likelihood of postpartum depression with escalating severity of hypertensive disorders. Notably, women experiencing severe features of preeclampsia, such as severe high blood pressure or the presence of HELLP syndrome, exhibited a striking four-fold increased risk of postpartum depression (AOR = 4.540, 95% CI: 1.194-17.255) compared to their normotensive counterparts. These graded associations lend support to a causal linkage, rather than just a correlation, between hypertensive disorders in pregnancy and later postpartum depression. This finding emphasizes the impact of hypertensive disorders on the mental health of postpartum women and highlights the importance of considering the severity of hypertension in predicting postpartum depression outcomes.

Our study has illuminated the intricate nature of postpartum depression, emphasizing the pivotal role of diverse risk factors spanning socio-demographic, clinical, and psychosocial domains. Our examination revealed that the identified risk factors extended beyond hypertensive disorders of pregnancy alone, incorporating aspects

such as obstetric history, maternal health indicators, and neonatal outcomes. Examples of these factors encompassed marital status, employment, parity, spontaneous abortions, NICU admissions, prolonged hospital stays, prematurity, among others.

This extensive analysis significantly auges our comprehension of the intricate interplay between hypertensive disorders during pregnancy and the subsequent risk of postpartum depression. The findings underscore the necessity of adopting a multidimensional approach to maternal care and mental health support, particularly for women with hypertensive disorders during pregnancy. By considering a spectrum of factors, ranging from social determinants to clinical outcomes, our study advocates for a holistic understanding of the complexities associated with postpartum mental health.

The recognition of diverse risk factors sheds light on the experiences of women during the perinatal period, emphasizing that the risk of postpartum depression is influenced by a confluence of factors extending beyond the hypertensive condition itself. This sophisticated exploration emphasizes the importance of tailoring interventions based on individualized risk profiles, thereby enabling a more targeted and personalized approach to the identification, prevention, and management of postpartum depression among individuals with a history of hypertensive disorders during pregnancy. Such an approach aligns with the broader paradigm of personalized and patient-centred care, fostering improved maternal well-being and mental health outcomes.

The implications of our findings carry significant weight. Considering the relatively common occurrence of hypertensive pregnancy complications, affecting up to 10% of pregnancies according to Ananth et al. (2013), our study signals the necessity for effective monitoring and preventative support within this high-risk group. Specifically, women with a history of hypertensive disorders during pregnancy should undergo screening for postpartum depression, accompanied by appropriate follow-up care. The imperative for comprehensive support and early intervention for at-risk populations is heightened to mitigate the prevalence and impact of postpartum depression.

Our study underscores the critical importance of vigilance and tailored support for women with hypertensive conditions during pregnancy to address the risk of postpartum depression. The findings unequivocally highlight that the presence of preeclampsia, particularly in severe cases, significantly amplifies the risk of

postpartum depression. This highlights the urgency of early identification and targeted support for these women. Therefore, our research not only emphasizes the need for increased monitoring and support for women with a history of hypertensive disorders during pregnancy but also calls for a focused and timely intervention to address the heightened risk associated with severe cases of preeclampsia.

The meta-analysis utilized data extracted from the systematic review, employing the equal-effects model as the primary statistical methodology. Odds ratio was chosen as the measure of association, and the metafor package in R facilitated the meta-analysis. Our meta-analysis provides robust evidence supporting a significant association between HDP and subsequent PPD. A meticulous examination of individual studies by Chen et al., Sarosh et al., and Strapasson et al. formed the basis of our meta-analysis, comprising three studies. Calculated Odds Ratios (OR) for each study were 2.61, 2.38, and 2.24 for Chen et al., Sarosh et al., and Strapasson et al., respectively. These values consistently exceeded 1, signifying a positive association and an elevated odds of postpartum depression in women with HDP compared to normotensive controls. Pooling the data across studies yielded a statistically significant pooled odds ratio of 2.40, indicating that women with HDP face 2.4 times higher odds of developing PPD compared to normotensive controls. The precision of this estimate was underscored by a narrow confidence interval, emphasizing the accuracy of the findings. Significantly low statistical heterogeneity ($I^2 = 0.00\%$) across studies further enhances the reliability and coherence of our meta-analytical results.

Strapasson et al.'s study, the earliest contributor to our meta-analysis, laid foundational evidence for establishing the positive HDP-PPD association. Advancing from Strapasson et al.'s to Chen et al.'s and ultimately to Sarosh et al.'s studies revealed increasing precision in effect size estimates, reflecting a maturing comprehension of the intricate relationship between HDP and PPD. The consistency in the positive direction of log odds ratios and narrowing confidence intervals across studies supports this trend, indicating a growing refinement in our understanding. This cumulative evidence, marked by increasing precision and a consistent directional trend, enhances the robustness and reliability of the established link between hypertensive disorders during pregnancy and the subsequent risk of postpartum depression. Additionally, the temporal sequence of studies establishes clarity that hypertensive disorders precede depression onset, reinforcing a causal linkage. This

epidemiological finding is further supported by biological plausibility with shared underlying drivers such as inflammation, obesity, stress, placental insufficiency, and vascular dysfunction.

The stability of the association between hypertensive disorders of pregnancy and postpartum depression was rigorously examined through an all-embracing sensitivity analysis, employing multiple models and measures. This meticulous scrutiny aimed to assess the reliability and consistency of the identified relationship across diverse analytical approaches. The absence of significant heterogeneity, coupled with consistent results observed across various models, serves as a testament to the robustness of the findings. In delving into the intricacies of the sensitivity analysis, the uniformity of results emerged as a key strength, bolstering the credibility of the established association. The stability of the relationship was further affirmed by the confirmation of low p-values, indicating statistical significance across different analytical methodologies. This robustness in the face of varied models and measures not only enhances the reliability of the identified association but also instils confidence in the generalizability of the findings. The sensitivity analysis, therefore, acted as a robust validation, affirming the stability of the association between HDP and PPD under diverse analytical conditions.

The global landscape of research on HDP and PPD was meticulously explored, encompassing studies conducted across diverse regions, including Denmark, South Korea, Turkey, Colombia, and the Netherlands. The synthesis of evidence from these geographically distinct studies consistently revealed associations between HDP and PPD, aligning with and affirming the broader pattern observed in our meta-analysis. The inclusion of studies from varied international settings contributes to the external validity of our findings, demonstrating the universality of the association between HDP and PPD. Despite differences in healthcare systems, cultural contexts, and population characteristics across these global locations, the similarity in observed associations emphasizes the validity and generalizability of the relationship. This collective evidence, drawn from studies conducted on a global scale, strengthens the foundation of our findings, and emphasizes the relevance of the HDP-PPD association across diverse populations and healthcare contexts.

Considering the substantial disease burden imposed by hypertensive disorders in pregnancy and postpartum depression, elucidating this relationship holds critical public health implications. Our findings bring to light the importance of close monitoring and care in the postpartum period for women with a history of preeclampsia or other hypertensive conditions during pregnancy. Early identification through depression screening and appropriate follow-up care in this population may offer opportunities for improved outcomes. A deeper understanding of shared pathogenic mechanisms promises to inform more tailored and effective prevention and treatment strategies.

Qualitative interviews conducted with healthcare professionals in Ghana yielded profound insights into the lived experiences and perspectives surrounding the HDP – PPD association. Engaging doctors and midwives with diverse backgrounds, the participants offered valuable perspectives on the incidence, prevalence, trends, perceptions, screening practices, risk factors, and explanatory mechanisms related to these maternal health conditions. Specifically, expert interviews were conducted with these healthcare professionals at the University of Ghana Medical Centre Ltd, targeting doctors and midwives to gain in-depth insights into their experiences and perspectives regarding the association between HDP and PPD in Ghana.

A purposive sampling approach was employed, selecting ten female participants, consisting of five doctors and five midwives, each possessing a minimum of 5 years of experience in their respective roles. The criterion for data saturation was applied to ensure a comprehensive exploration of the subject. Thematic analysis was rigorously performed on the transcripts derived from these interviews. The diverse ranks, years of practice, and regions of experience within the medical field among the participants contribute significantly to a comprehensive understanding of the subject matter. By encompassing insights from individuals at different stages of professional maturity with experience in other geographical settings within Ghana, the interviews ensured a thorough exploration of the association between HDP and PPD. This diversity not only enriched the qualitative perspectives on HDP and PPD but also facilitated a holistic understanding of these conditions.

The insights from healthcare professionals emphasize the dynamic nature of monthly incidence rates for HDP, highlighting the intricate variability within a single healthcare setting. The reported estimates of PPD among patients with HDP exhibited a broad

spectrum, ranging from 2% to 50%. This variability emphasized the challenges in establishing a definitive prevalence rate, pointing to the complex interplay of factors influencing the occurrence of PPD in the context of HDP. Furthermore, instances of postpartum depression in the absence of HDP were deemed rare, with healthcare professionals often attributing such cases to stressors associated with the labor process.

A range of contributing factors was identified by healthcare professionals, including traumatic deliveries, insufficient social support, financial or emotional strain, and the potential effects of medication. These factors were recognized as influential elements that could contribute to the development or exacerbation of HDP and PPD. Traumatic deliveries were highlighted for their impact on maternal mental health, emphasizing the need for comprehensive support in such cases. The significance of social support, or its absence, emerged as a crucial determinant in maternal well-being, underscoring the importance of a robust support system during the perinatal period. Financial and emotional strain was acknowledged as stressors that could contribute to the complexity of these maternal health conditions. Additionally, the potential effects of medication were considered, emphasizing the importance of a careful and personalized approach to pharmacological interventions in the context of HDP and PPD. These multifaceted factors collectively contribute to a more comprehensive understanding of the challenges faced by women dealing with HDP and PPD, guiding healthcare professionals in crafting holistic and tailored interventions.

The discussion on trends among healthcare professionals brought to light varying levels of awareness regarding the association between the two conditions. While some participants observed clear patterns, others noted a lack of specific trend observations, suggesting potential gaps in monitoring or awareness regarding the dynamics of HDP and PPD. Despite this variance, a consistent belief emerged among participants that the co-occurrence of these conditions is increasing, signalling a shared concern within the healthcare community about the rising prevalence of these interconnected maternal health issues.

Diverse factors contributing to the observed increase in the co-occurrence of HDP and PPD were identified by participants. Economic challenges, lack of public awareness, insufficient social support, stress, and traumatic outcomes were highlighted as

prominent influencers. These perspectives underscored the need for comprehensive strategies addressing not only the medical aspects but also the broader societal and economic determinants affecting maternal mental health. Factors such as socioeconomic background, financial constraints, and emotional imbalance were identified as potential contributors to PPD in the presence of HDP.

The participants' views on the association between HDP and PPD varied, reflecting the intricate nature of this relationship. Some emphasized a direct connection, attributing postpartum depression to adverse outcomes associated with hypertensive disorders, while others presented a more detailed perspective, acknowledging the complexity of these associations. These diverse viewpoints underscore the need for tailored approaches in understanding and addressing the mental health needs of pregnant and postpartum women with HDP.

The midwives expressed diverse perspectives on the potential link between HDP and subsequent PPD. While some acknowledged the association, others were uncertain about direct causality. Factors contributing to the association included lack of support, financial constraints, and the mental toll of an HDP diagnosis during pregnancy.

The findings revealed a reliance on clinical judgment rather than standardized tools in screening for PPD in women with a history of HDP. Limited familiarity with formalized screening tools, such as the Edinburgh Post Natal Depression Scale, suggests an opportunity for training and integration of these tools into routine clinical practice. The participants' emphasis on a comprehensive approach, considering various signs and symptoms, aligns with the complex and multifaceted nature of postpartum mental health. The use of standardized screening tools for identifying PPD risk among patients with a history of HDP was limited. Majority of these frontline maternal healthcare professionals expressed unfamiliarity with widely recognized tools such as the EPDS, relying instead on clinical judgment and observation of signs and symptoms.

Factors contributing to the association between HDP and PPD included medication-induced stress, lack of counselling during pregnancy, intrapartum events, social support, the stress of managing hypertension, and the psychological impact of pregnancy and unmet expectations. Healthcare professionals' perspectives highlighted a range of risk factors and explanatory mechanisms contributing to the

association between HDP and PPD. Financial strain, lack of social support, antenatal procedures, increased medical demands, and concerns related to early delivery and Neonatal Intensive Care Unit (NICU) emerged as key factors. These insights provide a holistic understanding of the challenges faced by women with HDP, emphasizing the interconnectedness of biological, social, and healthcare-related factors.

7.1 Implications for practice, policy, and theory

Through a comprehensive mixed-methods approach, our findings converge to construct a compelling narrative that highlights the intimate interconnection between HDP and PPD. The collective evidence, drawn from both quantitative and qualitative methodologies, substantiates the association on multiple fronts.

The higher prevalence of postpartum depression among women with HDP, as revealed by quantitative assessments, serves as a quantitative anchor to this association. Moreover, the heightened incidence of postpartum depressive symptoms linked to the severity of hypertensive disorders further strengthens the relationship, indicating a dose-response relationship between the two conditions. The statistically significant heightened odds, supported by robust meta-analytical evidence, provide a quantitative underpinning to the increased risk faced by women with HDP.

Qualitative corroboration adds a rich and distinct layer to our understanding, capturing the lived experiences and perspectives of healthcare professionals in Ghana. Their insights into the incidence, prevalence, trends, perceptions, and risk factors associated with HDP and PPD offer a contextualized view that aligns with the quantitative evidence. This triangulation of data from both quantitative and qualitative sources fortifies the conclusion that women with HDP face a markedly greater risk for postpartum depressive symptoms.

In that regard, identifying women with HDP as a vulnerable population necessitates vigilant screening, support, and early intervention to mitigate both the risks and detrimental impacts of postpartum depression. The evidence-backed understanding of factors contributing to PPD in affected women opens avenues for targeted interventions, promising a significant improvement in overall well-being. In essence, this research serves as a robust evidentiary foundation, advocating for tailored strategies to address the unique needs of women with HDP and reduce the burden of

postpartum depression in this population. The implications of this interconnectedness are profound for maternal health practices policies and theories.

7.1.1 Implication for practice

The research emphasizes profound practical implications, advocating for early identification and provision of timely, tailored support for women with hypertensive disorders during pregnancy who are at elevated risk for postpartum depression.

Specifically, the findings call for comprehensive perinatal care strategies that integrate mental health screening and management into standard maternal care pathways for women with HDP. This demands increased awareness, training, and use of validated screening tools among frontline healthcare practitioners providing obstetric services to recognize mental health issues early in this vulnerable subgroup.

Moreover, the results highlight the need for targeted psychosocial counselling, peer support groups, and postpartum monitoring programs focused on women with a history of gestational hypertension or preeclampsia. Such structured interventions can provide informational, emotional, and instrumental support to buffer against postpartum depression during this critical window.

Ultimately, the study compels healthcare systems and perinatal providers to acknowledge the intricate interconnections between medical and mental health factors. Implementing a holistic care framework that addresses both physiological and psychosocial risks will require cross-disciplinary coordination and resource mobilization but promises significant dividends in promoting maternal mental health and wellbeing.

The multidimensional nature of postpartum depression aetiology demands an equally multifaceted and integrated approach to care. These research findings underscore the practical urgency of restructuring perinatal services to foster such whole-patient practices benefitting both mother and child.

7.1.2 Implication for policy Integration

The research highlights the critical need to integrate robust mental health screening, awareness, and support programs into both antenatal and postpartum care frameworks at a systems level. Findings compel policymakers to acknowledge the

reliable and multifaceted association between hypertensive pregnancy disorders and postpartum depression risk in developing maternal health policies and care models.

The study advocates strongly for comprehensive maternal mental health policies that incorporate psychological wellbeing as an integral component, not an ancillary consideration. This thesis demands policies targeting the entirety of the woman's health across the reproductive continuum, addressing psychosocial risks with equal emphasis to physiological ones.

The W.H.O. guide for the integration of perinatal mental health in maternal and child health services, published in September 2022, presents a comprehensive framework that can be effectively implemented within maternal healthcare services in Ghana. This guide offers an evidence-informed approach, providing guidance to program managers, health service administrators, and policymakers responsible for planning and managing maternal and child health services. By following the recommendations outlined in the guide, Ghana can develop and sustain high-quality, integrated mental health services for women during the perinatal period.

Similarly, The Royal College of Obstetricians and Gynaecologists' (RCOG) Guidelines on Management of Women with Mental Health Issues during Pregnancy and the Postnatal Period (Good Practice No 14) (2011) and National Institute for Health and Care Excellence (NICE) Antenatal and postnatal mental health: clinical management and service guidance (2014) are examples of policies that can be integrated into policies governing Ghanaian maternal health services.

These guidelines provide additional support and evidence-based recommendations for addressing perinatal mental health concerns within maternal healthcare settings. The RCOG guidelines offer specific guidance on the management of women with mental health issues during pregnancy and the postnatal period, including recommendations for assessment, treatment, and support. Similarly, the NICE guidance provides comprehensive clinical management and service guidance for antenatal and postnatal mental health care, offering evidence-based interventions and pathways for care delivery.

By incorporating these guidelines into Ghanaian maternal mental health policies, the country can further enhance its capacity to deliver effective mental health care to pregnant and postpartum women. These policies offer valuable insights into best

practices for perinatal mental health care, ensuring that women receive timely and appropriate support to address their mental health needs during this critical period. Additionally, by aligning with international best practices and standards, Ghana can strengthen its commitment to promoting maternal mental health and well-being, ultimately improving outcomes for women and their children across the country.

Prioritizing allocation of resources towards structured perinatal mental health initiatives is imperative, including awareness campaigns, screening protocols, counselling supports and culturally competent follow-up care of at-risk postpartum women. Such programs promise significant return on investment.

Effective policy implementation will demand ongoing collaboration between researchers, healthcare bodies, and policymakers to align interventions with the most updated evidence-base and community-defined needs. Cross-sector coordination is vital for service integration.

The unambiguous research findings advocate for the urgent prioritization of maternal mental health within broader public health policy agendas, underscoring the vital necessity of this long-neglected domain. Committing resources towards maternal mental health promotion constitutes an investment in the health of current and future generations.

7.1.3 Implication for theory

The study significantly contributes theoretical insights by delving into the intricate lived experiences and perspectives of healthcare professionals concerning the association between HDP and PPD. This exploration of the multifaceted nature of the HDP-PPD relationship challenges existing theoretical frameworks, such as the biopsychosocial model, stress and coping theory and ecological systems theory, signalling the need for a more distinct and comprehensive understanding of postpartum mental health dynamics.

The biopsychosocial theory which we employed in our research (see section 2.2.2) traditionally posits that biological, psychological, and social factors interact to influence health outcomes. However, our findings suggest that while this model provides a valuable framework, it may oversimplify the complexity of the relationship between hypertensive disorders during pregnancy and postpartum depression.

Our research emphasizes the importance of expanding the model to include aspects, especially cultural and systemic factors that deeply impact women's experiences during the perinatal phase. Cultural elements cover beliefs, practices related to care and childbirth family dynamics and societal attitudes, toward motherhood and mental health. These factors can greatly influence how women view pregnancy and childbirth, their access to care and support, as well as their adjustment during the postpartum period regarding mental health. Furthermore, systemic factors such as policies, regulations, resource distribution, institutional norms, socioeconomic and ethnic healthcare disparities along with biases in healthcare environments all play roles. They affect women's access to high quality prenatal care services availability of health support during the phase and support systems for new mothers. Together these cultural and systemic components form the context within which women navigate through pregnancy childbirth and postpartum experiences.

Recognizing and fully grasping these elements are crucial for providing fair care to pregnant individuals both during pregnancy and postpartum phases. This is essential not for enhancing mental health wellness but also for promoting positive pregnancy outcomes and childbirth experiences, for all women. By integrating these broader contextual elements into the theoretical framework, we can better understand the diverse range of influences on postpartum mental health outcomes. Thus, our study advocates for a theoretical framework that transcends traditional boundaries, acknowledging the complexity of factors influencing postpartum mental health outcomes. In essence, the research prompts a paradigm shift towards more comprehensive and integrative theoretical perspectives that align with the complex reality of women's experiences during the perinatal period.

7.2 Limitations and future research

7.2.1 Limited Number of Studies

While this meta-analysis significantly contributes to understanding the relationship between hypertensive disorders during pregnancy (HDP) and postpartum depression (PPD), the inclusion of a limited number of studies restricts the generalizability of the results. Future research should prioritize the incorporation of additional studies specifically investigating the association between HDP and PPD. A more extensive

pool of studies would enable more robust analyses, enhancing the reliability and applicability of the findings.

7.2.2 Variability in Estimates

The observed variability in estimates among healthcare professionals suggests a need for standardized measures to accurately determine prevalence and co-occurrence rates. Future research should focus on establishing standardized criteria for assessing the relationship between HDP and PPD, ensuring consistency across studies. This approach would facilitate more accurate comparisons and interpretations of prevalence rates, reducing potential biases introduced by diverse estimation methods.

7.2.3 Nuances in HDP Types/Severity

The study emphasizes the need for further investigation into the nuances between different types and severity levels of hypertensive disorders during pregnancy and their differential risks for postpartum mental health issues. Future research could delve into distinctions between gestational hypertension and preeclampsia, exploring how variations in HDP types contribute to varying risks of postpartum depressive symptoms. This nuanced understanding is crucial for tailoring interventions to specific HDP profiles.

7.2.4 Long-Term Impacts of HDP

The study suggests that future research should extend beyond the limited postpartum timeframe and explore the long-term impacts of hypertensive disorders during pregnancy on maternal mental health. Investigating mental health trajectories over an extended period would provide insights into the persistence and evolution of postpartum depressive symptoms among individuals with a history of HDP. Understanding the long-term impacts is essential for developing comprehensive healthcare strategies that address the holistic well-being of affected women.

7.2.5 Small Sample Size and Reliance on Self-Reported Experiences

Acknowledging its limitations, the study recognizes the small sample size and reliance on self-reported experiences. This underscores the need for larger-scale studies with diverse participant profiles to ensure a more comprehensive representation of the healthcare landscape. Future research endeavours should prioritize expanding

sample sizes and incorporating objective measures to enhance the robustness of findings and reduce potential biases associated with self-reported data.

7.2.6 Continuous Monitoring and Inclusion of New Studies:

Despite the limitations, the consistent results and global confirmation of the HDP-PPD relationship suggest a broader pattern. Future research efforts should focus on continuous monitoring and the inclusion of new studies to refine understanding further. This iterative approach ensures that evolving evidence is systematically incorporated, contributing to an ongoing and nuanced comprehension of the association between HDP and PPD.

7.3 Recommendation

The synthesis of evidence from our systematic review, meta-analysis, and frontline healthcare workers' perspectives culminates in a call for proactive recommendations to enhance maternal well-being during the perinatal period in Ghana. These recommendations span from standardizing practices to capacity building and targeted interventions, providing a roadmap for healthcare leaders, policymakers, and researchers to collaboratively address the complex interplay of HDP and PPD. Our study not only highlights the critical associations between HDP and PPD but also propels us toward actionable recommendations for the betterment of maternal health in Ghana.

7.3.1 Inclusion of additional healthcare perspectives

Future research should explore the perspectives of a broader range of healthcare professionals, including psychologists and psychiatric specialists. Their insights can contribute to a more comprehensive understanding of the association between HDP and PPD from different clinical perspectives. Additionally, conducting longitudinal studies can track trends and explore causality over an extended period, providing a more dynamic understanding of the temporal aspects of the HDP-PPD relationship.

7.3.2 Enhancing robustness

Future research should address the identified limitations, including expanding sample sizes and refining methodologies, to enhance the robustness of findings. The inclusion

of more extensive and more diverse participant pools will contribute to a more representative understanding of the relationship between hypertensive disorders during pregnancy (HDP) and postpartum depression (PPD). This approach is essential for generating findings that can be more confidently generalized to broader populations.

7.3.3 Standardization

Standardization forms the bedrock for effective healthcare strategies. To enable consistent monitoring of trends and intervention impacts over time and across regions, it is crucial to standardize definitions, screening practices, and surveillance surrounding HDP and PPD in Ghana. This unified approach will foster a more accurate understanding of the prevalence and co-occurrence of these conditions, allowing for effective healthcare strategies.

7.3.4 Capacity building

The multifaceted nature of the relationship between HDP and PPD necessitates a comprehensive approach. Building obstetric and broader maternal healthcare capacity is paramount. This involves enhancing mental health literacy, incorporating trauma-informed care approaches, and bolstering counselling skills among healthcare professionals. Strengthening the capacity of the healthcare workforce is vital to address gaps in current practices and foster a supportive environment.

7.3.5 Targeted interventions

Recognizing the need for targeted interventions, we recommend the design, pilot, and evaluation of psychosocial interventions and support networks specifically tailored for women experiencing HDP. These interventions aim to alleviate stressors and strengthen coping mechanisms, offering a more holistic approach to maternal care during the perinatal period.

7.3.6 Empowering women

Empowering women with knowledge is crucial. Creation of patient education programmes that raise awareness of potential HDP outcomes and provide self-care strategies, while setting reasonable expectations for the postpartum period is essential. Informed and prepared mothers can better navigate the challenges, fostering a healthier transition into motherhood.

7.3.7 Formalized Training

Formalizing training on validated tools promises to augment clinical judgment and build a rigorous foundation for mental health promotion within maternal health. Simultaneously, the provision of sensitively discerning distress through engagement makes a tangible difference for patients navigating the complex postpartum terrain marred by hypertensive disorders.

7.3.8 Research

Research is a dynamic tool for progress. Conducting further mixed-methods research elucidating mediators between HDP and PPD in Ghana and assessing targeted intervention benefits using rigorous study designs is pivotal. This ongoing research will refine our understanding, inform interventions, and contribute to evidence-based maternal healthcare practices.

7.3.9 Collaborative Implementation

The translation of these recommendations into tangible improvements requires collaborative efforts between researchers, healthcare leaders, and policymakers. Implementing these recommendations can lead to improved identification of PPD risks and spur innovations in preventative and supportive care for this vulnerable population of women in Ghana. Collaborative endeavours hold the key to a holistic and integrated healthcare approach.

7.3.10 Comprehensive Exploration

Exploring the relationship between various types of hypertensive disorders during pregnancy and postpartum depression is crucial for developing a comprehensive understanding. Future research endeavours should differentiate between gestational hypertension and preeclampsia, considering severity levels of HDP. This nuanced exploration will contribute to tailoring interventions based on specific HDP profiles and severity, providing more targeted support for affected individuals.

7.3.11 Collaborative Efforts and Data Access

Collaborative efforts are imperative to overcome challenges related to data access and reporting variations. Researchers, healthcare providers, and policymakers should work collaboratively to establish standardized criteria for data reporting and sharing. This collaborative approach will not only enhance the consistency of findings across

studies but also facilitate the integration of diverse datasets, fostering a more unified and comprehensive understanding of the HDP-PPD association.

7.3.12 Enriching Evidence Base:

Future research should actively explore additional studies to enrich the evidence base, contributing to a more nuanced understanding of the association between HDP and PPD. The inclusion of diverse populations, both ethnically and geographically, is essential. Moreover, employing varied methodological approaches, such as longitudinal studies and intervention trials, will provide a richer understanding of the dynamics of this complex relationship.

7.4 Contribution to knowledge

Our findings do not only add to the academic discourse but also holds practical implications for healthcare practitioners, policymakers, and the broader community engaged in women's health and well-being. The recognition of the need for comprehensive and individualized maternal care strategies, accounting for varied risk factors beyond hypertensive disorders, provides a foundation for more effective interventions and mental health support for pregnant and postpartum women in Ghana.

In essence, this research enhances our understanding of the specific challenges faced by women in Ghana, contributes to the global discourse on maternal mental health, and advocates for tailored healthcare approaches to address the complexities of the HDP-PPD association in this unique socio-cultural context. Our exploration of the association between HDP and PPD in Ghana contributes significantly to the existing body of knowledge in several key areas as detailed below:

7.4.1 Existence of Positive Association in Ghana

The study decisively establishes the existence of a positive association between hypertensive disorders during pregnancy and postpartum depression among Ghanaian women. This specific finding is crucial for both the academic realm and healthcare practitioners, as it underscores the urgency of addressing the mental health implications of HDP within the Ghanaian context.

7.4.2 Policy and Clinical Guidelines

The research decisively demonstrates that women experiencing more severe HDP face amplified risks of encountering PPD in Ghana. Integrating this recognition into maternal health policies and clinical practice guidelines can promote improved screening, management, and mental health outcomes during this critical life stage. This contribution has direct implications for shaping policies and guidelines to address the intricate relationship between HDP and maternal mental well-being.

7.4.3 Interconnectedness of Biological, Social, and Healthcare-Related Factors

The study's findings highlight the interconnectedness of biological, social, and healthcare-related factors influencing the association between HDP and PPD. This holistic perspective adds depth to the understanding of maternal mental health, emphasizing the need for interventions that consider the complex interplay of various factors.

7.4.4 Limited Familiarity with Standardized Tools

The research sheds light on the reliance on clinical judgment rather than standardized tools in screening for PPD among women with a history of HDP in Ghana. The lack of familiarity with formalized screening tools, such as the EPDS, highlights an opportunity for training and integration of these tools into routine clinical practice. This insight contributes to the discourse on improving healthcare practices and detection mechanisms for maternal mental health in the Ghanaian context.

7.4.5 Intricacies and subtleties

The qualitative insights from interviews with healthcare professionals in Ghana add valuable contextual nuances to the statistical associations uncovered in the systematic review. The complexities of the association, including financial and emotional burdens associated with adverse outcomes and NICU care, are emphasized. This subtle understanding contributes to a more profound comprehension of the intricate nature of the health challenges faced by pregnant and postpartum women.

7.4.6 Global Health Understanding

By extending the systematic review to include literature from LMICs, the research contributes to a more comprehensive understanding of the HDP-PPD association. This global perspective allows for the identification of generalizable patterns,

addresses health equity issues, and expands the evidence base for contextualizing successful interventions. The findings provide insights that go beyond individual countries, contributing to global discussions on maternal health.

7.4.7 Holistic Maternal Care

The research underscores the critical need for a holistic approach to maternal care, considering medical, cultural, and social aspects. It advocates for a shift towards comprehensive and individualized maternal care strategies, recognizing the multifaceted nature of postpartum depression. This emphasis on holistic care contributes to the ongoing discourse on improving maternal health outcomes globally.

7.5 Summary of the chapter

Maternal mental health is a multifaceted and critical aspect of overall well-being during the perinatal period. This study undertook a comprehensive investigation into the association between HDP, especially severe cases like preeclampsia, and PPD among Ghanaian women. The research amalgamated findings from a systematic review, meta-analysis, and qualitative interviews with healthcare professionals, offering a holistic perspective on this intricate relationship.

The systematic review and meta-analysis yielded compelling evidence of a significant positive association between HDP, particularly severe presentations like preeclampsia, and an elevated risk for developing PPD. This brought to limelight the clinical importance of recognizing HDP as a crucial risk factor requiring vigilant attention. The findings advocate for a paradigm shift in maternal mental health approaches, emphasizing the need for improved screening, support, and mental health outcomes for this at-risk population of postpartum women.

The qualitative exploration provided valuable insights into the lived experiences and perspectives of healthcare professionals in Ghana. Their diverse viewpoints, varying levels of awareness, and identification of contributing factors emphasized the need for comprehensive and context-specific interventions. The qualitative findings reinforced calls for greater clinical attention, screening vigilance, and multidimensional supportive care for women with HDP histories facing higher PPD risks.

The research, while primarily focused on Ghana, incorporates literature from LMICs to provide robust insights, identify generalizable patterns, address global health equity

issues, and expand the evidence base. Extending the systematic review beyond Ghana reflects a commitment to overcoming research limitations and contributing to global health discourse. The comprehensive analysis offers valuable insights with implications for research and public health interventions on a global scale. Recognizing shared challenges and factors influencing maternal health across LMICs, the study provides a universally applicable understanding of the HDP-PPD association, with direct implications for the Ghanaian setting.

This multifaceted research illuminates a significant and intricate association between hypertensive disorders during pregnancy and postpartum depression among Ghanaian women. The findings have theoretical, practical, and policy implications, urging a paradigm shift in maternal mental health approaches. The study does not merely contribute to academic discourse but holds profound implications for healthcare practices and policy reforms aimed at improving the mental well-being of postpartum women.

The implications highlight the need for standardized PPD screening protocols for women with HDP histories, enhanced education on maternal mental health issues for providers, holistic care models addressing medical, social, and financial burdens mothers face, and destigmatization and peer support programs mitigating PPD impact. The observed increase in co-occurring cases indicates an escalating public health concern requiring prioritization in health policies and resource allocation. Further research should also examine nuances among HDP subtypes and differences in regional healthcare practices.

Acknowledging the limitations of this study, future research directions could encompass quantitative verification of prevalence and co-occurrences, comparisons of PPD risks across different HDP subtypes, in-depth case analyses linking HDP characteristics to PPD trajectories, and assessing healthcare provider competencies in identifying PPD signs. Despite these limitations, the study provides profound insights into the interconnected medical and mental health challenges confronting mothers with HDP histories, concluding an extensive multidimensional thesis illuminating the complex HDP-PPD association.

As we reflect on this research journey, it is evident that unravelling the complex interplay between HDP and PPD is essential for improving maternal well-being. In

conclusion, the sophisticated nature of this relationship necessitates a holistic and integrated healthcare approach, recognizing emotional wellness alongside physical health as imperative components of comprehensive maternal care.

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Appendix A: Participant Information Sheet

Date: …….

Participant Identification Number for this Study: …….

Project Title: The Association between Hypertensive Disorders of Pregnancy and Postpartum Depression in Ghana.

Principal researcher: Dr Kwaku Mari Addo, PhD Student

Supervisors: Professor Maddie Ohl and Professor Hafiz T.A. Khan

Thank you for your interest in participating in this research study. Before agreeing to take part, please carefully review the following information about the study and what your interview participation would entail.

The research ethics for this study have been approved by the University. I want to provide you with full details so you can make an informed decision about whether to participate in this interview.

Please take time to read through this invitation letter thoroughly. It explains the study's purpose and procedures, what your involvement would require, and measures taken to protect your privacy.

After reviewing the details, please let me know if you have any other questions. I'm happy to provide any additional information needed as you are considering taking part in this research. Your participation is completely voluntary, so there is no pressure to agree to be interviewed if you have any hesitation.

Thank you again for your time and consideration. I look forward to your decision.

What is this research about?

This study will examine if high blood pressure in pregnancy correlates to or potentially increases risk for postpartum depression among women living in Ghana.

Who is being invited to participate, and why?

The researcher is interested to talk medical experts – doctors, and midwives- working in Ghana.

What tasks will I be asked to do?

An interview will take place at a comfortable location of your choice. During these interviews, you will be questioned about your observations and experiences regarding the potential association between hypertensive disorders of pregnancy and postpartum depression among women residing in Ghana.

Do I have to participate? What if I change my mind?

Your participation is completely voluntary. You may choose not to answer any question or stop the interview at any time. If you decide to participate, you will need to provide consent. However, you can change your mind at any point. You are free to withdraw from the interview completely, decline to answer any question, or skip any sensitive topics - without needing to provide a reason. Withdrawing will not affect you negatively in any way.

Will it be beneficial to me if I participate?

This study is part of a PhD research project. The goal is to generate new knowledge that can support policymakers in improving healthy lifestyles in Ghana. While you will not benefit directly from participating, the findings aim to inform policies that promote public health, which could indirectly benefit the population. Your insights may help shape recommendations and initiatives to encourage healthy behaviours in Ghana.

How will the data that I will provide be handled?

The interview will be recorded solely for research purposes. No comments will be attributed to you by name in any reports or publications. There are no anticipated risks involved with participating. The data you provide will be analysed by the researcher to develop their PhD project. The research will be published in academic journals or presented at scientific conferences, but again, your identity and responses will remain completely confidential. The outcome of the research will, however, be made available to you.

All information will be handled in accordance with the Data Protection Act 1998 and the General Data Protection Regulation 2018. Besides the principal investigator, the supervisor and authorized University of West London personnel may access the data. This is solely to monitor proper adherence to research processes and ethical confidentiality standards.

What will happen if I change my mind after taking part in the survey?

Should you choose to participate in the survey and decide to retract your response, you are free to do so without the need to provide a specific reason. Your data will not be saved or analysed. If you wish to express your intention to withdraw, you can get in touch with the lead researcher using the contact details provided at the bottom of this invitation.

How does this research ensure safety of my participation?

The University's research ethics committee, consisting of independent members, diligently evaluates every research project conducted within the institution to ensure safety, rights, and adherence to ethical standards. It's important to note that the University of West London's ethics committee has granted approval for this study. Participation in the study is entirely voluntary, and if you choose to take part, you have the option to withdraw your participation at any time, should you wish to do so.

Who do I contact if I have any concerns or complaints?

If you have any questions or issues regarding any aspect of this study, please feel free to get in touch with one of the following researchers:

Professor Maddie Ohl (Principal Supervisor) – Maddie.ohl@uwl.ac.uk

Professor Hafiz Khan (second supervisor) – hafiz.khan@uwl.ac.uk

Appendix B: Consent Form

Topic of project: Hypertensive Disorders of Pregnancy - AI-aided patient identification and precision medicine intervention of in early pregnancy.

Name of Researcher: Dr Kwaku Mari Addo

PARTICIPANT CONSENT FORM

I consent to take part in this research. I acknowledge that my involvement in the study is entirely voluntary. Any data collected for this study will be held in strict confidence and will not be utilized for financial gain. My identity will not be disclosed in any published reports. I retain the right to decline participation or withdraw from the study at any time without any impact on my future care. I have had the opportunity to pose questions, and I am satisfied that all my inquiries have been addressed.

Name:

Email Address:

Phone Number:

Signature: Date:

THE PART BELOW IS TO BE COMPLETED BY THE RESEARCHER

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.

Signature (Researcher): Date:

Appendix C: Interview Questionnaires

Hello, my name is Dr Kwaku Mari Addo, and I am a researcher student at University of West London, UK. I am conducting interviews with midwives and doctors as part of my thesis entitled “The association between hypertensive disorders of pregnancy and postpartum depression in Ghana”.

The purpose of this study is to explore the real-world perspectives of care providers like you who work directly with pregnant and postpartum women, to supplement the findings from our earlier review on this topic. Your experiences and insights will help us better understand the relationship between these conditions and how to improve identification and treatment of postpartum depression.

This interview should take around 30 minutes. I will be asking you questions about your professional experiences related to hypertensive disorders, postpartum depression, screening processes, and managing patients. Please feel free to speak openly and honestly about your perspectives. There are no right or wrong answers.

Your participation is completely voluntary. You may choose not to answer any question or stop the interview at any time. I will not collect any identifying information about you or your workplace. Your responses will remain confidential and used only for the purposes of this academic research study.

The interview will be recorded solely for research purposes, but the recording will be deleted after it is transcribed. No comments will be attributed to you by name in any reports or publications. There are no anticipated risks involved with participating. The research may be published in academic journals or presented at scientific conferences, but again, your identity and responses will remain completely confidential. You may withdraw at any time during the interview.

Do you have any questions before we begin? Are you willing to participate in this interview? Please let me know if you need me to clarify or expand on any part of this preamble before we start the questions.

Interview questions.

1. In your practice, approximately how many pregnant patients with hypertensive disorders do you see per month?

2. Of those patients with hypertensive pregnancy disorders, what percentage would you estimate are diagnosed with or exhibit symptoms of postpartum depression?
3. How often do you encounter or diagnose patients with postpartum depression that did not have hypertensive conditions during pregnancy?
4. Have you noticed any trends in terms of the rates of hypertensive disorders in pregnancy and postpartum depression among your patients over the past 5-10 years? If so, please describe.
5. Do you feel the frequency of these co-occurring conditions is increasing, decreasing, or remaining stable in your practice? What factors do you think contribute to this?
6. Based on your experience, do you see an association between women who experience hypertensive disorders during pregnancy and the development of postpartum depression?
7. In your practice, what percentage of women with hypertensive pregnancy disorders would you estimate also experience postpartum depression? How does this compare to women without hypertensive disorders?
8. Are you familiar with the Edinburgh Postnatal Depression Scale? If so, do you use it or any other screening tools to identify women at risk for postpartum depression following a hypertensive pregnancy disorder? Or is it based on clinical judgment?
9. What are some signs and symptoms you look for when screening for postpartum depression in patients who had hypertensive disorders during pregnancy?
10. In your professional opinion, what factors may contribute to the association between hypertensive disorders in pregnancy and postpartum depression?
11. In your opinion, why are women with hypertensive pregnancy disorders at higher risk for developing PPD?

Appendix D: Research and Data Management Statement

UNIVERSITY OF WEST LONDON

RESEARCH DATA MANAGEMENT STATEMENT

As a student or member of staff undertaking a research project, I understand that I am responsible for the following:

- Not collecting data prior to ethical approval.
- Maintaining accurate records of the methodologies used and the results obtained throughout the research project.
- Ensuring research data is kept in a manner that is compliant with legal obligations, the University Research Data Management Policy, the Research Ethics Code of Practice and the University Data Protection Policy and where applicable the requirements of funding and professional bodies.
- Ensuring backups of data and documents are made and updated at regular intervals during the research project.
- Ensuring anonymisation of research data containing personal information at the point of collection where possible. Where personal data cannot be anonymised, all identifying information must be removed from working files and kept separate in locked filing cabinets/files or secure password protected electronic folders. Working files must not contain identifying information.
- Transcribing all video and/or audio data using codes or pseudonyms for the identification of individuals.
- Ensuring the storage of confidential or personal data, particularly special category research data is treated with care and is made accessible only to authorised persons. Electronic folders containing personal data will be password protected. Electronic folders containing special category data will be encrypted **and** password protected. This relates to information concerning a subject's racial or ethnic origin, political opinions, religious beliefs, trade union activities, physical or mental health, sexual life, or details of criminal offences.
- Ensuring secure physical storage of personal and/or sensitive personal data in lockable cabinets.
- Not re-using data for a different purpose unless separate ethical approval is given.
- Ensuring secure disposal of research data in accordance with legal, ethical, research funder and collaborator requirements.
- Unless otherwise required, disposing of research data after the following periods
    - UG Students – to be destroyed once marks are ratified by the Assessment Board

September 2018

Appendix E: Ethics Approval Letter (UWL)

UNIVERSITY OF WEST LONDON
The Career University

College of Nursing, Midwifery and Healthcare
Research Ethics Panel
Paragon House
Boston Manor Road
Brentford TW8 9GA
Tel: +44 (0)20 8209 4215
Email: cnmh.ethics@uwl.ac.uk

Name: Kwaku Mari Addo
Student No: 21399933
Date: 13th November 2023

Dear Kwaku

Re: Application for Ethical Approval 01690
The Association Between Hypertensive Disorders of Pregnancy and Postpartum Depression in Ghana.

Thank you for sending in your application for ethics approval. As the Chair of the College Research Ethics Committee I have considered your application and unconditionally approved the project.

If your project does not progress, or if you make any changes to your proposal or methodology can you please inform the Panel in writing as this may entail the need for additional review. It is your responsibility, as the principal investigator, to submit a report on the progress/completion of the research twelve months from the date of this letter. This is just a reminder that your report form will need to be completed by **13th November 2024.**

The Panel wish you well with your improvement project and look forward to your report.

Yours sincerely

Rowan Myron
Associate Professor
Chair College Research Ethics Committee

Appendix F: Ethics Approval Letter (UGMC)

UNIVERSITY OF GHANA MEDICAL CENTRE
World Class Patient Care, Training and Research
Medical and Scientific Research Centre

1st February, 2024

Dr. Kwaku Mari Addo
Department of Obstetrics and Gynecology
University of Ghana Medical Centre
P.O. Box LG 25
Legon-Accra.

Protocol Title: The Association Between Hypertension Disorders of Pregnancy and Postpartum Depression in Ghana

Protocol #:	UGMC/IRBREVIEW/089/23
Funding Source:	Self-funding
Review Date:	January 15th, 2024
Effective Date:	January 22nd, 2024
Expiration Date:	January 31st, 2025
Review Type:	Expedited
Review Action:	Approved

Dear Dr, Addo,

Decision on your Protocol Renewal

On January 15th, 2024, after a review of your submitted protocol for ethical clearance, the University of Ghana Medical Centre Institutional Review Board (UGMC-IRB) granted **Approval** for the above-referenced submission. Please note that the approval for this protocol will lapse on January 31st, 2025, and requires you to submit progress and final report to the UGMC-IRB.

This approval includes the following:

1. **Proposal**
2. **Work Plan**
3. **Budget**
4. **Data collection tool**

The UGMC-IRB requires you to conduct the study in accordance with the protocol and its appendices as submitted for approval and to comply with all its requirements, subject to ethical and safety considerations, including complying with ICH Good Clinical Practice.

Please contact the UGMC-IRB Administrator via ***Tel: +233-(302)-550843-5 Ext.16207*** or ***Email:*** msrc@ugmc.ug.edu.gh if you have any questions.

Sincerely,

Dr. Maurice Ankrah,
Chair, UGCM-IRB.

Address: P. O. Box LG 25, Legon, Accra, West Africa
Ghana Post GPS: GA-337-6980
Google Map: University of Ghana Medical Centre
Phone: 233-(302)-550843, 233-(302)-550844, 233-(302)-550845
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Facebook: University of Ghana Medical Centre
LinkedIn: University of Ghana Medical Centre
Twitter: University of Ghana Medical Centre
Instagram: University of Ghana Medical Centre
Website: www.ugmedicalcentre.org

Appendix G: Search Strategy

("Hypertensive disorders of pregnancy" OR "chronic hypertension" OR "white-coat hypertension" OR "masked hypertension" OR "gestational hypertension" OR “pregnancy induced hypertension” OR "transient gestational hypertension" OR "pre-eclampsia" OR "Pre-eclampsia" OR "Preeclampsia" OR "Pre-eclampsia superimposed on chronic hypertension" OR "Eclampsia" OR "HELLP syndrome")

AND

("perinatal mental health" OR "maternal mental health" OR "maternal mental health" OR "postpartum depression" OR "postpartum psychosis" OR "maternal anxiety" OR "maternal stress").

AND

("low- and middle-Income countries" OR "developing countries" OR "Afghanistan" OR "Albania" OR "Algeria" OR "American Samoa" OR "Angola" OR "Argentina" OR "Armenia" OR "Azerbaijan" OR "Bangladesh" OR "Belarus" OR "Belize" OR "Benin" OR "Bhutan" OR "Bolivia" OR "Bosnia and Herzegovina" OR "Botswana" OR "Brazil" OR "Bulgaria" OR "Burkina Faso" OR "Burundi" OR "Cabo Verde" OR "Cambodia" OR "Cameroon" OR "Central African Republic" OR "Chad" OR "China" OR "Colombia" OR "Comoros" OR "Democratic Republic of Congo" OR "Côte d'Ivoire" OR "Cuba" OR "Djibouti" OR "Dominica" OR "Dominican Republic" OR "Ecuador" OR "Egypt” OR "El Salvador" OR "Equatorial Guinea" OR "Eritrea" OR "Eswatini" OR "Ethiopia" OR "Fiji" OR "Gabon" OR "Gambia" OR "Georgia" OR "Ghana" OR "Grenada" OR "Guatemala" OR "Guinea" OR "Guinea-Bissau" OR "Guyana" OR "Haiti" OR "Honduras" OR "India" OR "Indonesia" OR "Iran" OR "Iraq" OR "Jamaica" OR "Jordan" OR "Kazakhstan" OR "Kenya" OR "Kiribati" OR "Korea" OR "Kosovo" OR "Kyrgyz Republic" OR "Lao PDR" OR "Lebanon" OR "Lesotho" OR "Liberia" OR "Libya" OR "Madagascar" OR "Malawi" OR "Malaysia" OR "Maldives" OR "Mali" OR "Marshall Islands" OR "Mauritania" OR "Mauritius" OR "Mexico" OR "Micronesia Federation" OR "Moldova" OR "Mongolia" OR "Montenegro" OR "Morocco" OR "Mozambique" OR "Myanmar" OR "Namibia" OR "Nauru" OR "Nepal" OR "Nicaragua" OR "Niger" OR "Nigeria" OR "North Macedonia" OR "Pakistan" OR "Palau" OR "Papua New Guinea" OR "Paraguay" OR "Peru" OR "Philippines" OR "Russian Federation" OR "Rwanda" OR "Samoa" OR "São Tomé and Príncipe" OR "Senegal" OR "Serbia" OR "Sierra Leone" OR "Solomon Islands"

OR "Somalia" OR "South Africa" OR "South Sudan" OR "Sri Lanka" OR "St. Lucia" OR "St. Vincent and the Grenadines" OR "Sudan" OR "Suriname" OR "Syrian Arab Republic" OR "Tajikistan" OR "Tanzania" OR "Thailand" OR "Timor-Leste" OR "Togo" OR "Tonga" OR "Tunisia" OR "Turkey" OR "Turkmenistan" OR "Tuvalu" OR "Uganda" OR "Ukraine" OR "Uzbekistan" OR "Vanuatu" OR "Vietnam" OR "West Bank and Gaza" OR "Yemen" OR "Zambia" OR "Zimbabwe")

SCOPUS

TITLE-ABS-KEY (hypertensive AND disorders AND of AND pregnancy OR chronic AND hypertension OR essential AND hypertension OR secondary AND hypertension OR white-coat AND hypertension OR masked AND hypertension OR gestational AND hypertension OR pregnancy AND induced AND hypertension OR transient AND gestational AND hypertension OR pre-eclampsia OR pre AND eclampsia OR preeclampsia OR pre-eclampsia AND superimposed AND on AND chronic AND hypertension OR eclampsia OR hellp AND syndrome) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (EXACTKEYWORD , "Human")) AND (LIMIT-TO (AFFILCOUNTRY , "Brazil") OR LIMIT-TO (AFFILCOUNTRY , "Cameroon") OR LIMIT-TO (AFFILCOUNTRY , "Moldova") OR LIMIT-TO (AFFILCOUNTRY , "South Africa") OR LIMIT-TO (AFFILCOUNTRY , "China"))

PUBMED

(((hypertensive disorders of pregnancy or chronic hypertension or essential hypertension or secondary hypertension or white-coat hypertension or masked hypertension or gestational hypertension or pregnancy induced hypertension or transient gestational hypertension or pre-eclampsia or Pre-eclampsia or Preeclampsia or Pre-eclampsia superimposed on chronic hypertension or Eclampsia or HELLP syndrome AND ((humans[Filter]) AND (english[Filter]))) AND (maternal health outcome or maternal outcome or outcomes or maternal mortality or maternal morbidity or maternal mental health or postpartum depression or postpartum psychosis or maternal physical health or hyperemesis gravidarum or gestational age at delivery or spontaneous abortion or preterm birth or preterm premature rupture of membranes or

still birth or intrauterine growth restriction AND ((humans[Filter]) AND (english[Filter]))) AND (Early pregnancy or first trimester or pregnancy in the early stages or early gestation AND ((humans[Filter]) AND (english[Filter]))) AND (low- and middle-Income countries or developing countries or Afghanistan or Albania or Algeria or American Samoa or Angola or Argentina or Armenia or Azerbaijan or Bangladesh or Belarus or Belize or Benin or Bhutan or Bolivia or Bosnia and Herzegovina or Botswana or Brazil or Bulgaria or Burkina Faso or Burundi or Cabo Verde or Cambodia or Cameroon or Central African Republic or Chad or China or Colombia or Comoros or Costa Rica or Cuba or Djibouti or Dominica or Dominican Republic or Ecuador or Egypt or El Salvador or Equatorial Guinea or Eritrea or Eswatini or Ethiopia or Fiji or Gabon or Gambia or Georgia or Ghana or Grenada or Guatemala or Guinea or Guinea-Bissau or Guyana or Haiti or Honduras or India or Indonesia or Iraq or Jamaica or Jordan or Kazakhstan or Kenya or Kiribati or Kosovo or Kyrgyz Republic or Lebanon or Lesotho or Liberia or Libya or Madagascar or Malawi or Malaysia or Maldives or Mali or Marshall Islands or Mauritania or Mauritius or Mexico or Moldova or Mongolia or Montenegro or Morocco or Mozambique or Myanmar or Namibia or Nauru or Nepal or Nicaragua or Niger or Nigeria or North Macedonia or Pakistan or Iran Islamic Republic or Congo Democratic Republic or Congo Republic or Ivory coast or Korea Democratic Peoples Republic or Lao PDR Micronesia Federation or Sao Tome and Principe or Yemen Republic or Saint Lucia or Saint Vincent and the Grenadines or Palau or Papua New Guinea or Paraguay or Peru or Philippines or Russian Federation or Rwanda or Samoa or Senegal or Serbia or Sierra Leone or Solomon Islands or Somalia or South Africa or South Sudan or Sri Lanka or Sudan or Suriname or Syrian Arab Republic or Tajikistan or Tanzania or Thailand or Timor-Leste or Togo or Tonga or Tunisia or Turkey or Turkmenistan or Tuvalu or Uganda or Ukraine or Uzbekistan or Vanuatu or Vietnam or West Bank and Gaza or Zambia or Zimbabwe AND ((humans[Filter]) AND (english[Filter])))

Appendix H: R Code used for Meta-Analysis

Code for metafor package was written by Wolfgang Viechtbauer.

 # Install packages

```{r}
install.packages(c("robumeta", "metafor", "dplyr"))
```

 # Load Packages

```{r}
library("robumeta")
library("metafor")
library("dplyr")
```

 # Load Data

```{r}
associations <- read.csv("asso_data.csv")
associations
```

 # Calculate log transformed odds ratios and corresponding sampling variances

```{r}
dat <- escalc(measure="OR", ai=a, n1i=n1, ci=c, n2i=n2,
              slab=paste(author, ", ", year, sep=""), data=associations)
dat
```

 # Generate the Equal-effects model (using log risk ratios and variances as input)

```{r}
res <- rma(yi, vi, data=dat, method = "EE", digits=4)
res
```

 # Predict pooled estimates

```{r}
predict(res, transf=exp, digits=4) #summary of effect size (odds ratio)
```

 # Format pooled estimates to 5 decimal points.

```{r}
formatC(res$pval, format="f", digits=5) # p-value of the summary estimate
```

 # Calculate individual weights of articles

```{r}
dat$weights <- paste0(round(weights(res)), "%")  # weights in % (rounded)
dat$pvals   <- round(summary(dat)$pval, digits=4) # p-values of the individual trials
```

 # Settings for Forest plot

```
par(mar=c(4,4,2,2))
forest(res, xlim=c(-1,2.5), atransf=exp, at=log(c(2/3, 1, 3/2)),
       header=TRUE, top=2, mlab="Summary", efac=c(0,1,3),
       ilab=data.frame(dat$weights, dat$pvals), ilab.xpos=c(0.7,1.4), ilab.pos=2)
text(0.7, -0.3, "100%", pos=2)
text(1.45, -0.3, formatC(res$pval, format="f", digits=5), pos=2)
```

text(0.8, 5, "Weight", pos=2, font=2)

text(1.4, 5, "P-Value", pos=2, font=2)

 # Generate forest plot

```{r}

forest(res)

forest(res, addpred=TRUE, header=TRUE)

print(forest(res, addpred=TRUE, header=TRUE))

**# Generate funnel plot**

```{r}

funnel(res)

funnel(res, ylim=c(0,.8), las=1)

funnel(res, ylim=c(0,.8), las=1, digits=list(1L,1))

```

 # Generate contour-enhanced funnel plot

```{r}

funnel(dat$yi, dat$vi, yaxis="seinv",

      xlim=c(-3,2), ylim=c(.00001,8), xaxs="i", yaxs="i", las=1,

      level=c(.10, .05, .01), shade=c("white", "gray55", "gray75"),

      legend=TRUE, back="gray90", hlines=NULL, ylab="Precision (1/se)")

```

 # Generate trim and fill plot

```{r}

```
funnel(trimfill(res), las=1, ylim=c(0,.8), digits=list(1L,1), legend=TRUE)
```

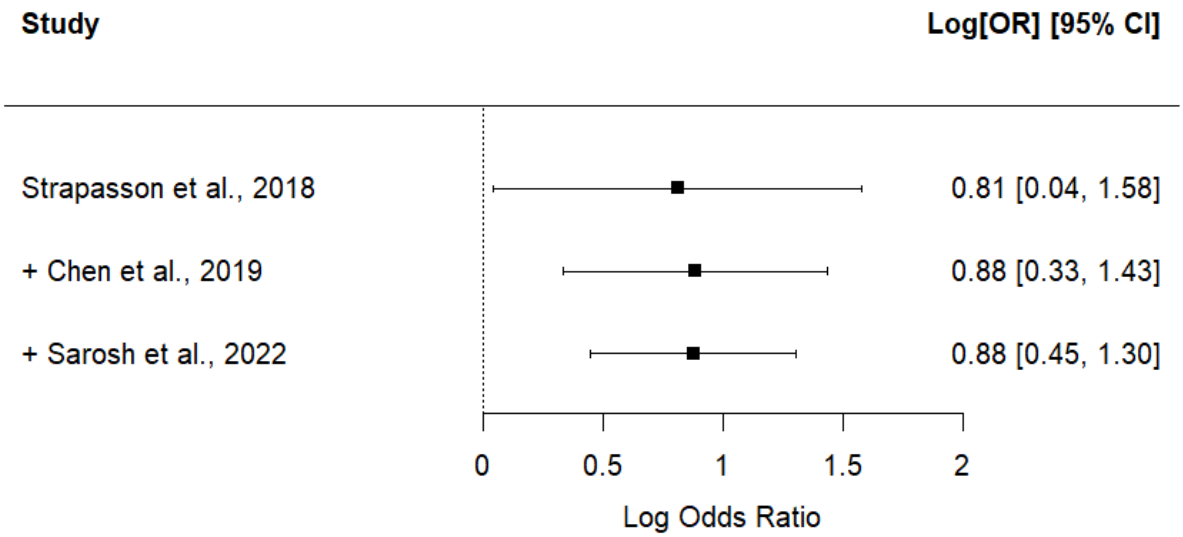
 # Identify outliers

```{r}
par(mar=c(5,6,4,2))
plot(influence(res), cex=0.8, las=1)
```

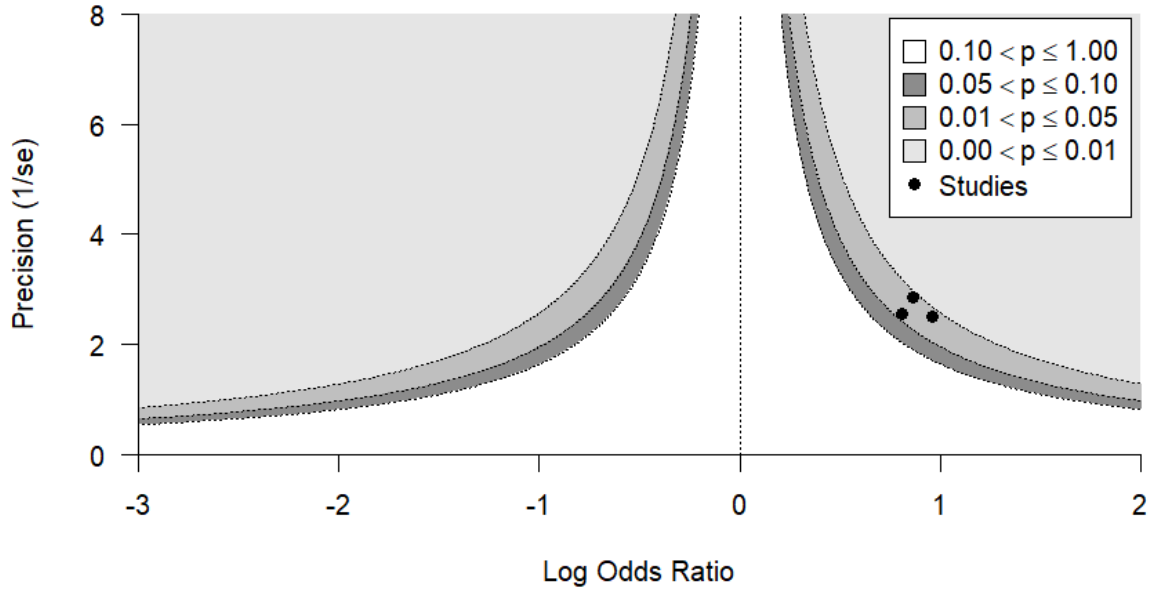
 # cumulative meta-analysis

```{r}
sav <- cumul(res, order=dat$year)
sav
forest (sav, xlim=c(-2,2.9), header=TRUE)
```

Appendix I: Supplemental Figures



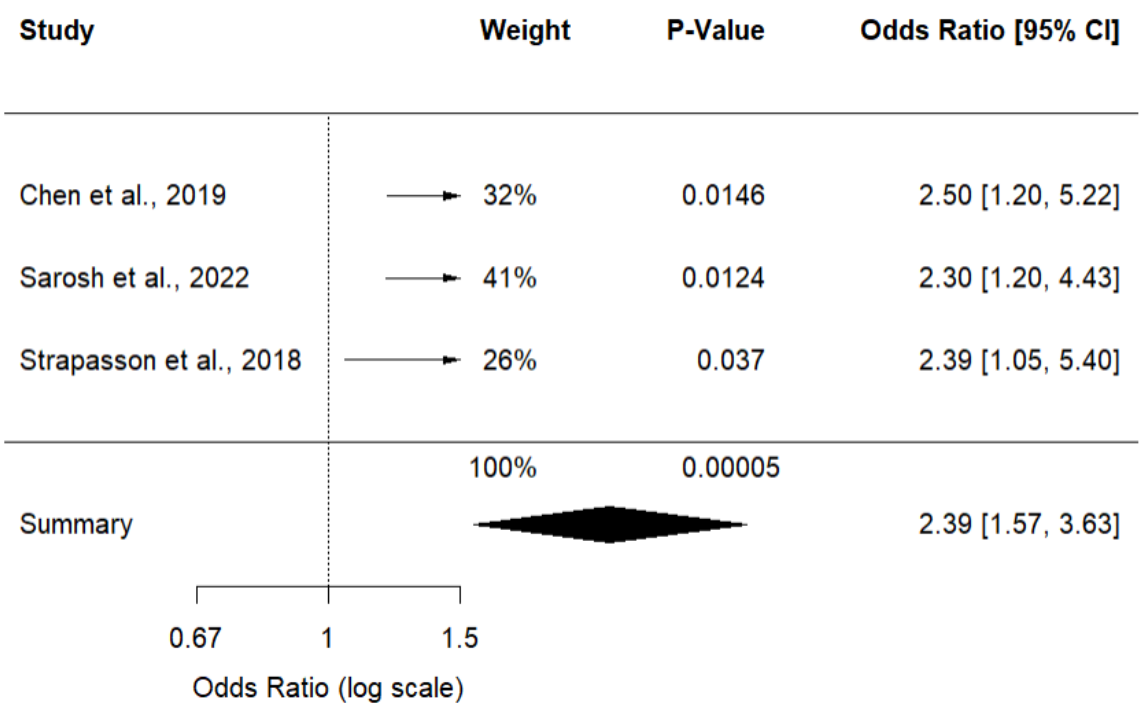
Supplemental Figure 1: Cumulative Forest plot for EE-OR model



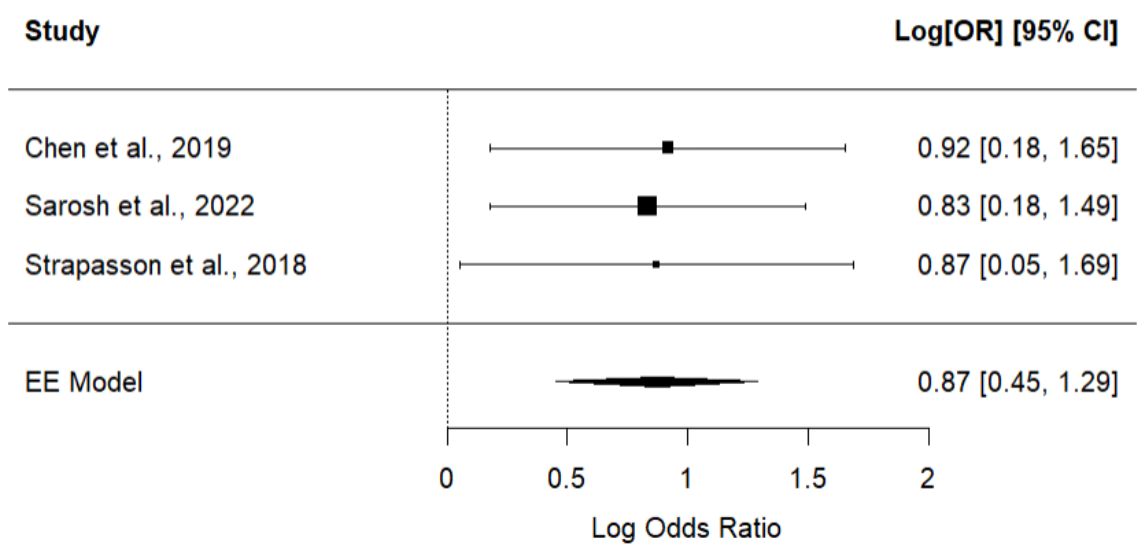
Supplemental Figure 2: Enhanced-contour plot for EE-OR model

```
Equal-Effects Model (k = 3)

I^2 (total heterogeneity / total variability):   0.00%
H^2 (total variability / sampling variability):  0.01

Test for Heterogeneity:
Q(df = 2) = 0.0271, p-val = 0.9865

Model Results:

estimate      se    zval    pval   ci.lb   ci.ub
  0.8705  0.2140  4.0669  <.0001  0.4510  1.2900  ***

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

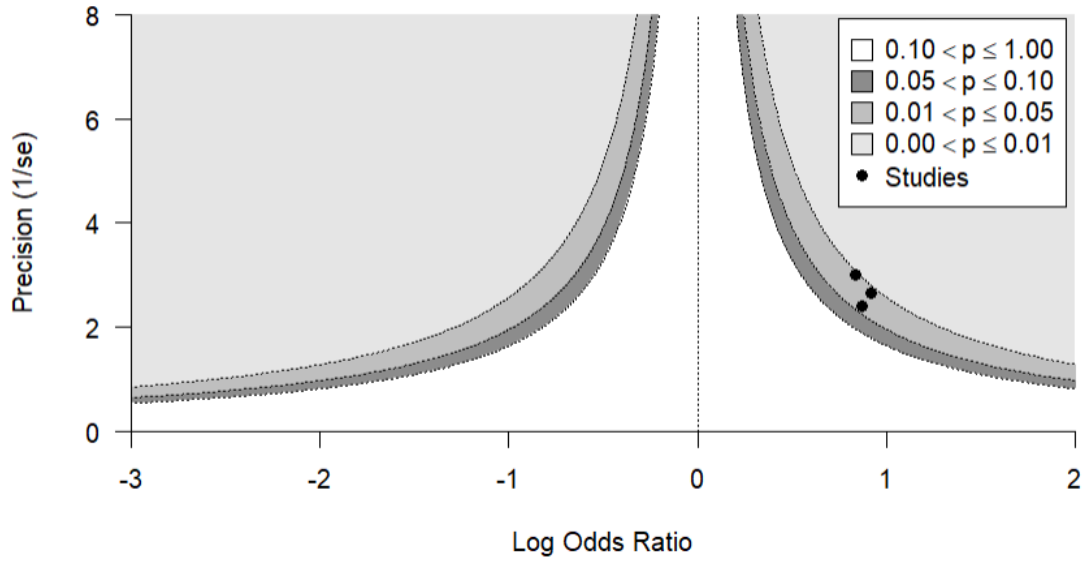
Supplemental Figure 3: Summary for EE-PE model



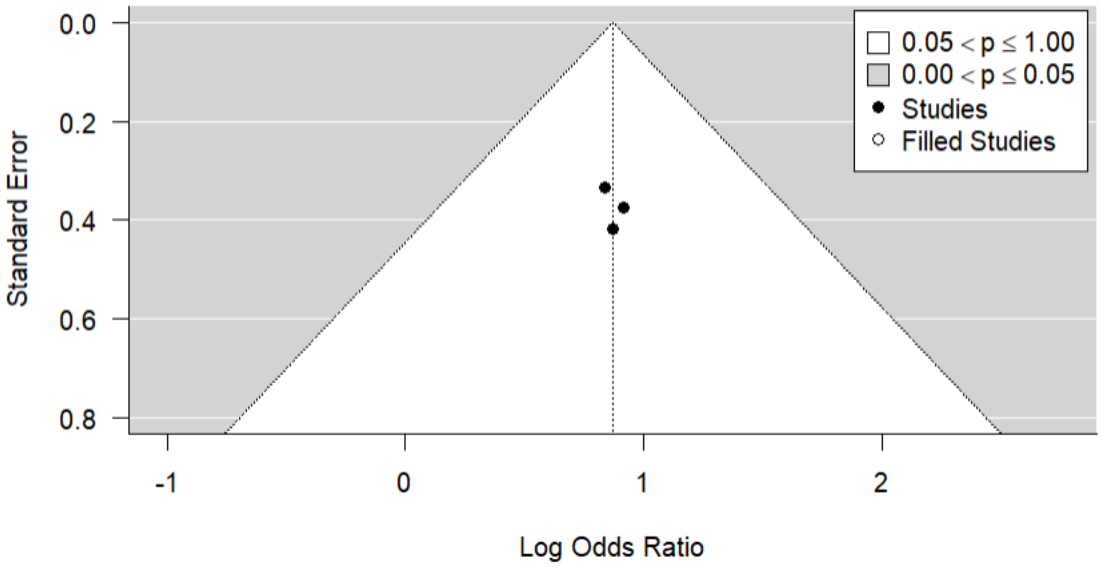
Supplemental Figure 4: Odds ratio for EE-PE model



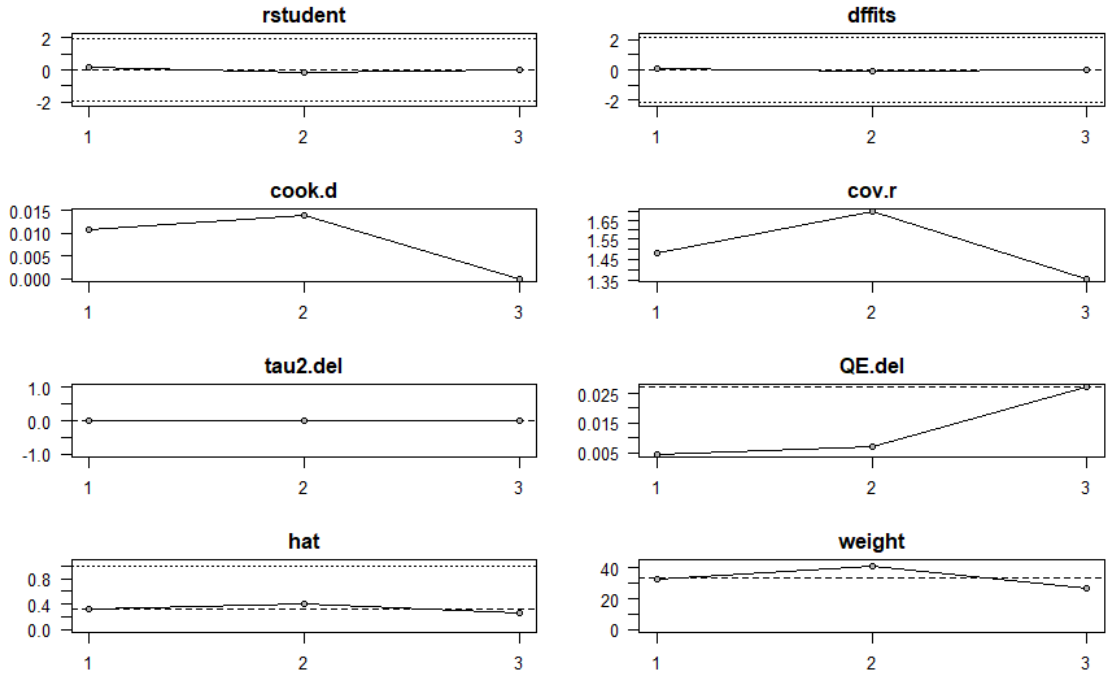
Supplemental Figure 5: Log odds ratio for EE-PE model



Supplemental Figure 6: Contour-enhanced funnel plot for EE-PE model



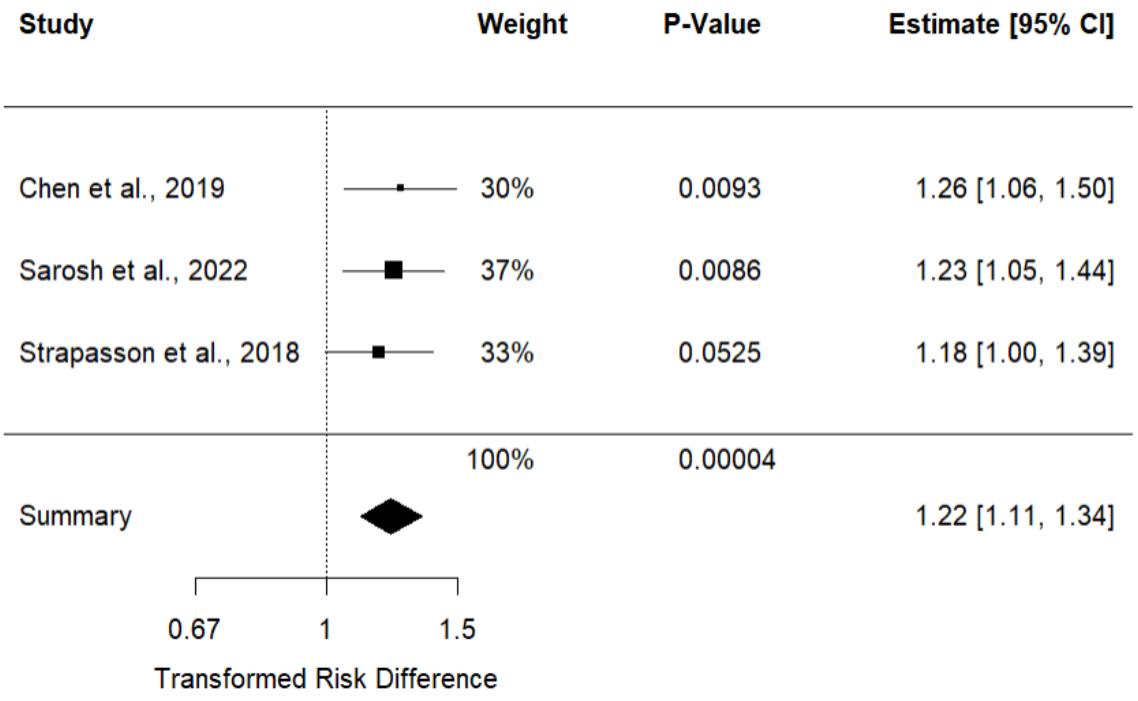
Supplemental Figure 7: Trim and fill method for EE-PE model



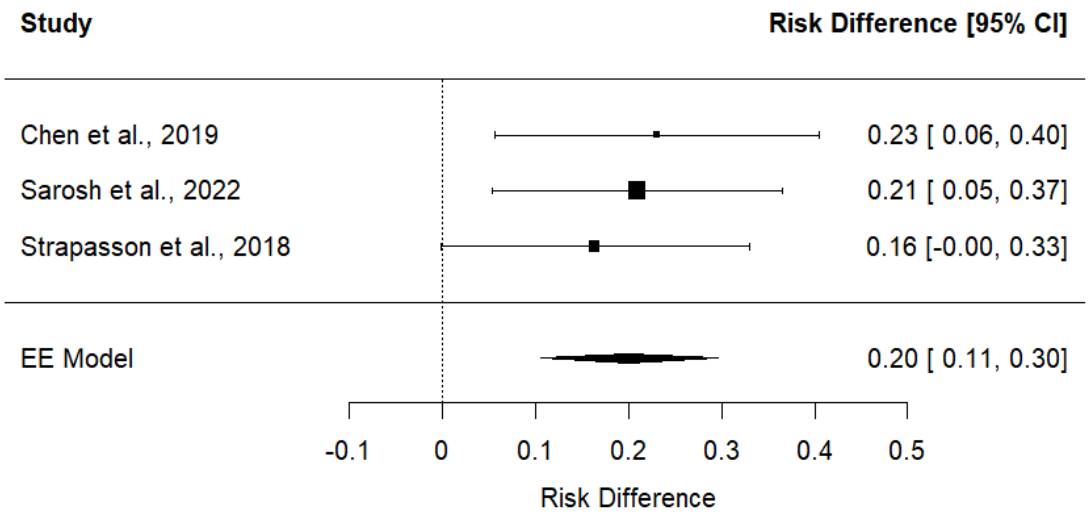
Supplemental Figure 8: Studentized residuals and Cook's distances for EE-PE model

```
Equal-Effects Model (k = 3)

I^2 (total heterogeneity / total variability):   0.00%
H^2 (total variability / sampling variability):  0.16

Test for Heterogeneity:
Q(df = 2) = 0.3129, p-val = 0.8552

Model Results:

estimate      se    zval    pval   ci.lb   ci.ub
  0.2009  0.0486  4.1362  <.0001  0.1057  0.2960  ***

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

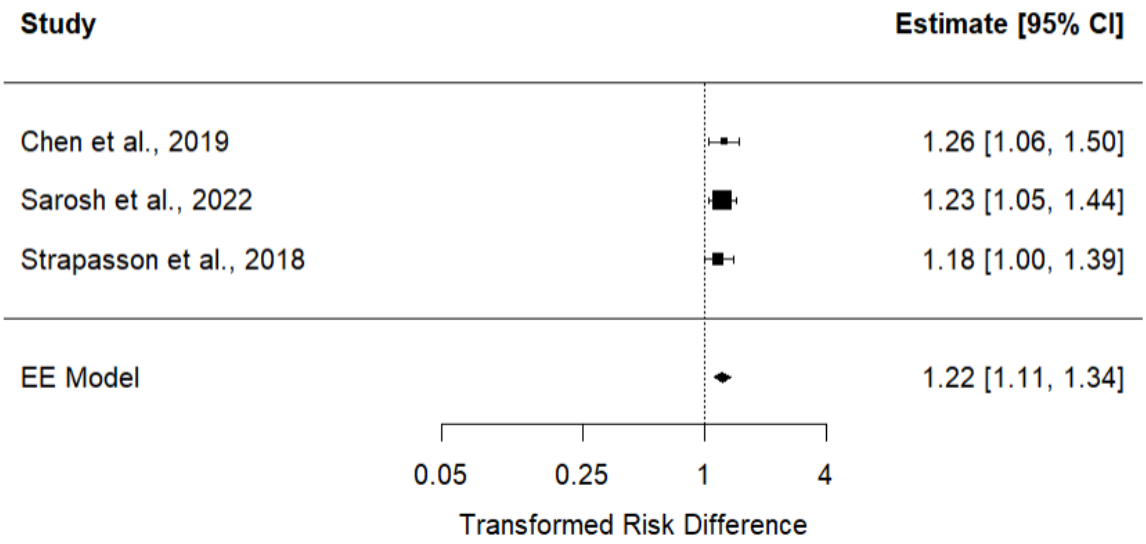
Supplemental Figure 9: Summary of EE-RD model



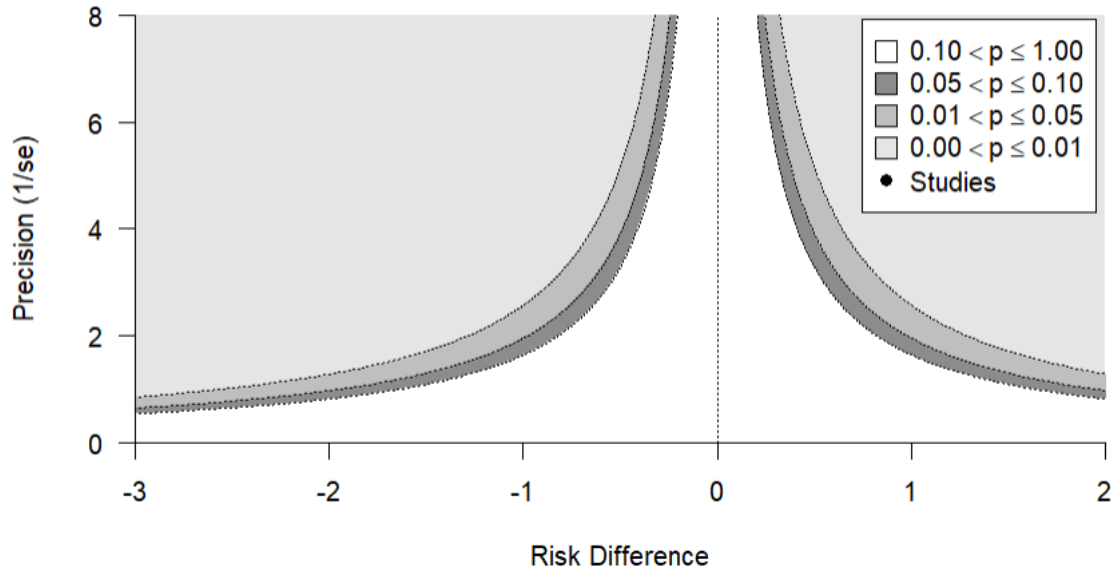
Supplemental Figure 10: Forest plot for transformed EE-RD model.



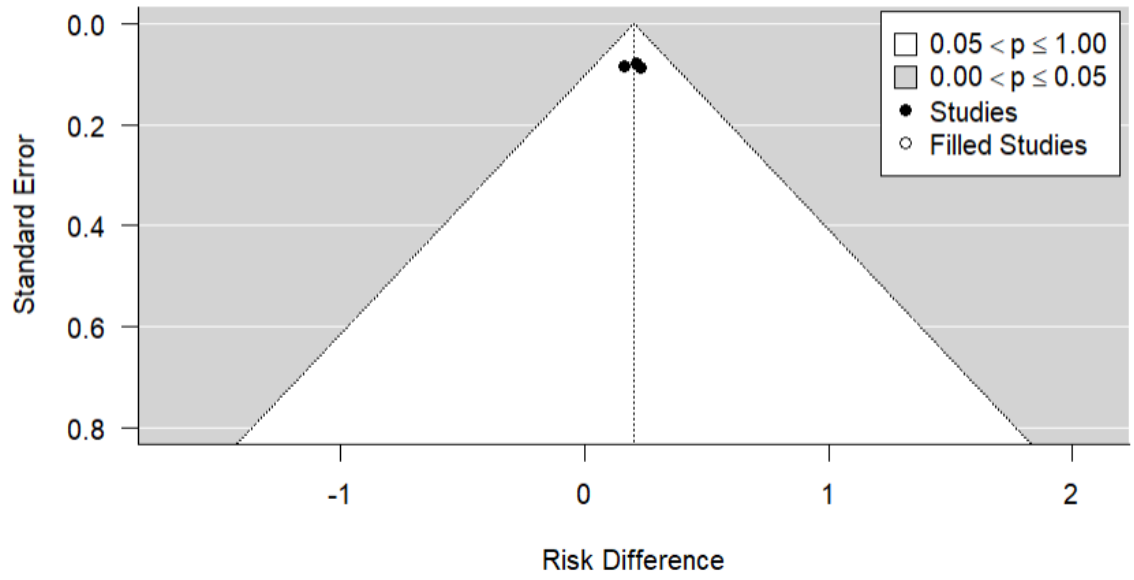
Supplemental Figure 11: Forest plot for EE-RD model



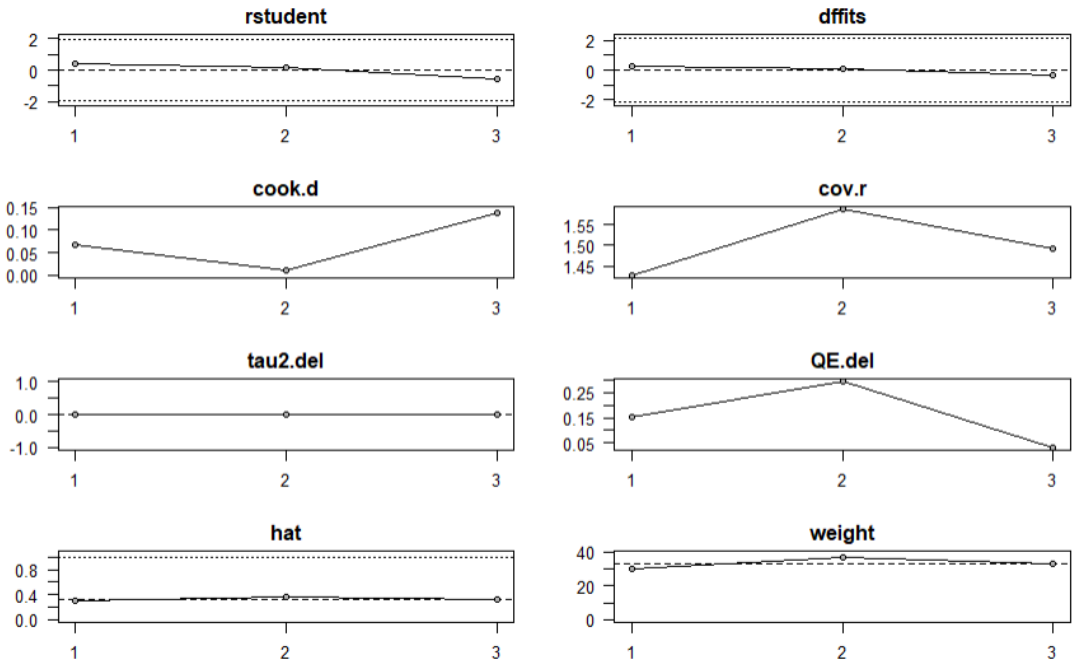
Supplemental Figure 12: Transformed RD for EE-RD model.



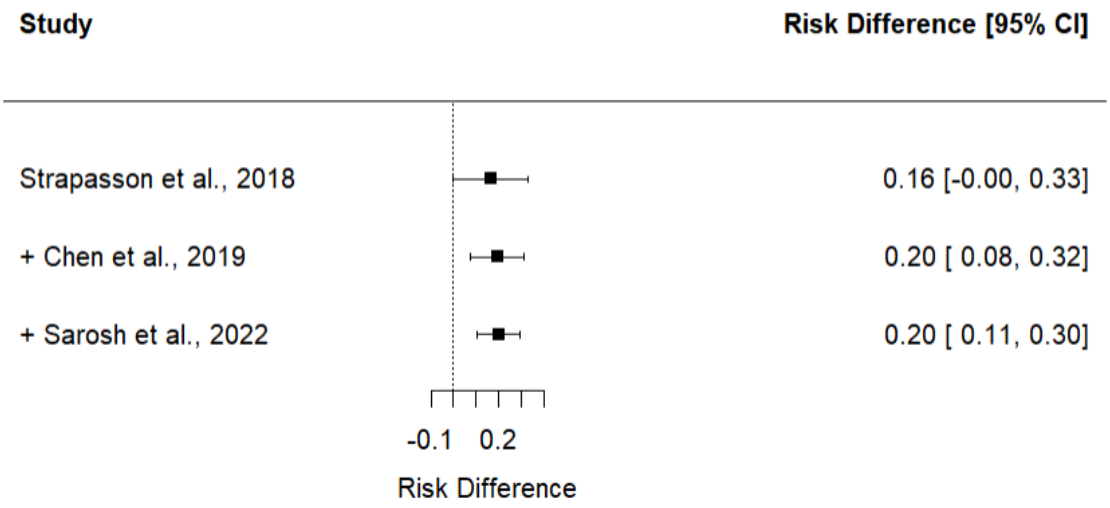
Supplemental Figure 13: Contour-enhanced funnel plot for EE-RD model



Supplemental Figure 14: Trim and fill method for EE-RD model



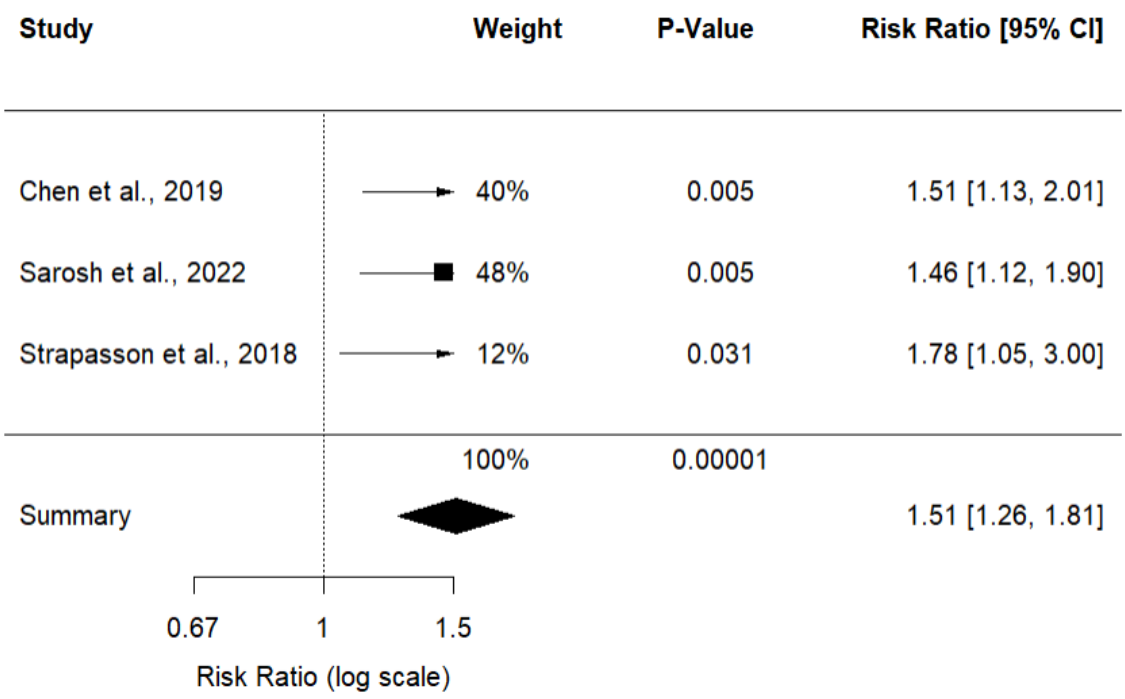
Supplemental Figure 15: Studentized residuals and Cook's distances for EE-RD model



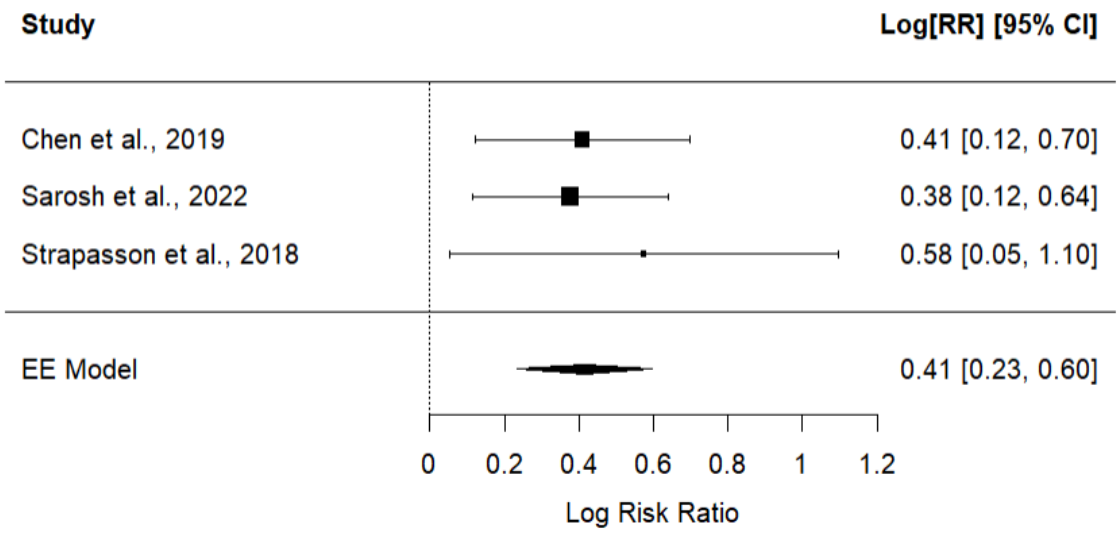
Supplemental Figure 16: Cumulative forest plot for EE-RD model

```
Equal-Effects Model (k = 3)

I^2 (total heterogeneity / total variability):   0.00%
H^2 (total variability / sampling variability):  0.22

Test for Heterogeneity:
Q(df = 2) = 0.4434, p-val = 0.8012

Model Results:

estimate      se    zval    pval   ci.lb   ci.ub
  0.4142  0.0925  4.4772  <.0001  0.2329  0.5956  ***

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

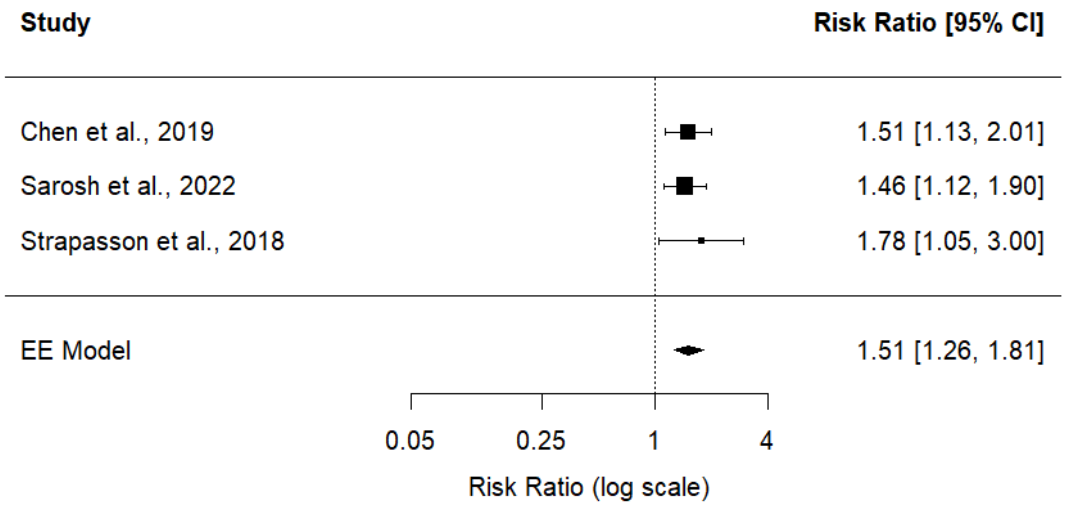
Supplemental Figure 17: Summary for EE-RR model



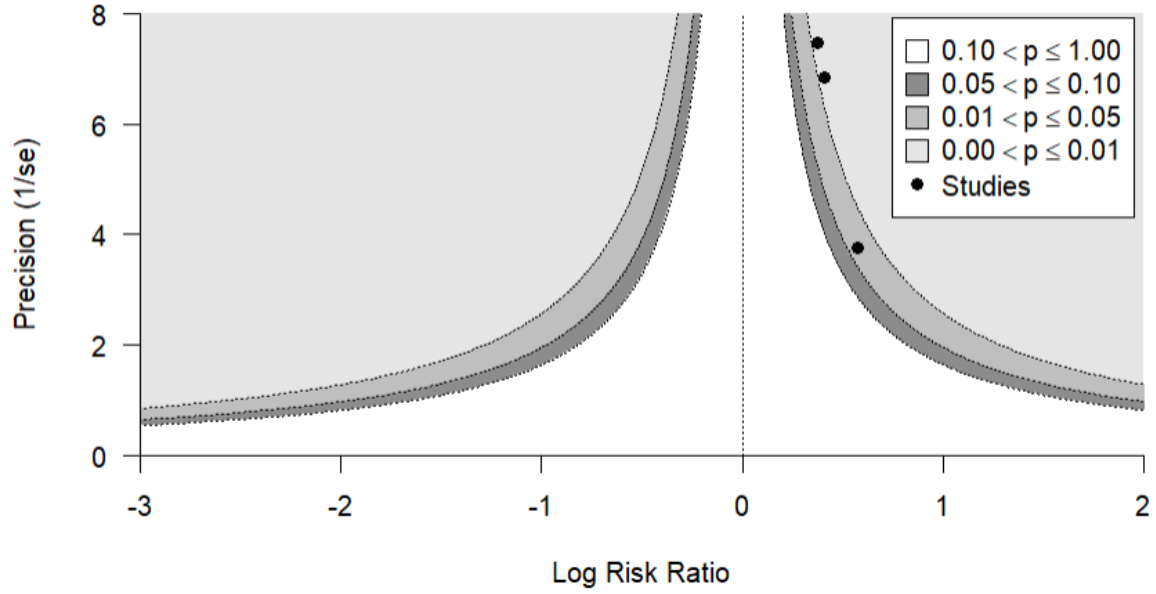
Supplemental Figure 18: Forest plot for EE-RR model



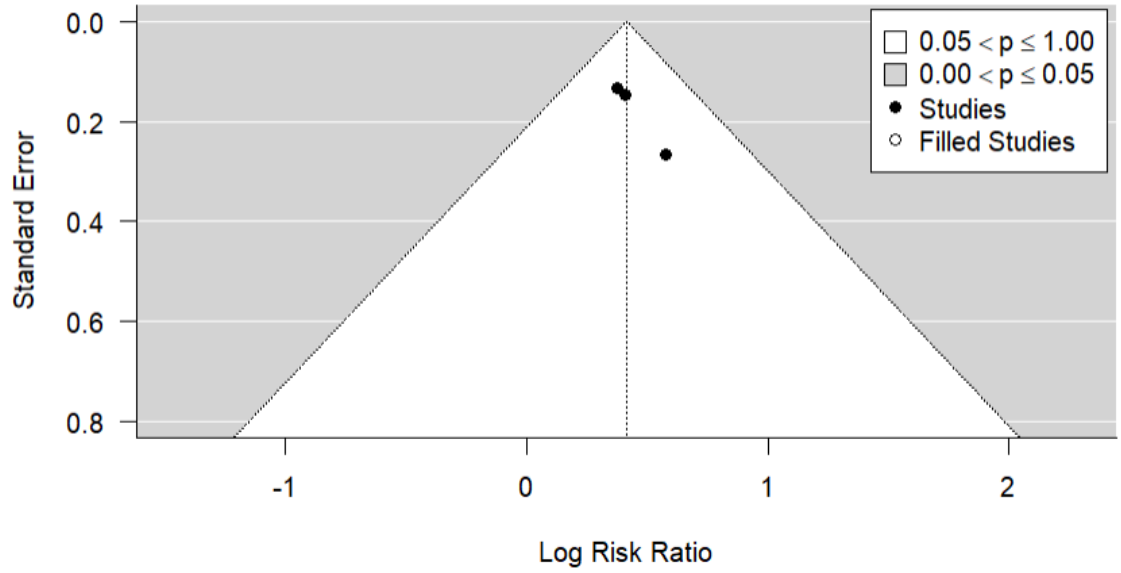
Supplemental Figure 19: Forest plot for EE-RR model using log risk ratio.



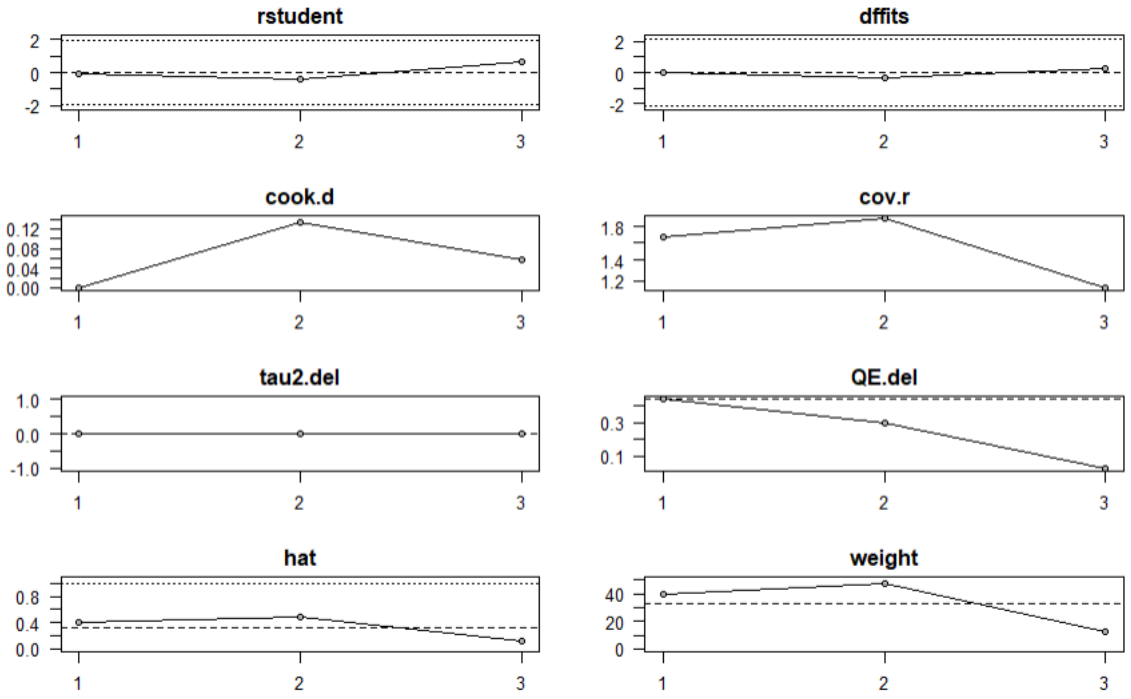
Supplemental Figure 20: Forest plot for EE-RR model



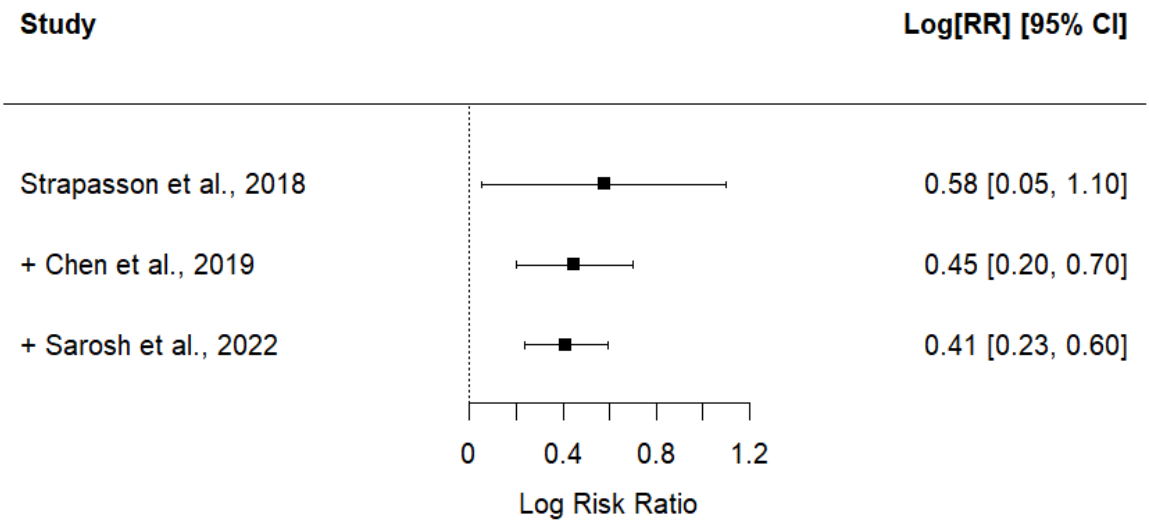
Supplemental Figure 21: Contour-enhanced funnel plot for EE-RR model



Supplemental Figure 22: Trim and fill method for EE-RR model



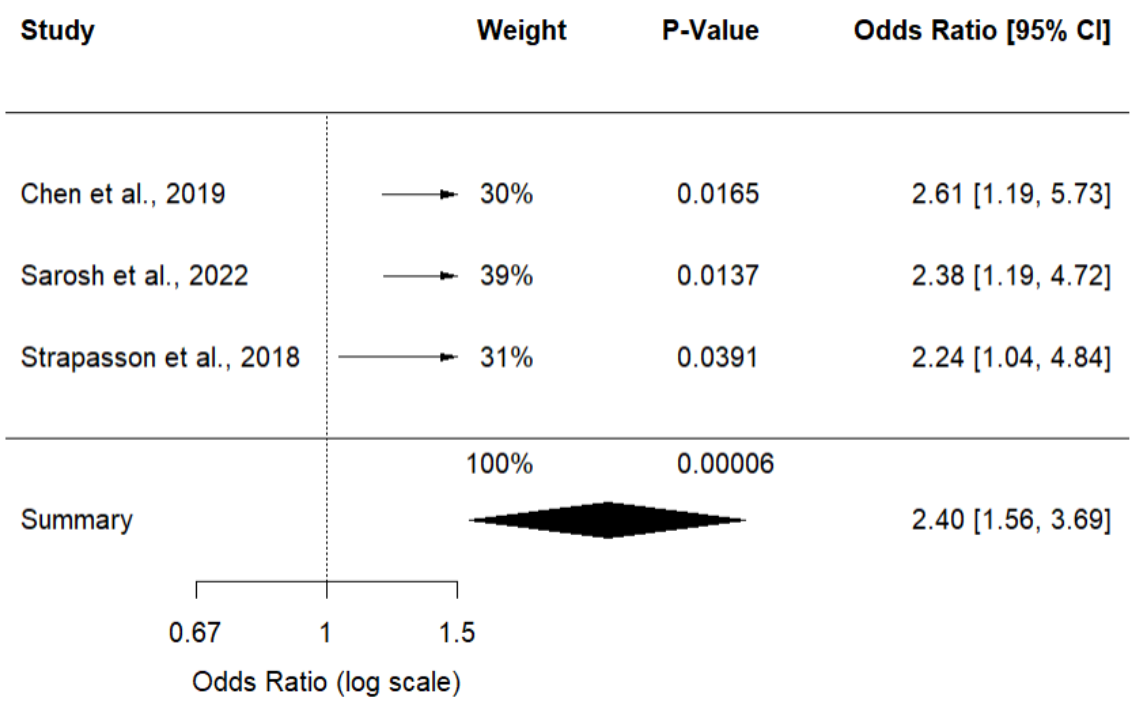
Supplemental Figure 23: Studentized residuals and Cook's distances for EE-RR model



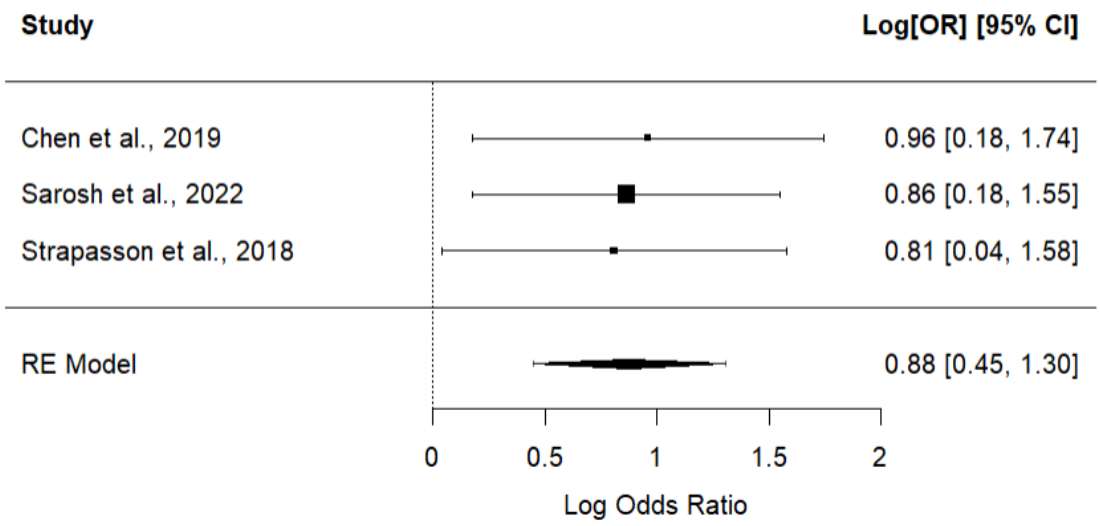
Supplemental Figure 24: Cumulative Forest plot for EE-RR model

```
Random-Effects Model (k = 3; tau^2 estimator: REML)

tau^2 (estimated amount of total heterogeneity): 0 (SE = 0.1443)
tau (square root of estimated tau^2 value):      0
I^2 (total heterogeneity / total variability):   0.00%
H^2 (total variability / sampling variability):  1.00

Test for Heterogeneity:
Q(df = 2) = 0.0746, p-val = 0.9634

Model Results:

estimate       se     zval    pval   ci.lb   ci.ub
  0.8757   0.2189   4.0010   <.0001   0.4467   1.3047   ***

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

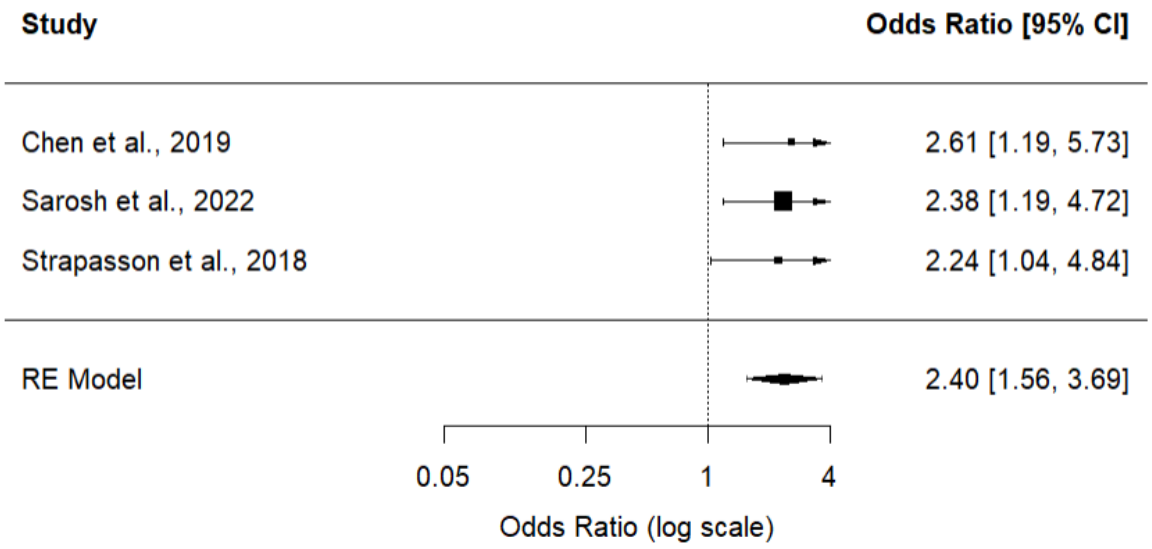
Supplemental Figure 25: Summary for RE-OR model



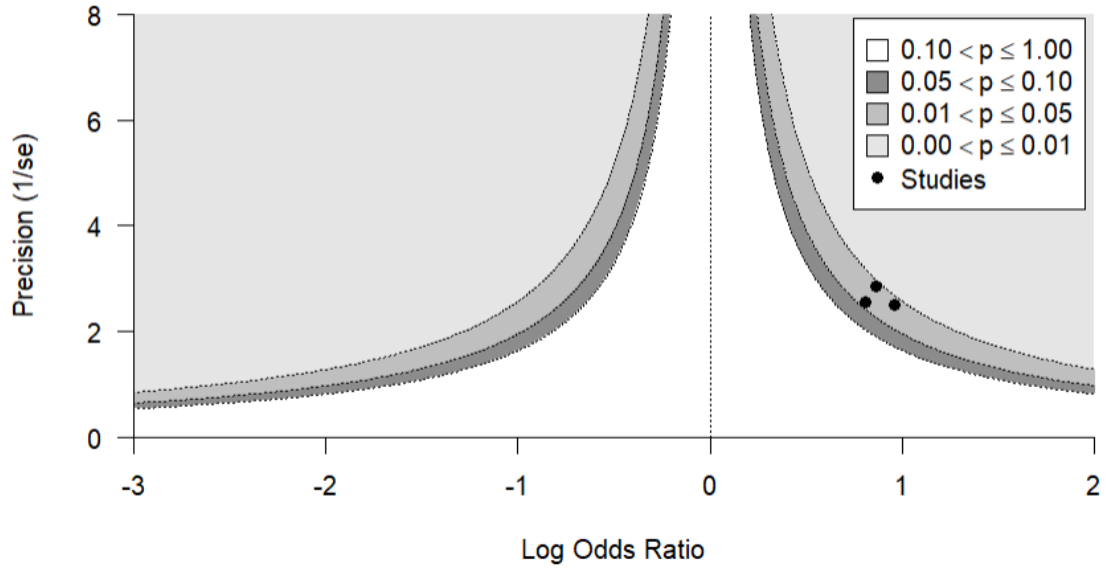
Supplemental Figure 26: Forest plot for RE-OR model



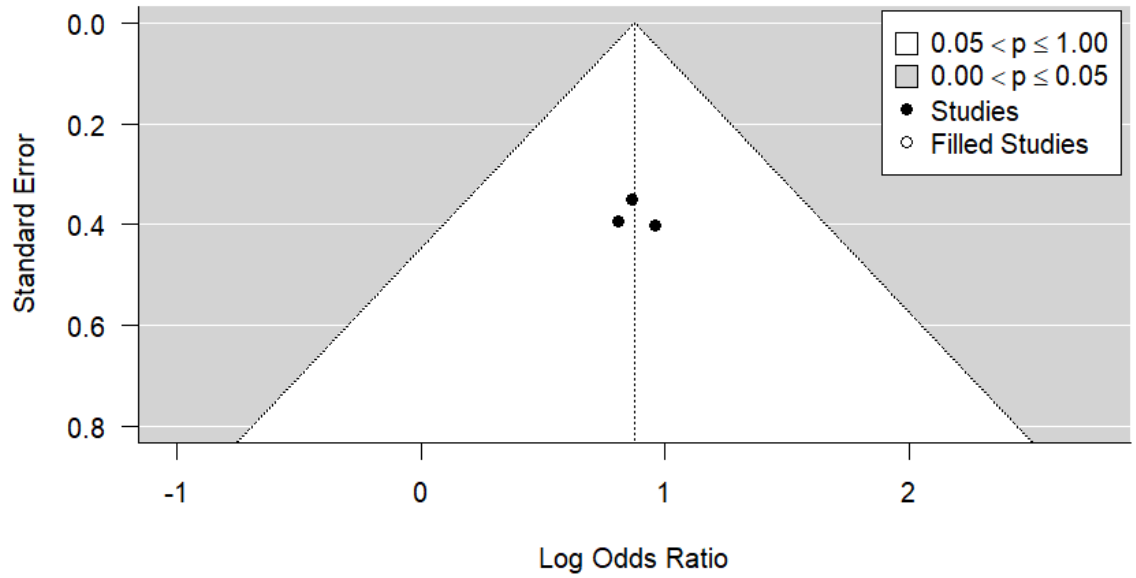
Supplemental Figure 27: Summary for RE-OR model using log odds ratio.



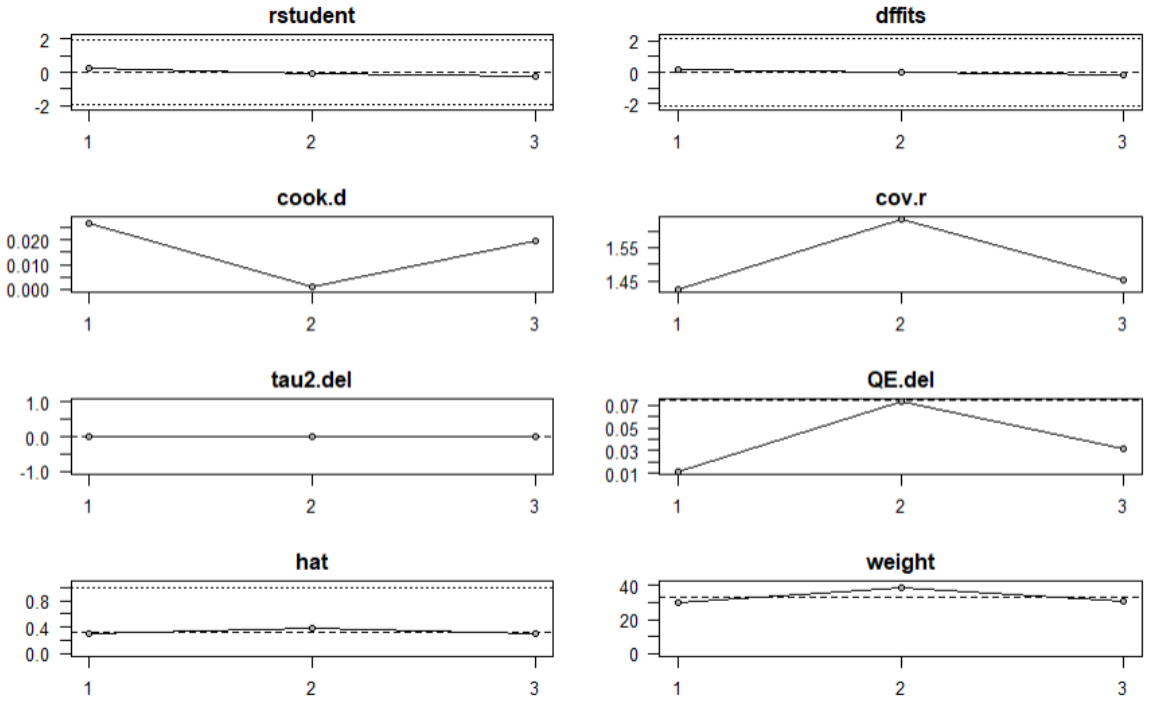
Supplemental Figure 28: Forest plot for RE-OR model



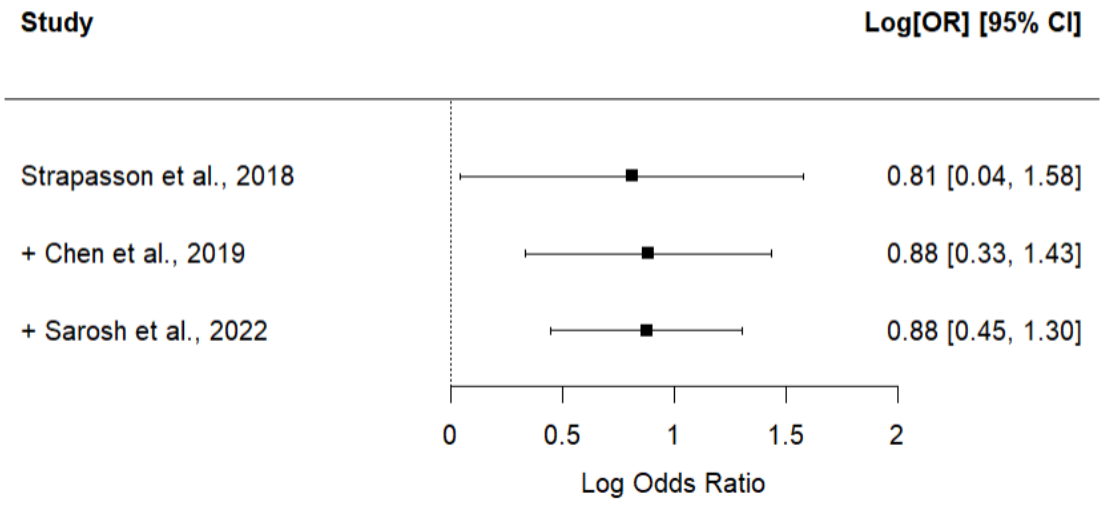
Supplemental Figure 29: Contour-enhanced funnel plot for RE-OR model



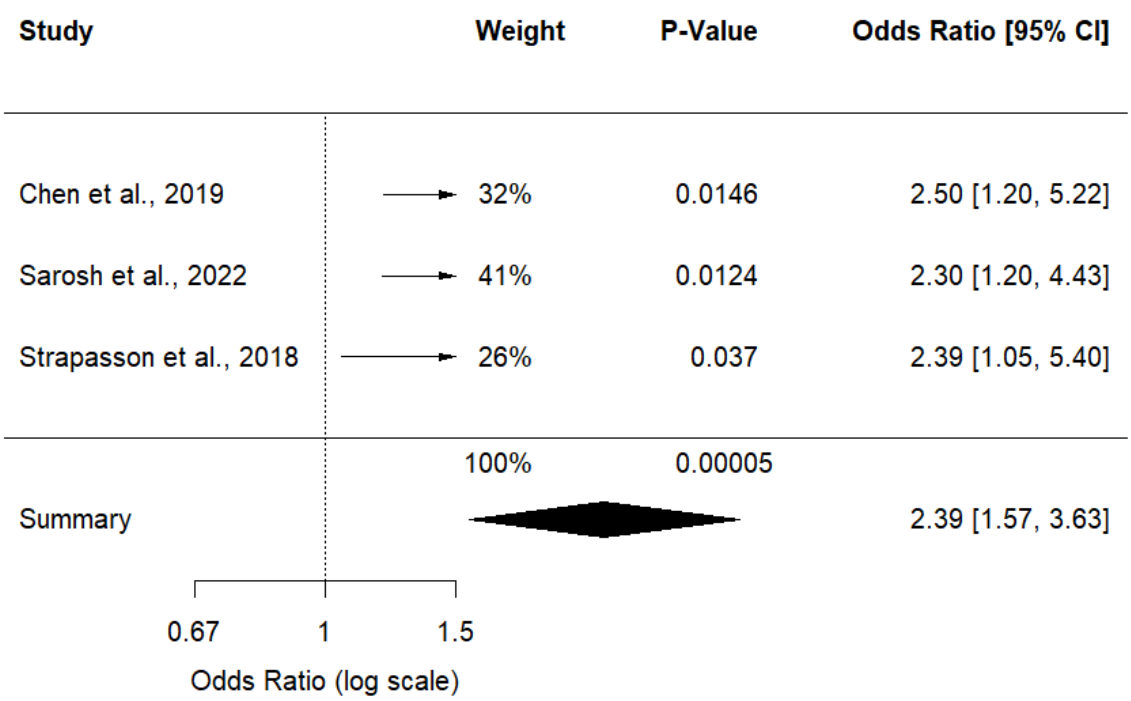
Supplemental Figure 30: Trim and fill method for RE-OR model



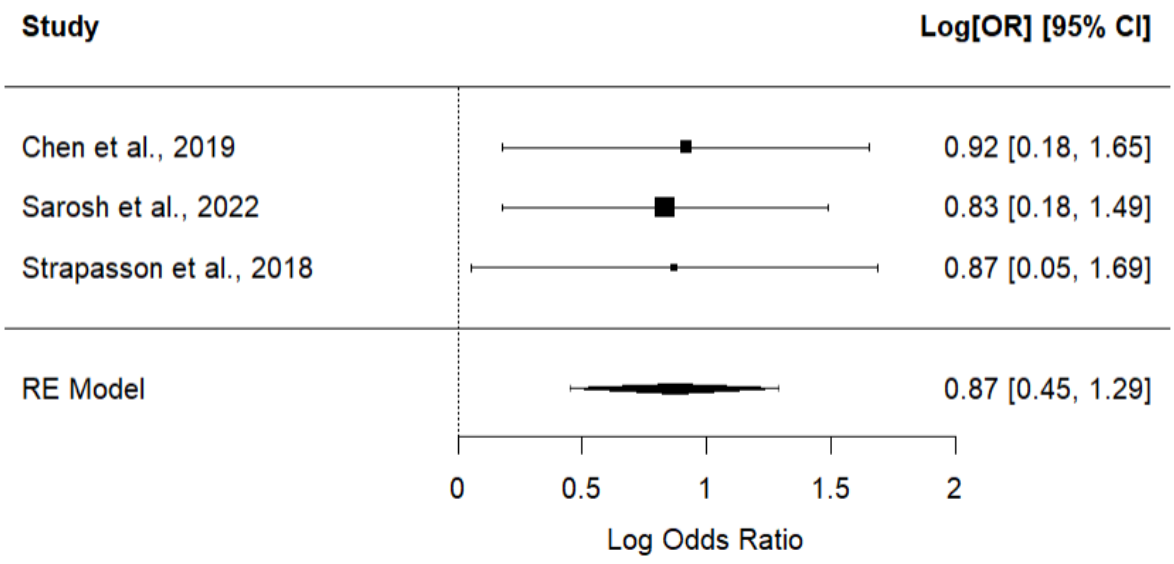
Supplemental Figure 31: Studentized residuals and Cook's distances for RE-OR model



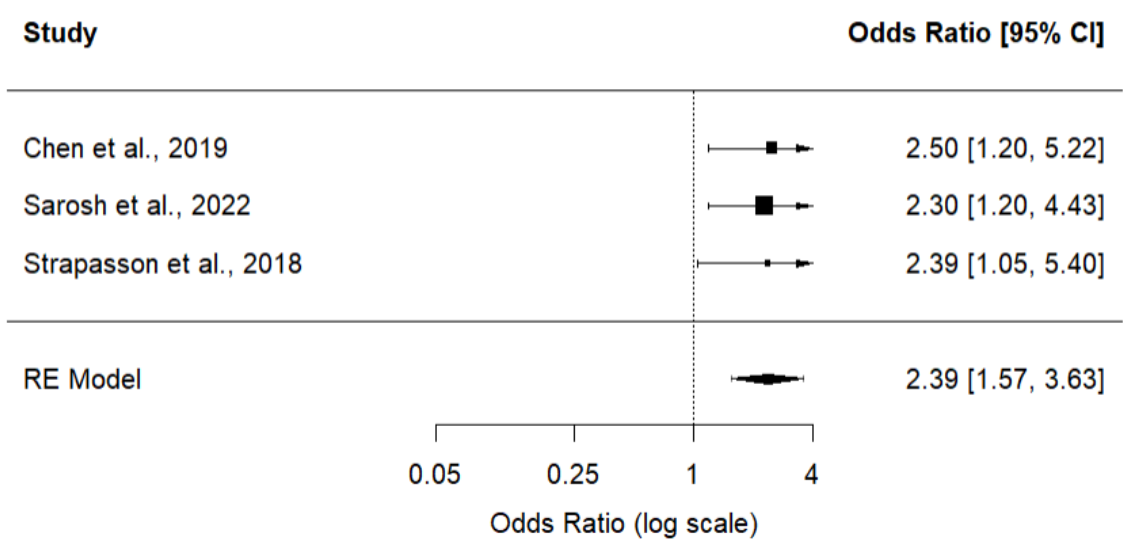
Supplemental Figure 32: Cumulative Forest plot for RE-OR model



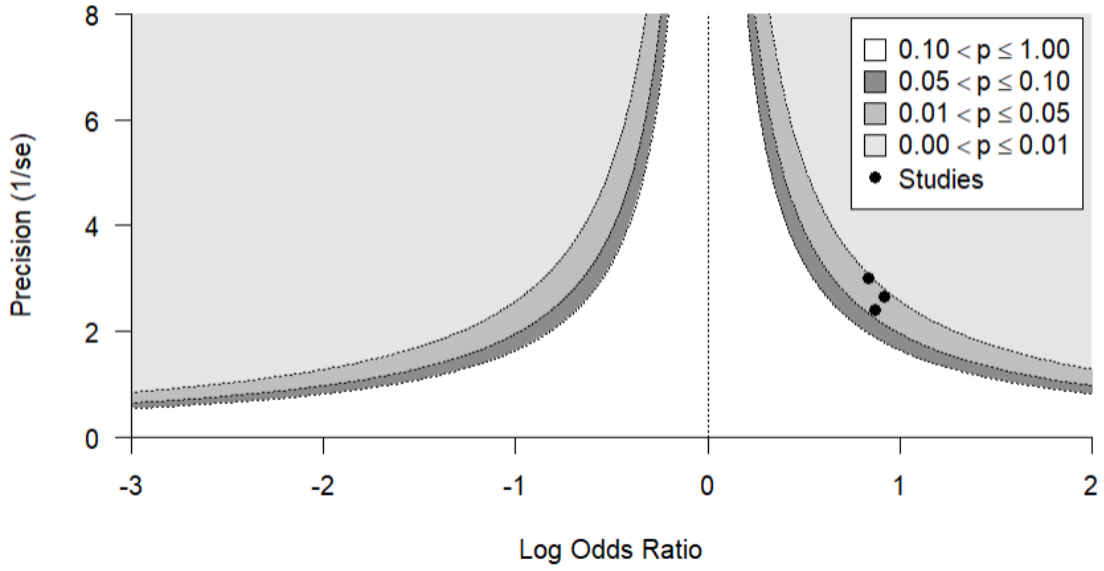
Supplemental Figure 33: Forest plot for RE-PE model



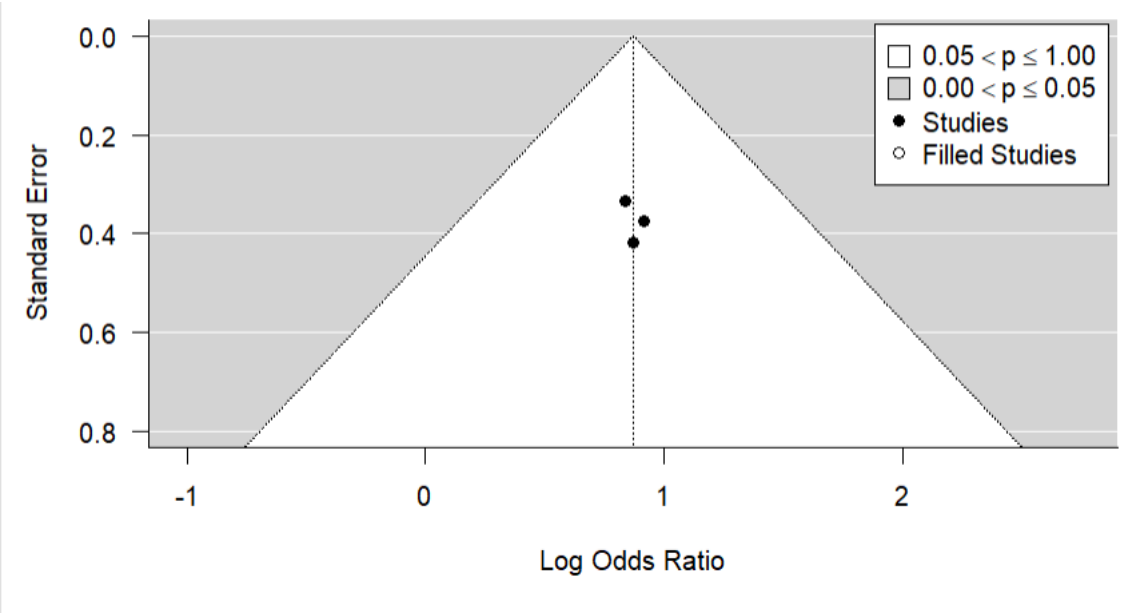
Supplemental Figure 34: Forest plot for RE-PE model using log odds ratio.



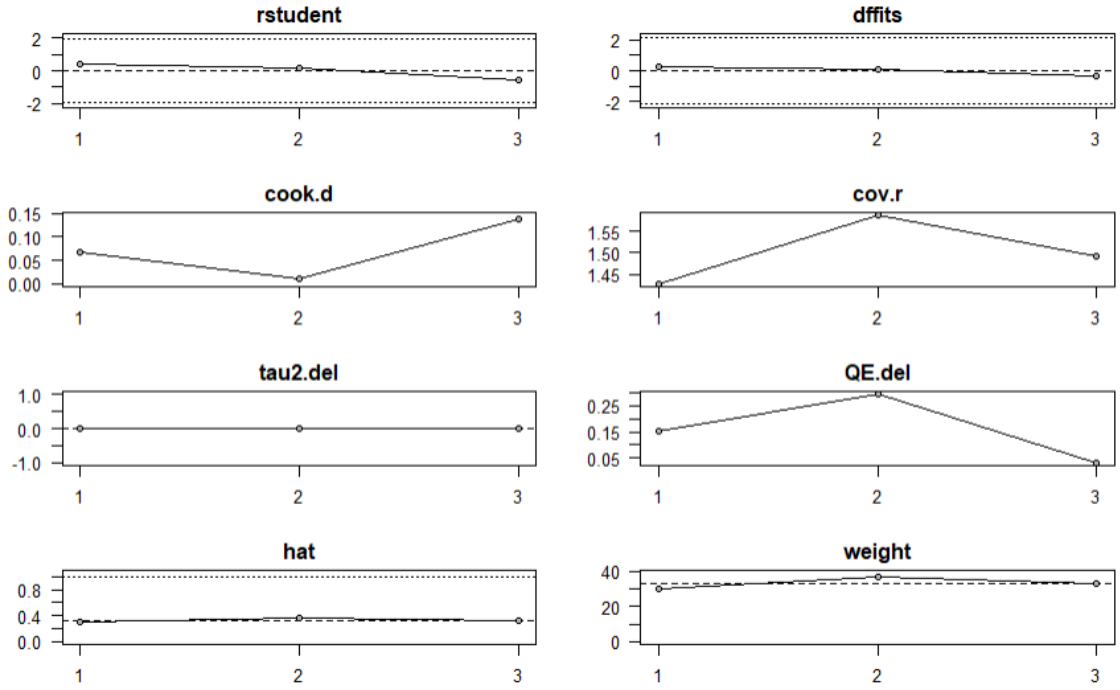
Supplemental Figure 35:Forest plot 2 for RE-PE model



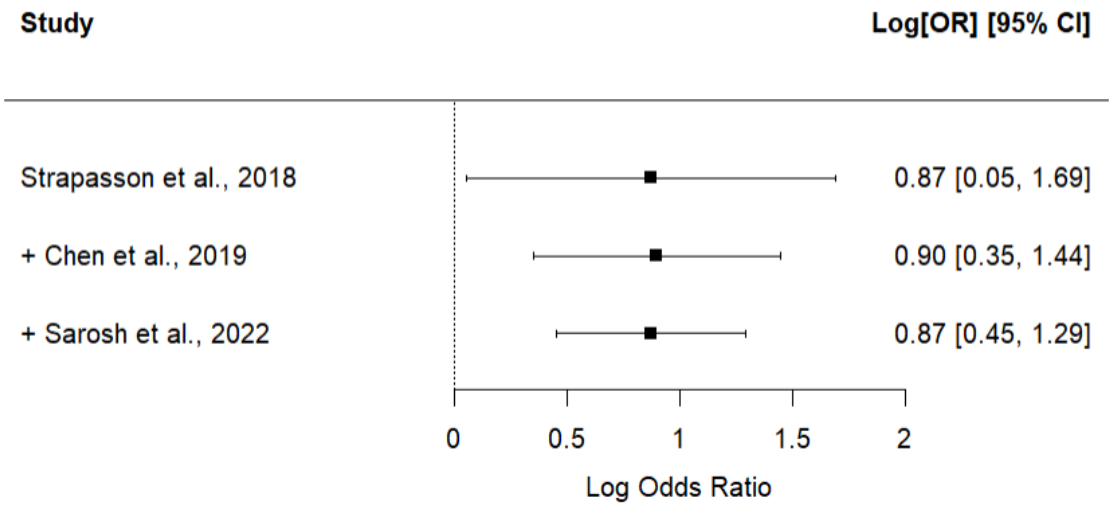
Supplemental Figure 36: Contour-enhanced funnel plot for RE-PE model



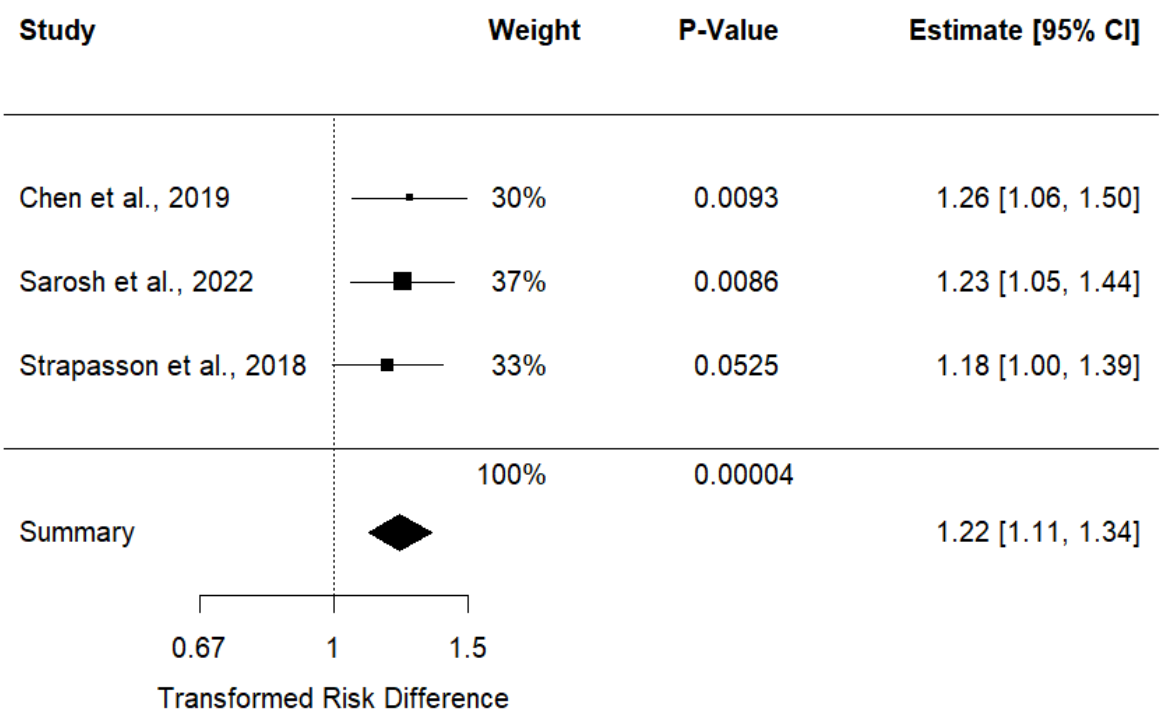
Supplemental Figure 37: Trim and fill method for RE-PE model



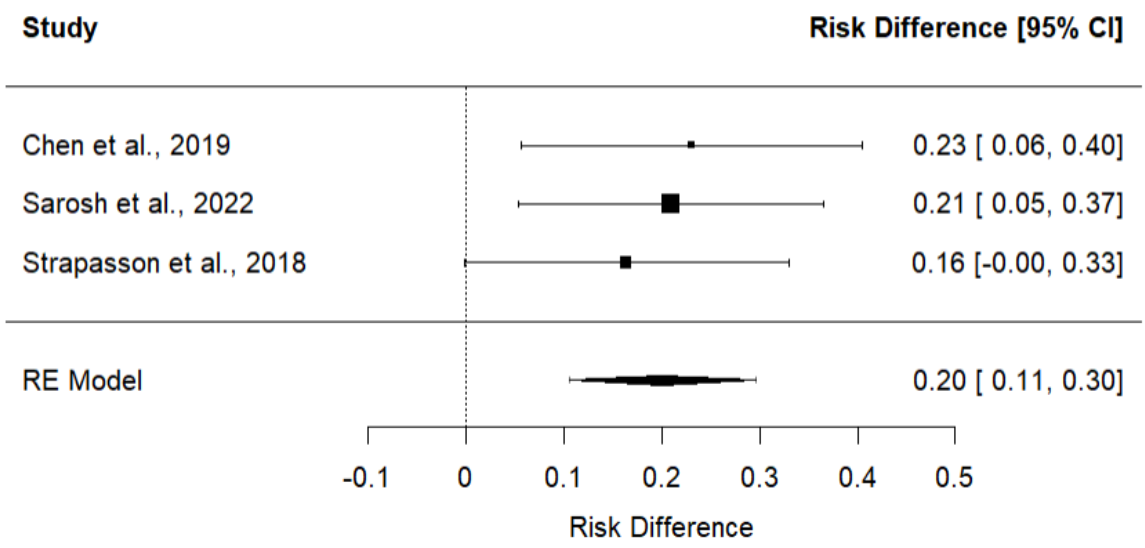
Supplemental Figure 38: Studentized residuals and Cook's distances for RE-PE model



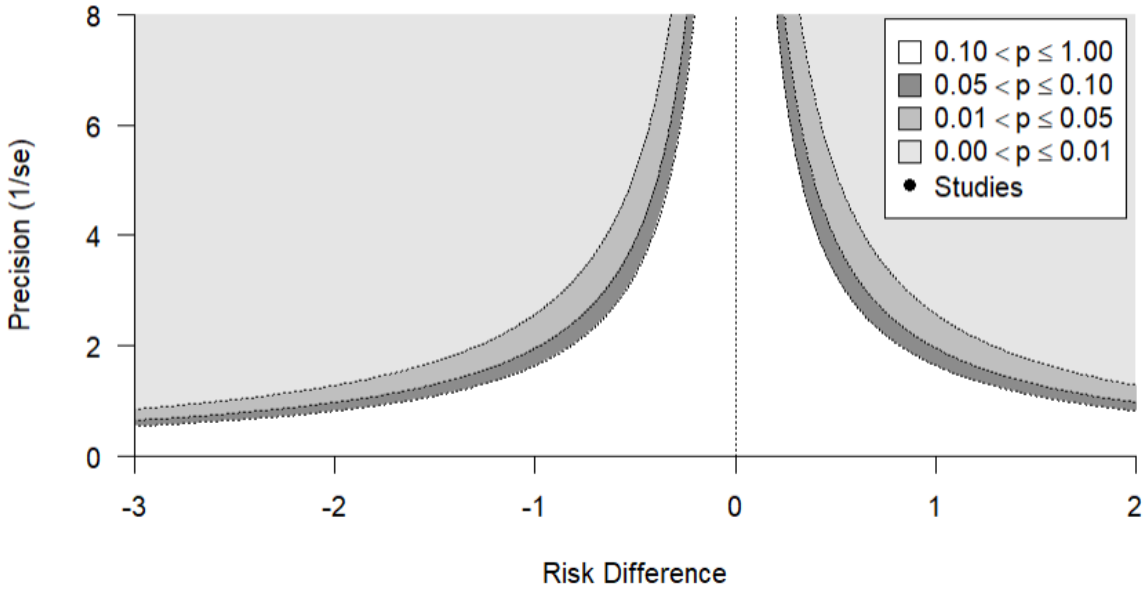
Supplemental Figure 39:Cumulative Forest plot for RE-PE model



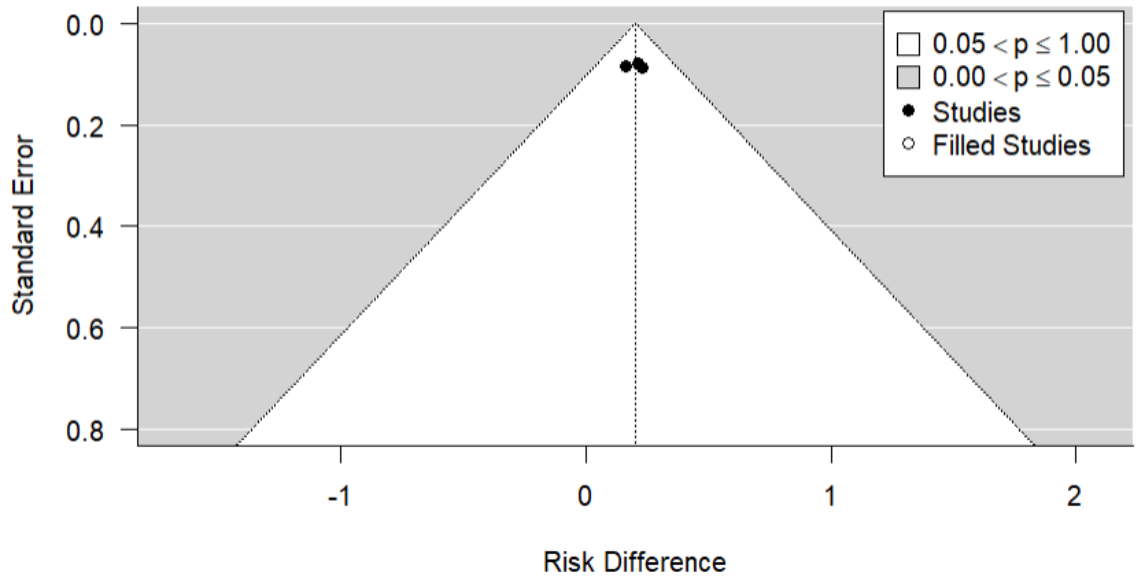
Supplemental Figure 40: Transformed risk difference for RE-RD model.



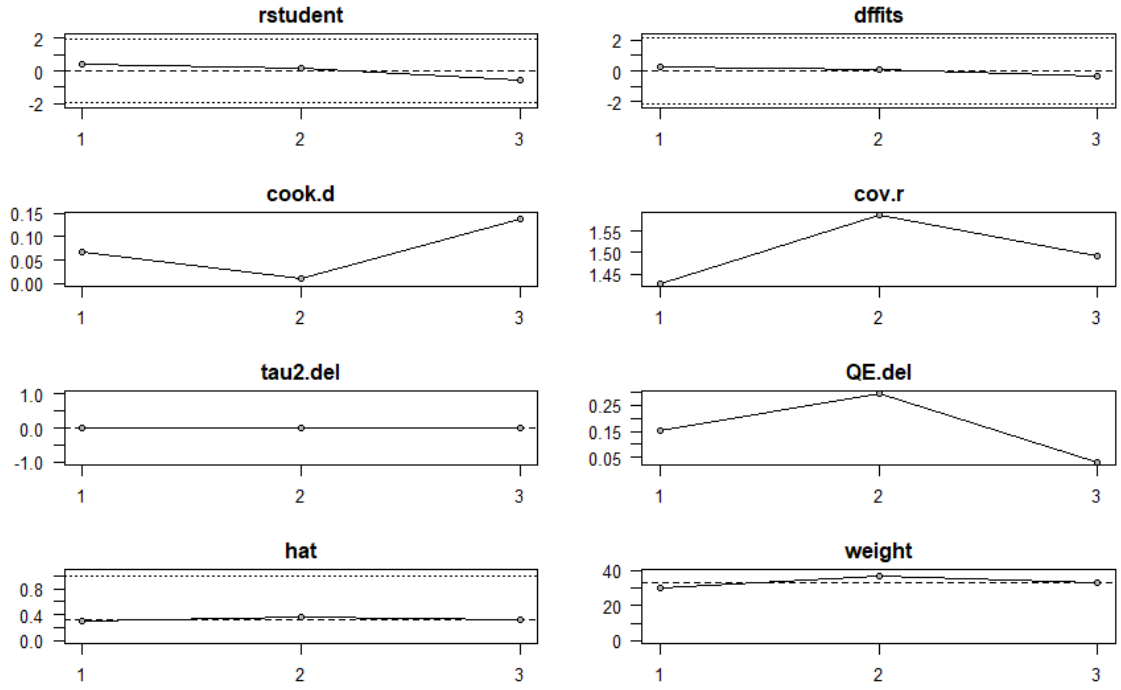
Supplemental Figure 41: Forest plot for RE-RD model



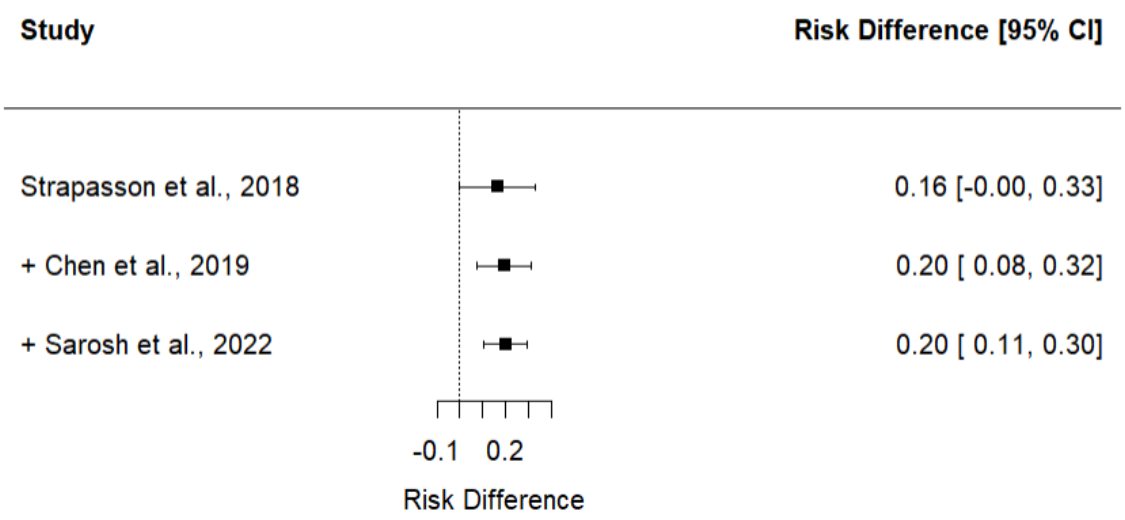
Supplemental Figure 42: Contour-enhanced funnel plot for RE-RD model



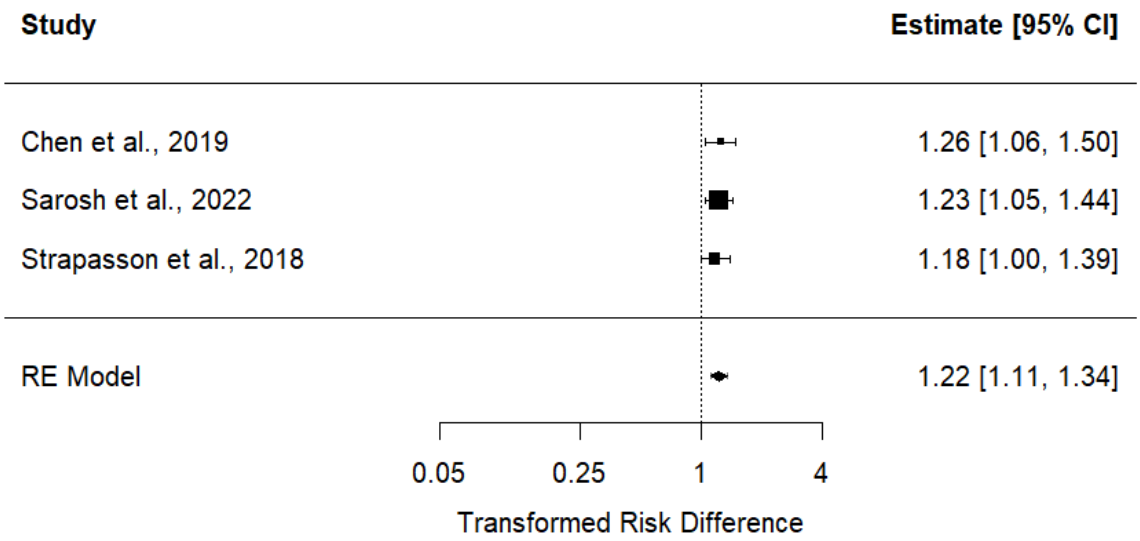
Supplemental Figure 43: Trim and fill method for RE-RD model



Supplemental Figure 44: Studentized residuals and Cook's distances for RE-RD model



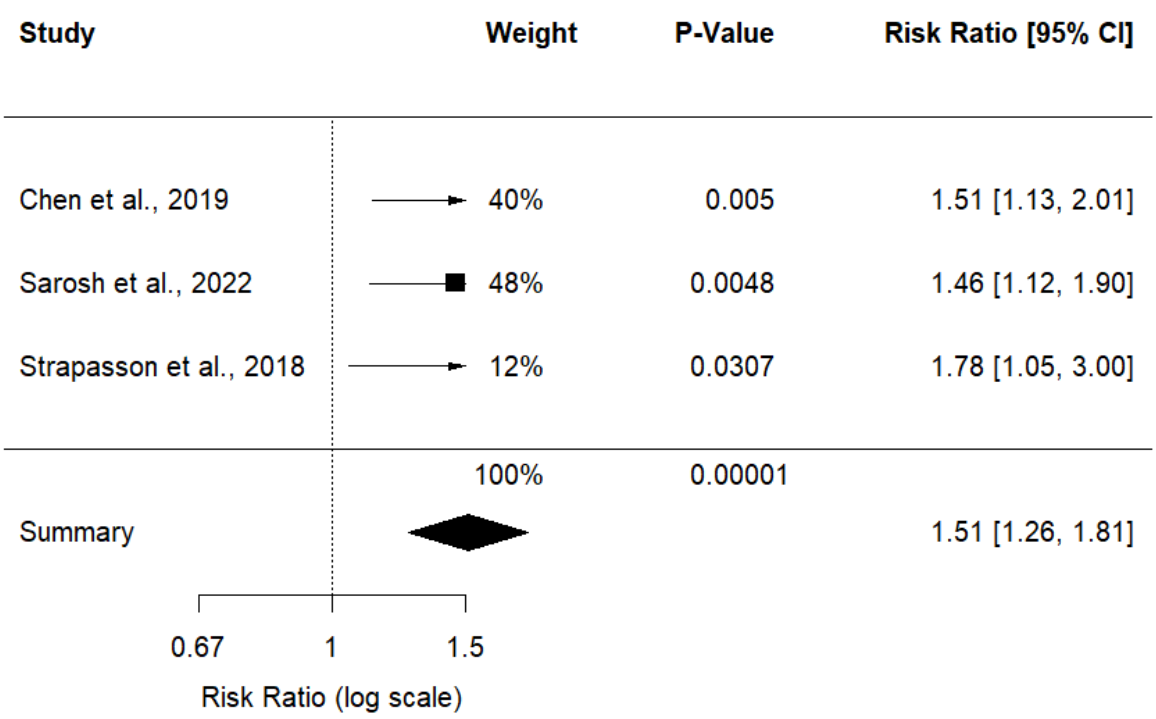
Supplemental Figure 45: Cumulative Forest plot for RE-RD



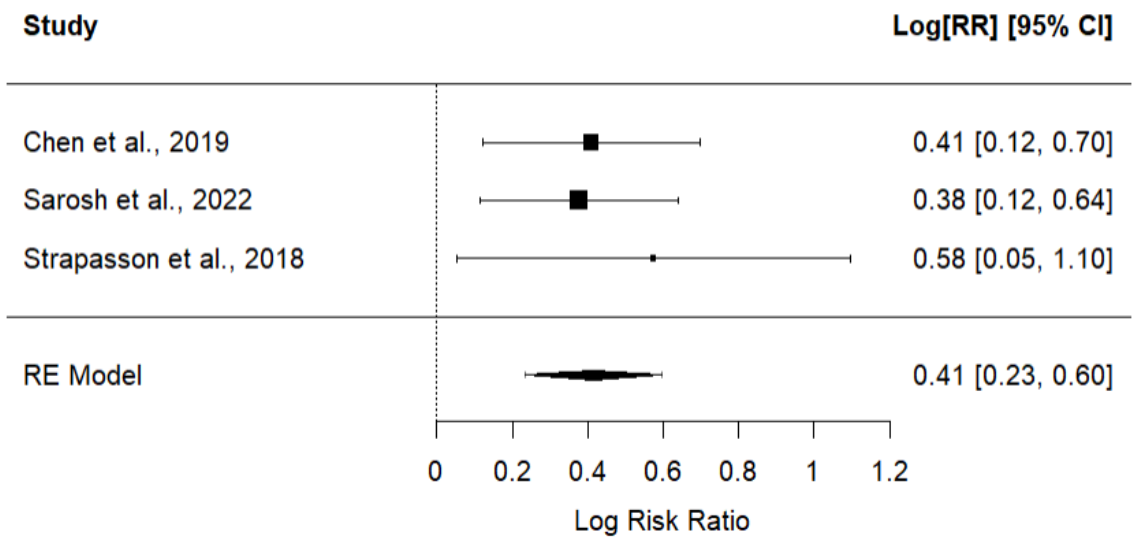
Supplemental Figure 46: Transformed risk difference for RE-RD model.

```
Random-Effects Model (k = 3; tau^2 estimator: REML)

tau^2 (estimated amount of total heterogeneity): 0 (SE = 0.0260)
tau (square root of estimated tau^2 value):      0
I^2 (total heterogeneity / total variability):   0.00%
H^2 (total variability / sampling variability):  1.00

Test for Heterogeneity:
Q(df = 2) = 0.4434, p-val = 0.8012

Model Results:

estimate      se    zval    pval   ci.lb   ci.ub
  0.4142  0.0925  4.4772  <.0001  0.2329  0.5956  ***

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

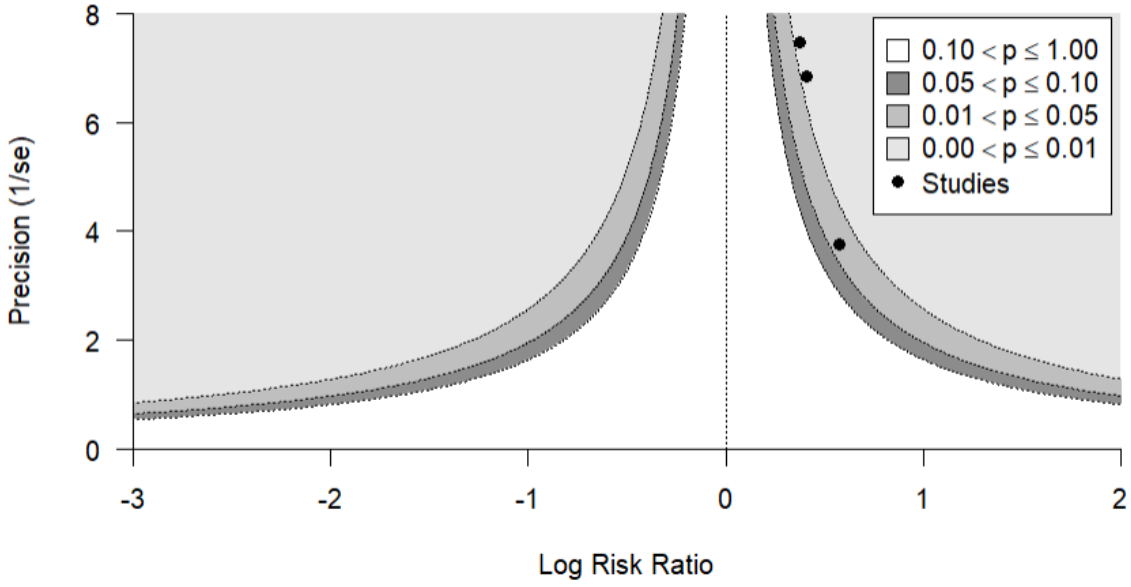
Supplemental Figure 47: Summary for RE-RR model



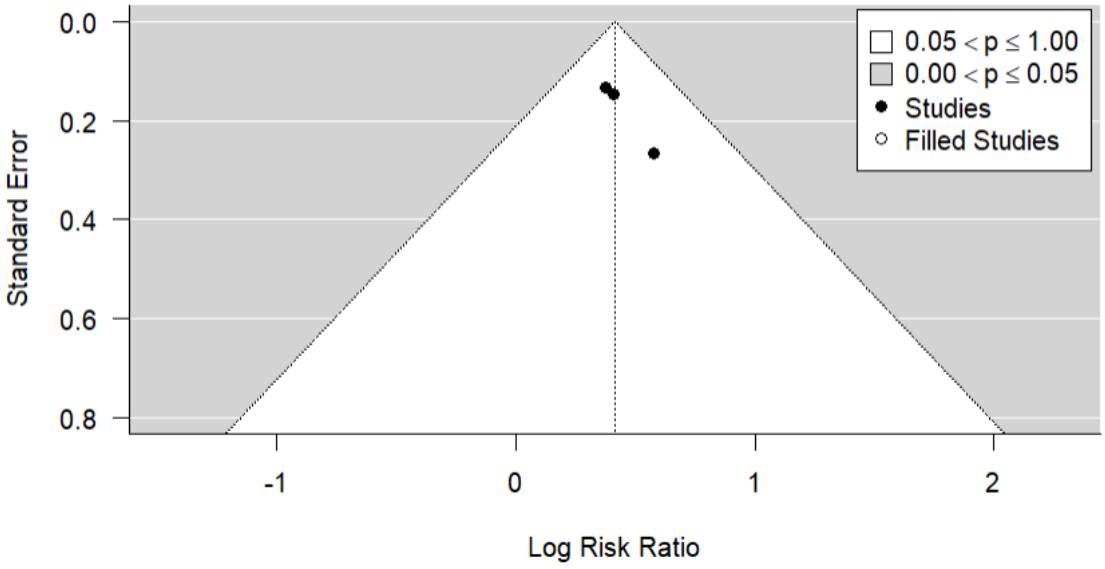
Supplemental Figure 48: Forest plot for RE-RR model



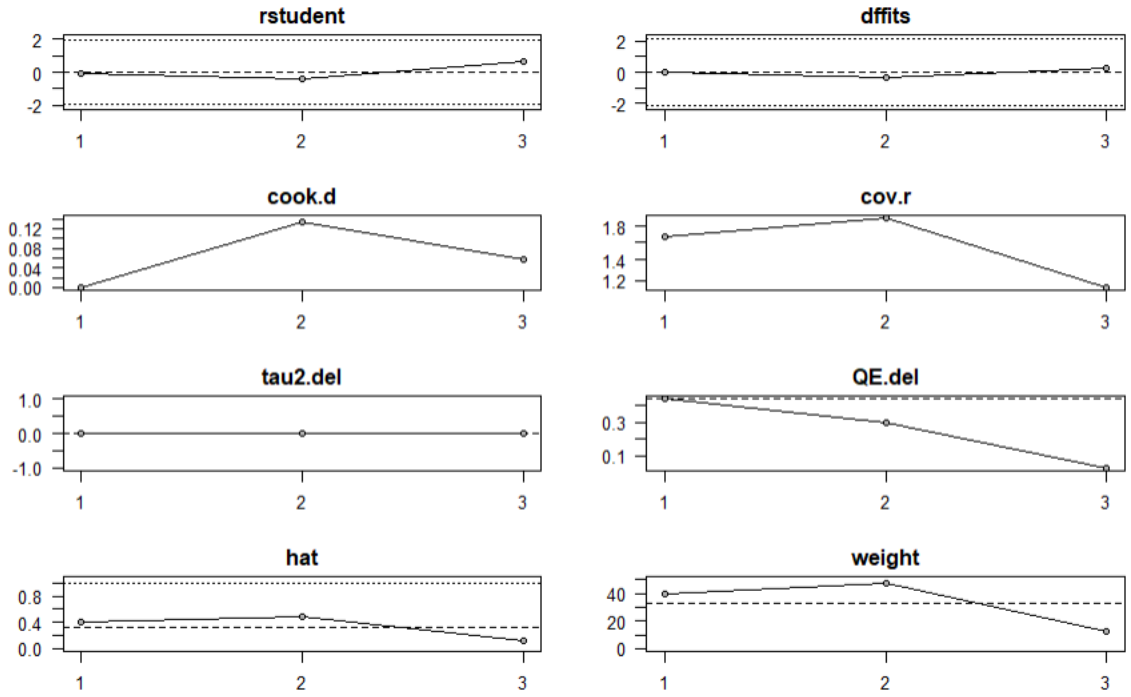
Supplemental Figure 49: Forest plot for RE-RR model using log risk ratio.



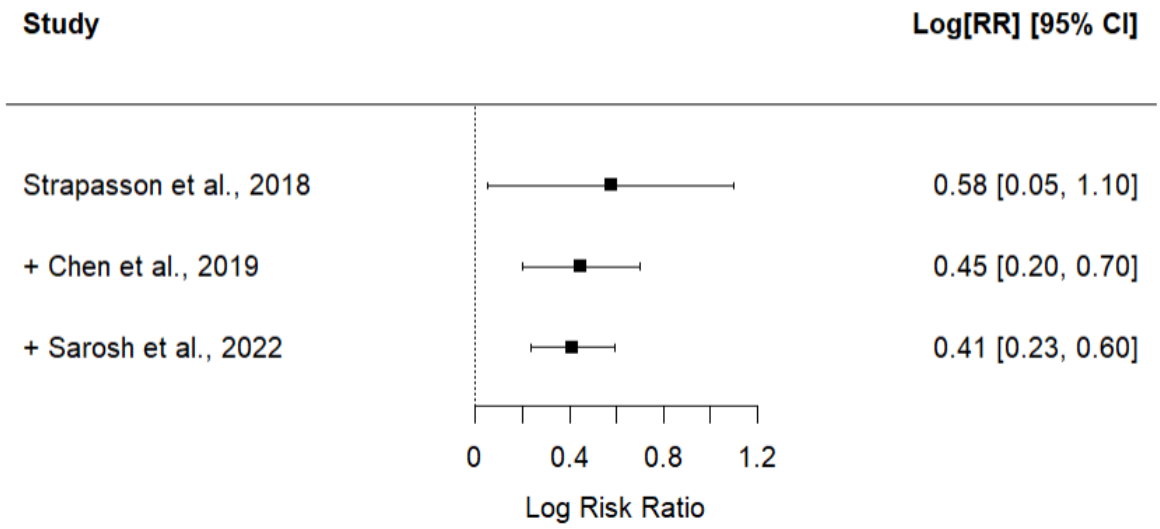
Supplemental Figure 50: Contour-enhanced Forest plot for RE-RR model



Supplemental Figure 51: Trim and fill method for RE-RR model



Supplemental Figure 52: Studentized residuals and Cook's distances for RE-RR model



Supplemental Figure 53: Cumulative Forest plot for RE-RR model