**Review Article**

**Maternal, Placental, and Fetal complications of preeclampsia in low resource settings**

**ABSTRACT**

**Background:** Preeclampsia remains a leading cause of maternal and perinatal morbidity and mortality, particularly in low- and middle-income countries (LMICs), where healthcare resources are limited. Understanding the spectrum of its complications is critical for early recognition and management.

**Objectives:** To review and synthesize existing literature on the maternal, fetal, and placental complications of preeclampsia, with a focus on challenges specific to low- and middle-income countries (LMICs).

**Methods:** This review draws on published data from peer-reviewed studies conducted predominantly in low-resource settings, highlighting major complications and discussing limitations in available data.

**Results:** Preeclampsia contributes to a wide range of maternal complications such as eclampsia, HELLP syndrome, and organ dysfunction. Fetal outcomes include growth restriction, preterm birth, and stillbirth. Placental pathology, though underreported, plays a central role in disease progression and outcomes. Majority of complications and consequences of preeclampsia are preventable, which is why it is no longer a major concern in developed countries. However, low- and middle-income countries (LMICs) must adopt suitable and context-specific strategies to reduce its burden.

**Conclusion:** Preeclampsia poses significant risks to mothers and infants in low- and middle-income countries (LMICs). Greater investment in early screening, community education, and health system strengthening is essential. More region-specific, recent data are needed to inform effective interventions.

**Key words**: preeclampsia, maternal and fetal complications, low resource setting

Introduction

Preeclampsia is a potentially life-threatening condition that falls within the spectrum of hypertensive disorders of pregnancy (HDP), which also includes gestational hypertension, mild preeclampsia, severe preeclampsia, and eclampsia [1]. Preeclampsia is a complex disorder involving multiple physiological pathways, it typically develops anytime after 20 weeks of gestation and up to 6 weeks postpartum [2,1]. It is diagnosed by new-onset hypertension with a systolic blood pressure ≥140 mmHg and/or diastolic BP ≥90 mmHg on two readings 4–6 hours apart in a previously normotensive patient, along with proteinuria of ≥1+ on dipstick or ≥300 mg per 24 hours [2]. According to the Royal College of Obstetricians and Gynaecologists, severe preeclampsia is characterized by blood pressure readings of ≥170/110 mmHg, taken twice at least 6 hours apart, with or without heavy proteinuria, and may be accompanied by maternal organ dysfunction, such as renal failure, hepatic impairment, neurological symptoms, pulmonary edema, or right upper quadrant pain [3,2].

Across the globe, preeclampsia ranks as the second most common cause of maternal mortality, estimated for 76,000 maternal deaths and 500,000 fetal and neonatal deaths annually due to its perinatal complications [3,19].

 Moreover, preeclampsia affects 2-8% of pregnancies and is responsible for 10-15% of direct maternal deaths, often in association with eclampsia [3]. Over the past 30 years, the incidence of preeclampsia has increased by 11%, becoming a leading cause of maternal mortality in several low-resource settings [1,20]. More than 99% of maternal deaths that are linked to hypertensive disorders of pregnancy occur in LMICs, where the risk of progression to eclampsia is significantly higher. Notably, nearly half of eclamptic seizures happen outside of healthcare facilities, highlighting serious delays in access to timely medical intervention [1].

“The gap in terms of access to adequate sexual and reproductive care represents a violation of human rights which affects millions of women throughout the world, particularly those living in low and middle-income countries” [4]. This disparity places numerous women and newborns at risk of preventable morbidity and mortality, particularly in low-resource settings. In 2015 alone, pregnancy-related complications caused the death of approximately 303,000 mothers, 99% of these deaths occurred in LMICs where the risk of dying from such causes is 30 times greater than in high-income countries [4]. Most of the maternal deaths occurred in rural areas and are largely preventable with urgent and adequate care during pregnancy, delivery, and the postpartum period [4]. In rural communities only 56% of births receive good quality care by qualified staff due to the limited availability of equipment, skilled healthcare providers, and referral systems.[4].

The aim of this article is to explore the maternal, placental, and fetal complications linked to preeclampsia, mainly in low-resource settings. It also sheds light on feasible strategies that can help reduce the burden and improve outcomes.

This review is based on recent literature sourced from PubMed, Google Scholar, BMC, PLOS, and other relevant databases. Articles were selected for inclusion based on their relevance to the topic, using keywords such as “preeclampsia,” “maternal complications,” “fetal outcomes,” “placental complications,” and “low-resource settings.” Only articles published in English were considered.

**Pathophysiology of Preeclampsia.**

Despite decades of research, preeclampsia remains incompletely understood. Numerous theories have been proposed, but its exact cause is still unsettled. It is, however, widely recognized as a complex, multi-systemic disorder arising from placental dysfunction [3]. One of the most accepted frameworks is the two-stage model: the first stage involves abnormal placentation early in pregnancy, while the second stage reflects the maternal systemic response to these placental abnormalities [3]. In the first stage, inadequate trophoblast invasion and impaired remodelling of the spiral arteries result in reduced placental perfusion and chronic ischemia [5][3]. This hypoperfusion triggers oxidative stress promoting the release of anti-angiogenic factors such as soluble fms-like tyrosine kinase-1 (sFlt-1) and reducing the placental growth factor (PlGF) [5]. The disrupted balance between pro- and anti-angiogenic factors contributes to endothelial dysfunction, a key mechanism underlying the clinical features of preeclampsia [5][3]. The second stage is characterized by systemic endothelial activation and inflammation, manifesting as hypertension, proteinuria, and organ dysfunction [3]. Uterine artery Doppler findings often show increased resistance, reflecting poor uteroplacental blood flow [5].

Genetic predisposition also plays a role in susceptibility, with certain variants being more common in African populations [5][3]. In addition, metabolic and cardiovascular conditions, such as obesity or pre-existing hypertension, are believed to contribute especially to late-onset preeclampsia by independently promoting endothelial dysfunction [3]. Environmental and socioeconomic factors, particularly in low-resource settings, further exacerbate the risk of preeclampsia by limiting access to prenatal care, which often leads to delays in diagnosis and inadequate management. Additionally, the prevalence of nutritional deficiencies such as low levels of calcium, magnesium, and essential vitamins can impair endothelial health and placental development, thereby increasing susceptibility to preeclampsia [5]. When preeclampsia progresses to eclampsia, the pathophysiological process extends to the central nervous system. A key mechanism is the disruption of the blood–brain barrier, which leads to cerebral edema and increases the risk of seizures. In severe cases, it may result in intracerebral hemorrhage or white matter necrosis [5].

**Maternal and Placental complications**

Hypertensive disorders during pregnancy, specifically preeclampsia and eclampsia remain among the leading causes of maternal morbidity and mortality worldwide, with the burden disproportionately affecting low-resource settings particularly sub-Saharan Africa [6]. Roughly 10% of maternal deaths globally are attributed to these conditions, with some regions like Uganda reporting that preeclampsia alone may account for up to 25% of maternal deaths [6].

The pathophysiology of preeclampsia often results in a cascade of life-threatening complications. Key maternal complications include progressing to Eclampsia, HELLP syndrome (characterized by Hemolysis, Elevated Liver enzymes, Low Platelet count), DIC (disseminated intravascular coagulation), acute kidney injury, pulmonary edema, cerebral hemorrhage, hepatic rupture, and stroke [7,8,3]. HELLP syndrome occurs in a significant subset of preeclamptic women, with prevalence varying globally ranging from 4.9% in Iran to 40% in India [8]. Its complications include respiratory failure, liver rupture, hemorrhage, and coagulation abnormalities. Women who present with epigastric pain, have a fivefold increased risk of developing HELLP syndrome [8].

“Pre-eclampsia-eclampsia syndrome also forms an infamous triad with obstetric hemorrhage and sepsis, together contributing significantly to maternal, fetal, and neonatal mortality, particularly in resource-constrained settings” [9]. This triad consists of three life-threatening obstetric emergencies that all pose a serious challenge in low-resource settings. In severe cases, preeclampsia may result in multiorgan involvement that includes kidney and liver failure, DIC (disseminated intravascular coagulation), and central nervous system complications [9]. A recent study reported neurologic dysfunction in 52.2% of women, liver dysfunction in 23.9%, hematologic abnormalities in 19.5%, and renal dysfunction in 13.2% [9].

Placental complications are intimately tied to preeclampsia due to abnormal placental implantation and perfusion, leading to placental insufficiency, abruption, and infarction. These contribute to fetal growth restriction, oligohydramnios, and intrauterine fetal demise [10,8].

In a Ugandan study, 19% of patients experienced eclampsia, 15% had placental abruption, and 2% developed coagulopathy; maternal mortality was noted in 1% [11]. Similarly, a study conducted in Nigeria reported common complications such as acute kidney injury occurring in 6.37%, followed by aspiration pneumonia at 5.26%, puerperal sepsis at 3.98%, and stroke in 3.0% of their patients [5].

Analysis of maternal outcomes further reveals that the immediate clinical causes of death among women with pre-eclampsia include renal failure, eclampsia, and multi-organ failure [12]. The risks of prolonged maternal hospital stay, neonatal intensive care unit (NICU) admission, and perinatal mortality were notably higher among this group [12]. Moreover, women with pre-eclampsia/eclampsia were also at increased risk of undergoing caesarean section and preterm delivery [12]. Furthermore, early-onset severe preeclampsia carries a graver prognosis. Studies report higher rates of neurologic (52.2%), hepatic (23.9%), hematologic (19.5%), and renal dysfunction (13.2%) in early-onset cases compared to later presentations [7]. These are compounded by higher rates of caesarean delivery, ICU admission, preterm birth, and perinatal mortality [12]. In resource-limited settings, the absence of prompt diagnosis and intervention significantly heightens these risks. Delayed diagnosis, lack of antenatal care, and socio-economic struggles amplify these risks in LMICs [7,10]. For example, women in developing countries are seven times more likely to develop preeclampsia and three times more likely to progress to eclampsia, with a fourteen-fold higher mortality risk [7]. According to institutional data from tertiary hospitals in sub-Saharan Africa, hypertensive disorders of pregnancy have now surpassed hemorrhage, becoming the leading cause of maternal mortality [1].

**Fetal and neonatal complications of preeclampsia**

Fetal complications of preeclampsia include iatrogenic prematurity, low birth weight, and NICU admission and stillbirth [7]. Preeclampsia, primarily a placental disorder, is strongly associated with low birth weight [10]. The condition is initiated by inadequate remodeling of the spiral arteries during early pregnancy, resulting from insufficient invasion by the extra-villous trophoblast [10]. This leads to restricted fetal growth caused by the decreased nutrients from the poorly formed materno-fetal circulation.[10] Moreover, preeclampsia was linked to the highest rates of extreme preterm birth, stillbirth, and low Apgar scores when compared to other hypertensive disorders such as gestational or chronic hypertension [12]. Although many factors influence neonatal survival, birth weight remains one of the most critical determinants [10].

In a central hospital in Zimbabwe, over half (54.5%) of the live babies were admitted to the NICU, reflecting the burden of neonatal complications in preeclamptic pregnancies [7]. Neonatal morbidity presents a major challenge in low-resource settings [7]. Premature babies born to preeclamptic mothers remain at increased risk of mortality even after being discharged from the hospital; for example, in urban Uganda, a discharge weight of 1500 grams is linked with 20% mortality rate within the first three months [10]. Low birth weight is a well-established risk factor for perinatal mortality worldwide, especially when compared to neonates born with appropriate gestational age [10]. In urban Uganda, pregnancies complicated by severe preeclampsia or eclampsia show a perinatal death that is twice as high as in normotensive pregnancies, with some studies reporting rates exceeding 20% [10].

The primary causes of early neonatal death includes extreme prematurity, very low birth weight, and complications such as respiratory distress syndrome [7]. In many cases, mothers arrive late in critical conditions, leaving no time for preventive measures like administering corticosteroids to support fetal lung maturation [7]. “Being born abruptly prematurely, having very low/low birth weight in a low-resource setting, the odds weigh heavily against the tender, fragile lives of the neonates. It is worrying that nearly half of the babies were lost through stillbirths and early neonatal deaths” [7]. This reflects the harsh reality faced by thousands of neonates born in low-resource settings, where simply surviving is difficult.

“According to WHO, approximately 2.6 million stillbirths at 28 weeks of gestation or later occurred worldwide in 2015.  Ninety-eight percent of these are to mothers in low- and middle-income countries where poverty and lack of resources may limit access to basic obstetric care, medications, monitoring equipment, medical staff, emergency transportation, and facility-based delivery” [13,14]. These statistics clearly demonstrate that the majority of the burden falls in LMICs. While many of these outcomes are preventable, poverty and limited resources make addressing them increasingly difficult. Fetal death ratios (FDR) in sub-Saharan Africa are approximately ten times higher than those in high-income countries (29 vs 3 per 1,000 births, respectively) [13]. Infant mortality among women with preeclampsia is also three times more frequent in LMICs compared to high-income countries [2]. Although the global stillbirth rate has declined by 2% annually from 2000 to 2015, most of these deaths could still be prevented with better care throughout the perinatal period [13]. Stillbirths are significantly associated with hypertensive disorders, maternal comorbidities, and poor access to quality care [13,14]. In a WHO trial across 7 LMICs, hypertensive disorders of pregnancy were the second most common cause of stillbirths, responsible for 28% of cases[13,14].These deaths were frequently linked to abruptio placentae, uteroplacental insufficiency, and placental infarction [13,14]. Furthermore, an analysis of 465 stillbirths in Ghana identified hypertension as the cause in 11.2% of cases, following intrapartum hypoxia (22.6%) and antepartum hemorrhage (14.4%) [14]. While in Zimbabwe, about 22% of stillbirths were linked to hypertensive mothers [7]. In another comparative study, the stillbirth rate was 13.1% and neonatal mortality was 6.0%, with 47% of neonates born under 2.5 kg and 12.1% exhibiting signs of intrauterine growth restriction[15].

**Discussion:**

**Prevalence and common maternal, placental, fetal complications**:

Rolnik et al. found that preeclampsia occurs in 2-8% of pregnancies [16]. While the World Health Organization (WHO) estimates the global prevalence of around 0.4% [5]. Data from Nigeria shows a much higher pooled prevalence of 4.51% [5]. This highlights differences in disease burden between high-income and low-resource regions [5]. Other reported prevalence rates includes 31% in Guadeloupe and Réunion, 34% in Mauritius and Thailand, 37.4% in Cameroon, 38% in China, 58% in Zimbabwe, 29% in Turkey, and 26% in India [16].

Kumari A. et al. documented maternal complication rates ranging from 14% and 53% among preeclamptic patients [11], emphasizing the substantial risk this condition poses to maternal health. Solwayo Ngwenya identified HELLP syndrome as the most common maternal complication in preeclamptic patients, occurring in 9.1% of 118 cases [11]. Another study by Xue-Jun Gao et al. observed that eclampsia occurred in 21% of preeclamptic cases, frequently accompanied by renal failure, placental abruption, and HELLP syndrome [11]. HELLP syndrome itself is notably prevalent and is linked to respiratory failure, liver rupture, and severe hematologic abnormalities [8]. Neurologic, hepatic, hematologic, and renal dysfunctions are more frequently reported in early-onset preeclampsia [15]. Other life-threatening conditions include DIC (disseminated intravascular coagulation), renal failure, hepatic rupture, and stroke [7,8,3].

Placental complications such as abruption, infarction, and insufficiency contribute significantly to poor perinatal outcomes, including fetal growth restriction, oligohydramnios, and intrauterine death [10,8] These placental abnormalities are underreported despite being central to the disease mechanism.

Fetal complications such as low birth weight, iatrogenic prematurity, and respiratory distress syndrome are among the common difficulties faced by neonates born to preeclamptic/eclamptic mother [7]. More than 54.5% of live-born neonates were admitted to the NICU, indicating serious postnatal complications [7].

**Maternal and fetal mortality in LMICs**

Prevalence of maternal mortality in women with preeclampsia is higher in low-income countries than in middle- and high-income settings [15]. “Despite all the research published in the last three decades on screening and prevention of preeclampsia, the condition remains one of the main causes of maternal and perinatal morbidity and mortality, both in low and high-income countries” [16]. It is disheartening that after decades long of research, there is still a lack of universally applied and effective protocols especially when the majority of resulting deaths are preventable.

In high-income countries, maternal mortality rates due to preeclampsia are typically below 1%, but in Nigeria, the rate is notably higher, with a pooled prevalence of 6.04% [5]. While in Zimbabwe, hypertensive disorders were ranked third among the causes of maternal mortality [16]. “The higher prevalence of maternal mortality associated with Preeclampsia /Eclampsia syndrome in low-resource settings could be related to late presentation of patients, associated with lack of proper knowledge, limited access to quality antenatal care, and poor obstetric care provision in health institutions due to resource constraints” [15]. This shows the urgent need for improving antenatal education, strengthening health systems, and ensuring timely access to care in low-resource settings.

WHO estimates that 22% of stillbirths are among hypertensive mothers in LMICs, with fetal death ratios in sub-Saharan Africa being ten times more than in high-income countries [2]. For instance, in Nigeria, the rate of fetal mortality is 16.73%, much higher than the global average for high-resource settings, which falls typically below 10% [5].

**Genetic and health factors contributing to preeclampsia**

Multiple factors may contribute to the increased severity of preeclampsia seen in sub-Saharan African women, including genetic predispositions, poor underlying health, and limited access to high-quality antenatal care [10]. Genetic background plays an important role, with certain variants linked to higher preeclampsia risk appearing more frequently in African populations [5]. Moreover nutritional deficiencies particularly in calcium, magnesium, and essential vitamin appear to affect endothelial function and placental development, thereby increasing the risks [5]. For example, one study found that women with serum magnesium levels below 0.7mmol/L had a “ more than 33-fold increased risk of developing preeclampsia” [21].

**Limited Access to Prenatal Care**

One of the primary contributors to maternal morbidity and mortality in preeclampsia cases is limited access to adequate prenatal care. Most of the cases of maternal morbidity and mortality are due to poor access to prenatal care services [2]. 98% of women in high-income countries receive at least one prenatal visit, this figure drops to 68% in LMICs. Moreover , the global recommendation is a minimum of four visits, yet only 61% of urban and 39% of rural women meet this target as reported in Haiti [2]. Dekker and Sibai mention that effective antenatal care and well-timed delivery are essential for tertiary prevention of preeclampsia [16]. In many low-income settings, however, women at high risk are often managed in under-resourced urban or rural clinics, leading to poor outcomes [16]. This disparity in prenatal care access underscores the importance of early detection and timely intervention, which could prevent many of the complications associated with preeclampsia.

**Screening and diagnostic limitations**

Currently, no single screening test for preeclampsia is both reliable and cost-effective enough to recommend widely in most developing countries [17]. In low-resource settings, basic assessments like measuring blood pressure and protein levels in urine are often limited by costs, the lack of proper equipment, and insufficient staff training [3]. Accurate blood pressure measurement also requires well-maintained devices and trained personnel, which are often unavailable in community-level care [3]. There is a clear need for an affordable and simple diagnostic tool for early detection in such settings [3].The challenges extend into intrapartum and neonatal care. “In community settings, fetal compromise is usually assessed by asking women about reduced fetal movements or by assessment for small for gestational age fetus” [3]. The lack of appropriate or well-equipped instruments serves as a significant barrier to effective healthcare delivery. By the time they seek hospitalization, they are faced with critical shortages that delay timely interventions and negatively impact prognosis.

**Challenges in implementing WHO guidelines in Sub-Saharan Africa**

An assessment of how well WHO guidelines for preeclampsia were followed in six sub-Saharan African countries revealed that recommended screening and treatment practices were rarely used, and access to magnesium sulfate remained limited, even though it is listed as an essential medication in all the countries surveyed [1]. This stands in contrast to favourable outcomes seen in settings where magnesium sulfate is routinely used, like Kuwait and UK, where there were no maternal deaths recorded [7]. Magnesium sulfate, a low-cost and widely recommended medication, has consistently demonstrated efficacy in preventing eclamptic seizures and altering maternal outcomes in cases of preeclampsia and eclampsia. Its ability to prevent seizures and reduce mortality is well-established, yet its use remains limited in many low-resource settings. Despite being recommended by the World Health Organization and listed as an essential drug, its availability and consistent use are still lacking. There is a need for better integration of magnesium sulfate administration into the community health worker’s toolkit. Similarly, “a successful example from Pakistan where CHWs and midwives have been trained to administer misoprostol in women with postpartum hemorrhage supports the recommendation that, with proper training, it is feasible to incorporate even emergency medication administration in community settings where accessibility and availability are an issue” [3].

**Preventable deaths in LMICs**

The WHO has reported that most maternal deaths related to preeclampsia could have been avoided with proper care and access to healthcare services [16]. Ukah et al. emphasized that earlier identification of women at high risk for complications could help prevent adverse outcomes through improved management strategies [16]. Studies also highlight the high prevalence of early-onset preeclampsia in countries such as Zimbabwe (58%) and India (26%), further emphasizing the need for improved screening and prenatal care in these regions [16]. Cost-effective interventions already exist that could save over one million babies each year [13]. So by early detection and timely intervention, such as the use of magnesium sulfate and delivery management, mortality rates can be significantly reduced. Additionally, adding routine laboratory testing for HELLP syndrome to preeclampsia diagnostic protocols and particularly for teenage mothers, those experiencing epigastric pain, or women referred from lower-level facilities can enhance early detection and management of high-risk cases [8]. By this slight addition alone, an even greater portion of the burden could be alleviated.

**Challenges in Low-resource settings**

There are many known difficulties that are faced during the treatment of preeclampsia, but due to its unknown pathology tackling it completely remained difficult and at times unattainable. This section will cover the main challenges in managing preeclampsia in LMICs and they centre around three overarching themes: (1) limited education and poor health literacy, (2) a shortage of obstetric care providers with specialized training, and (3) underdeveloped healthcare infrastructure for managing critically ill preeclamptic patients [1]. “Recognizing and addressing these root challenges holds great potential to improve outcomes in pregnancies complicated by preeclampsia” [1].

These obstacles can be categorized into patient-, provider-, system-, and community-level factors each playing a different role and together amplifying the burden.

**Patient-Level Challenges**

Limited education and poor health literacy are considered major contributors to patient-level challenges in preeclampsia care [1]. Many women view pregnancy as a normal and risk-free process and are often unaware of conditions like preeclampsia or the dangers it poses [1]. Some healthcare providers have observed that even patients currently undergoing treatment for preeclampsia may not fully grasp their diagnosis [1]. “One clinician shared, "Even those with preeclampsia, some of them don't know. Like you will be managing them and if another person asks them, they don't even understand what you're managing them for" (ID 3 HO Female)” [1].

Cultural beliefs can also lead to misinterpretations of clinical symptoms. For instance, swelling (edema), a potential sign of preeclampsia, may be perceived positively [1]. “A healthcare worker explained, "It takes a lot of time to teach [patients] basic things, like if you are getting swollen, edema, it may be a sign [of preeclampsia] [1]. Because traditionally in some areas, they might think that when you are getting edema it may be an indication that the fetus is a male" (ID 20 C Male)” [1].

Financial barriers further compound these challenges. In low-resource settings such as rural Haiti, women frequently delay or forgo antenatal care due to the costs associated with clinic visits, diagnostics, and transport [2]. Even when care is initiated, many are unable to complete their follow-up appointments [1,2]. In a survey of 41 LMICs, nearly 25% of women reported avoiding health facilities for delivery because they were staffed by male providers, such a preference for female providers also deter women from seeking facility-based care, resulting in delayed presentation and worse maternal and fetal outcomes [1,2].

**Additional patient-level barriers include:**

Conflicting cultural and religious beliefs, inadequate antenatal care (ANC) attendance, non-acceptance of medical diagnoses, poor adherence to treatment recommendations, and limited ability to make independent decisions about healthcare [1].Studies from Ethiopia, Haiti, Nigeria, and Zimbabwe similarly highlight these challenges, which contribute to delayed detection and hinder the delivery of appropriate care [1].

**Provider-Level Challenges**

Challenges at the provider level further hinder the management of preeclampsia. Key issues include: a shortage of skilled professionals in obstetrics and emergency maternal care, limited time available for patient counselling and education, inadequate monitoring of maternal and fetal well-being during pregnancy and, gaps in provider knowledge and confidence regarding preeclampsia management [1].

Additionally, diagnostic limitations in rural and low-resource settings severely impact timely diagnosis. Ultrasonography for fetal growth assessment is often unavailable, and fetal heart monitoring relies on less accurate tools like the Pinard stethoscope [1,3,2]. Blood pressure measurements are frequently compromised by outdated and poorly calibrated equipment, and proteinuria testing using dipstick as recommended by the WHO is inconsistently performed due to supply shortages and lack of training [1,3,2]. Moreover, most preeclampsia risk prediction models were developed in high-resource settings and rely heavily on laboratory parameters and frequent monitoring tools that are often unavailable in LMICs [16]. The absence of context-specific predictive models prevents early identification of at risk women and the timely application of preventive strategies [16].

**System-Level Challenges**

Structural and systemic factors contribute substantially to the delays and inadequacies in care. These include: inadequate healthcare infrastructure, including a shortage of intensive care units and blood products, financial barriers limiting access to diagnostics and hospital care, delays in laboratory testing critical for monitoring disease progression, insufficient supplies of essential medications such as magnesium sulfate, and lack of emergency transportation systems capable of timely referrals [1].

A study across six sub-Saharan African countries revealed extremely low compliance to WHO guidelines for preeclampsia screening and management, despite magnesium sulfate being listed as an essential drug in all surveyed nations [1]. These findings highlight a troubling gap between policy and practice. Additionally, inadequate obstetric and neonatal services greatly impact outcomes for mothers and infants. Preterm deliveries, often indicated due to severe preeclampsia, result in high perinatal morbidity and mortality rates due to limited availability of surfactant therapy, inadequate antibiotic coverage, and shortages of skilled personnel for neonatal care [1,3,9]

**Community-level challenges**

Finally, challenges at the community level cannot be overlooked. Most maternal deaths occur outside of healthcare facilities, in settings where antenatal care is either absent or severely limited [1,3]. “In community setups, determining the cause of death is difficult, and often reliance is placed on relatives' or caretakers' recall of the symptoms experienced by the women prior to death” [3] .If the cause of death cannot be determined, preventing future mortality from similar cases becomes challenging and lack of data limits research and slows progress in improving maternal and fetal outcomes .Early signs of preeclampsia often go unrecognized due to lack of training among community health providers, poor access to functional diagnostic tools, and the absence of standardized screening guidelines [1,3]. Blood pressure measurement errors, unreliable proteinuria testing, and delays in referral remain common [1,3].

**Strategies for improvement and prevention**

 Preeclampsia continues to be a significant factor in maternal and fetal morbidity and mortality, especially in LMICs. Preventing its onset and minimizing its complications requires a multifaceted approach that addresses both systemic barriers and individual-level risk factors. In resource-limited environments, where advanced diagnostic tools and specialist care are often inaccessible, innovative and practical strategies must be adopted. This section outlines key pillars of prevention, focusing on scalable, cost-effective interventions that can be integrated into existing healthcare systems.

**1. Community education and raising awareness**

Educating both women and midlevel healthcare providers to recognize early warning signs such as edema can help reduce delays in seeking care and prevent complications [2]. Learning about the signs and symptoms of preeclampsia and the possible dangers and consequences are crucial for early detection. Awareness campaigns can help overcome cultural barriers and encourage timely care seeking, especially in rural areas. In regions with a high incidence of eclampsia, community-based monitoring and education efforts may be the most effective way to address care gaps [18]. Universal antenatal care remains a critical preventative tool, offering opportunities to inform women about the dangers of severe pre-eclampsia/eclampsia [7]. These services must be both affordable and accessible, providing women with the knowledge they need to recognize danger signs and seek help early. This approach could significantly reduce complications and prevent avoidable maternal deaths [7].

**2. Improving health care coverage and Quality**

Early and consistent antenatal care is essential for identifying high-risk pregnancies. Delivering at or after 36 weeks in women with preeclampsia has been shown to reduce the risk of maternal complications [18]. Standardizing clinical protocols and ensuring routine screening for hypertension and proteinuria can improve early detection and management. To optimize outcomes in preterm births, (NICU) need to be properly equipped and staffed, resources that are often unavailable in low-resource settings [12]. For instance, while Canada has higher rates of preterm birth and NICU admissions, its perinatal mortality remains lower than LMICs. [12]. This reflects the impact of strong neonatal care systems, which must be strengthened globally. Neonatal health should be prioritized alongside maternal health on the global agenda [7]. “The adequate use of existing interventions and surveillance of related indicators have great potential to prevent stillbirths, particularly in Latin American and Caribbean countries” [13], which suggests that applying what is already existing can make a huge difference if consistent and successfully followed.

**3. Training and empowering healthcare providers**

Many strategies have been implemented globally to improve pre-eclampsia care at the health system level [6]. These include:(1) ensuring that treatment protocols for pre-eclampsia are readily accessible in clinical areas, and(2) providing multidisciplinary training for teams managing pre-eclampsia emergencies [6]. The impact of obstetric emergency training has been evaluated in various countries and identified as a major intervention in reducing maternal and neonatal mortality. In some settings, this training has been standardized nationally [6]. Training healthcare professionals, reinforcing health systems, and offering counseling to pregnant women are also considered vital investments to reduce stillbirths [13].

**4. Utilizing Risk Prediction Models**

Risk prediction models have shown great successes over the past years. Ukah et al. emphasized that simple testing to forecast severe early-onset preeclampsia could enhance care and outcomes in low-resource settings by facilitating earlier referrals [16]. The fullPIERS model, developed by von Dadelszen et al., demonstrated strong predictive power for adverse maternal outcomes in women with hypertensive disorders of pregnancy, showing an AUROC (Area Under the Receiver Operating Characteristic) of 0.88, with 76% sensitivity and 87% specificity [16]. It remained accurate for up to 48 hours, allowing time for interventions like corticosteroids or transfer [16]. Both internal and external validations confirmed its reliability across gestational ages [16]. Early identification of high-risk women may help prevent complications through timely care [16].

**5. Improving Access to Essential Medications**

Magnesium sulfate has been shown to reduce the risk of eclampsia by more than 50% in women with preeclampsia, according to WHO guidelines [3]. It is classified as an essential medicine, although data regarding its availability and impact on eclampsia rates remain limited in many settings [18]. Ensuring its availability and promoting its routine use represents a simple yet effective intervention. When combined with timely delivery, magnesium sulfate remains a cornerstone in reducing maternal and perinatal deaths due to hypertensive disorders at the facility level [18]. In addition to lowering the incidence of eclampsia, it has also been associated with a decreased risk of placental abruption when compared to placebo or no anticonvulsant treatment [3].

Another common medication is low dose aspirin. Its affordability and over-the-counter availability make it a practical and cost-effective as a preventive strategy, especially in LMICs, where other interventions may be less accessible. The Collaborative Low-dose Aspirin Study in Pregnancy (CLASP) demonstrated that aspirin, when started before 32 weeks of gestation, may help reduce the risk of recurrent early-onset preeclampsia [16].

**6. Innovative Approaches for Rural and Remote Areas**

In response to the ongoing challenges in LMICs, several innovative approaches have been introduced in recent years. One such example is the Healthy Pregnancy Initiative, which aims to strengthen prenatal care by equipping nurses in rural areas with proper tools, training, and supervision [4]. This model has shown that nursing staff, when adequately supported, are able to recognize and refer most obstetric risks in a timely manner, contributing to reductions in maternal mortality [4]. In this regard, this project has contributed to the improvement of prenatal care in rural areas [4].

Another interesting intervention for early detection of preeclampsia is a wristband that comfortably and snugly quantifies the expansion caused by edema called “Mom-Edema-Meter”, When measurements reach a specific threshold, women are advised to seek further medical care [2]. Applying such applicable interventions can alter the outcomes greatly, reducing the burden and saving lives.

**7. Policy and Health System Strengthening**

Sustainable prevention requires investment in maternal health systems, clear national guidelines, and collaboration between governments, NGOs (Non-Governmental Organization), and international partners to ensure equity in care. Understanding the underlying causes of fetal death could support more systematic care, helping to lower its occurrence and reduce risks in subsequent pregnancies [13]. “Despite the alarming rates, research into stillbirth and the implementation of effective solutions has been particularly sparse in low- resource settings” [14]. So, in general, encouraging research related to preeclampsia will allow each country to find the gaps in their healthcare system and this can become a first step to find shortcomings and provide good quality health care.

Moreover, tackling these challenges requires strengthening healthcare infrastructure, expanding access to prenatal care, and applying improved clinical management protocols to reduce the burden of pre-eclampsia/eclampsia on maternal and fetal health [5]. Developing and thoroughly assessing culturally tailored approaches for early detection, risk categorization, and clinical management of pre-eclampsia/eclampsia remains vital [5]. Such measures have the potential to greatly enhance maternal and neonatal outcomes [5]. Exploring how national public health strategies centered on pre-eclampsia/eclampsia awareness and prevention could be implemented is also promising for broader public health impact [5]. Establishing consistent diagnostic definitions and data reporting methods across healthcare systems is equally important for accurately evaluating the national disease burden [5].

Providing global policymakers with insights into how to address one of the leading causes of maternal and neonatal morbidity and mortality is crucial [7]. International efforts must include developmental aid and debt relief for poorer countries to ensure that funds are directed toward maternal and neonatal health issues [7]. Tackling such complex issues requires global efforts from various stakeholders, including, “field experts, financial institutions, health organizations, governments, and international organizations” [7].

Rather than relying solely on “vertical” programs that focus on specific diseases or “horizontal” strategies aimed at broad health system reform, a more integrated “diagonal approach" is recommended, where both disease prevention and health system strengthening are pursued simultaneously [3].

**Conclusion**

Preeclampsia remains a major contributor to maternal, placental, and fetal morbidity and mortality, especially in low- and middle-income countries where healthcare resources are limited. Based on the reviewed the main maternal complications in low-resource setting include prolonged hospital stay, increased rates for caesarean section, progression to eclampsia, HELLP syndrome, acute kidney injury, hepatic rupture, DIC (disseminated intravascular coagulation), pulmonary edema, neurologic complications such as cerebral hemorrhage, multi-organ failure, and, in severe cases, death. Placental complications commonly reported include abnormal implantation, reduced placental perfusion, placental insufficiency, abruption, and infarction. Fetal complications associated with preeclampsia include increased rates of neonatal intensive care unit (NICU) admissions, preterm birth, low birth weight often due to fetal growth restriction (FGR), oligohydramnios, stillbirth (intrauterine fetal demise) and perinatal mortality. The complications of preeclampsia are severe and far-reaching, even though many are preventable with timely identification, appropriate monitoring, and strategic interventions. This review also highlights the urgent need for resource-appropriate strategies tailored to low-resource settings, with the goal of reducing the burden of preeclampsia and improving the outcomes for both mothers and their babies alike.

**Limitations**

This review faced several limitations. Firstly, the available data does not comprehensively represent all LMICs, with notable gaps in geographic and demographic coverage. Furthermore, much of the data included is not recent, with very few studies conducted within the past two years, which may limit the relevance of findings to current healthcare contexts.

A major limitation is the fragmented focus of existing literature many studies concentrate either on maternal or fetal outcomes, with minimal integrated analysis of both. Additionally, there is a significant lack of research dedicated to placental complications, which hinders a full understanding of the triad of maternal, placental and fetal outcomes in preeclampsia. This imbalance limits the understanding of the full spectrum of preeclampsia outcomes in resource-constrained settings.

Additionally, a significant proportion of births in LMICs occur outside formal healthcare settings, such as in homes or under the care of traditional birth attendants. As a result, many cases of preeclampsia particularly those that do not escalate to severe complications go unreported, leading to underrepresentation in the data. Moreover, most documented cases reflect women who arrive late to care facilities, often already experiencing advanced or severe complications. This introduces a skew in the data, as early or mild cases are frequently missed, and the findings predominantly reflect the more critical end of the clinical spectrum.

Another concern is the variability in study designs, diagnostic criteria, and outcome definitions across the literature, making direct comparison and synthesis challenging. Many studies also lacked large sample sizes or were conducted in single-centre settings, limiting statistical power and external validity.

Disclaimer (Artificial intelligence)

Option 2:

Author(s) hereby declare that generative AI technologies have been used during the writing or editing of manuscripts. ChatGPT, developed by Open AI. The model used was GPT-4-turbo and accessed via: ChatGPT, chat.openai.com

Details of the AI usage are given below:

1. It was used in browsing the web to find literature.

2. It was used to summarize certain data that was read by the author(s).

3. It was used to edit and paraphrase the final draft.

4. It was used to generate Vancouver style references.

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