

# *Hypertensive Disorders of Pregnancy: Causes, Diagnosis, Complications, and Management Strategies*

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**Abstract:** Pregnancy-induced hypertension refers to elevated blood pressure occurring in pregnant women after the 20th week of gestation, with the potential to progress into severe conditions such as preeclampsia and eclampsia. It constitutes a prevalent and serious complication of pregnancy, posing a significant threat to the health of both the pregnant woman and the fetus. This review aims to provide a comprehensive and detailed summary of knowledge by exploring the etiology, diagnostic methods, potential complications, and management strategies associated with pregnancy-induced hypertension. A profound understanding of these aspects will facilitate healthcare professionals, physicians, and researchers in better comprehending and addressing the disease, enabling timely diagnosis, prevention, and treatment measures to mitigate adverse outcomes. Furthermore, this review underscores the importance of pregnancy-induced hypertension, promoting awareness and attention to the condition, and offering relevant education and health guidance to the public to safeguard the health and well-being of pregnant women and their fetuses.

## **1. Introduction**

Pregnancy-induced hypertension (PIH) refers to elevated blood pressure in pregnant women occurring after the 20th week of gestation, posing a severe threat to the health of both the maternal and fetal components of the pregnancy [1]. According to data from the World Health Organization, approximately 5% to 8% of pregnant women globally suffer from PIH, with a subset potentially progressing to conditions such as preeclampsia or eclampsia. These complications not only jeopardize the life of the pregnant woman but also entail serious risks for the fetus, including low birth weight, preterm birth, and neonatal mortality [2-3].

The etiology of PIH remains incompletely understood, although research indicates that genetic factors, diet and lifestyle, as well as immune and inflammatory responses, play crucial roles in its development [4-6]. Accurate diagnostic methods are paramount for the early detection and treatment of PIH, encompassing standardized and technical blood pressure measurements, identification of clinical features, and laboratory and imaging assessments. Complications arising from PIH manifest its severity, particularly with the progression to preeclampsia. Preeclampsia not only increases the long-term health risks for the mother, such as cardiovascular disease, kidney disease, and diabetes, but also introduces issues for the fetus, such as low birth weight, preterm birth, and intrauterine growth restriction. Therefore, early diagnosis and management of PIH are of utmost importance.

The management strategies for pregnancy-induced hypertension (PIH) underscore the crucial importance of early screening and preventive measures. Simultaneously, effective antenatal care and monitoring, including regular blood pressure measurements, fetal health surveillance, and assessment of maternal condition changes, can significantly reduce the risk of complications [7-10]. In severe cases, pharmacological treatment and specialized management measures may become necessary. Despite advancements in research on the prevention and treatment of PIH, numerous questions warrant further investigation. For instance, there is a need for the development of novel preventive and therapeutic approaches, exploration of personalized treatment strategies to enhance efficacy, and the undertaking of long-term follow-up and subsequent studies on PIH to gain deeper insights into its impact on maternal and fetal health [11-13].

Through this review, a comprehensive analysis of the etiology, diagnostic methods, potential complications, and management strategies of PIH is presented. A profound understanding of these aspects contributes to heightened awareness of PIH and provides clinicians with more comprehensive and accurate guidance, thereby mitigating the risk of this condition and safeguarding the health of both pregnant women and fetuses.

## **2. Causes**

### **2.1 Relationship between Genetic Factors and Pregnancy-Induced Hypertension**

A study conducted by the Medical University of Poznań in Poland, involving the assessment of a cohort of 912 early-pregnancy women, concluded that parental chronic hypertension influences the risks of pre-eclampsia (PE) and pregnancy-induced hypertension (PIH) in different ways [1]. Modifiable factors, such as overweight/obesity and smoking, may exacerbate these associations. Paradoxically, smoking may also have a beneficial impact on the risk of pre-eclampsia. Importantly, in the subgroup of women with a normal Body Mass Index (BMI), parental hypertension was not identified as an independent risk factor for GH/PE. Furthermore, a study by the Chang Gung Memorial Hospital team in Taiwan, which tracked 4,091,641 deliveries, revealed a familial clustering pattern for pre-eclampsia and PIH. Women with a positive family history of pre-eclampsia had a 2.6 times higher risk of developing pre-eclampsia compared to women without such history, and the familial clustering pattern of pre-eclampsia was present in parturients across all age groups [2]. Literature [3-8] provides insights into and analyzes the relationship between genetic factors and pregnancy-induced hypertension from various perspectives, including genetic diversity, blood type, congenital diseases, and other genetically related factors.

### **2.2 Impact of Dietary and Lifestyle Factors on the Development of Pregnancy-Induced Hypertension**

Researchers have qualitatively analyzed the influence of dietary and lifestyle factors on the development of pregnancy-induced hypertension (PIH) by examining specific dietary structures, habits, and types within particular regions and populations. For instance, literature [9-13] extensively details relevant analyses and clinical cases. Notably, literature [12] investigates the relationship between the Mediterranean diet and lifestyle during pregnancy and the development of PIH, using Italy as an example for analysis and discussion. Clinical results suggest that the Mediterranean diet can indirectly reduce the risk of PIH by preventing pregnancy-related disorders (such as gestational diabetes and hypertension) and exerting a positive effect.

On another note, researchers have explored the impact of specific dietary supplements on the development of PIH. Literature [14-16] indicates that the use of folic acid supplements can lower the risks of pregnancy-induced hypertension and pre-eclampsia.

## 2.3 The Role of Immune and Inflammatory Responses in Pregnancy-Induced Hypertension

Pregnant women face an increased risk of severe consequences from Coronavirus Disease 2019 (COVID-19). However, the pathophysiology leading to the increased incidence and its potential impact on the developing fetus remain unclear. Literature [17] reveals that women infected with SARS-CoV-2 exhibit a robust immune response at the maternal-fetal interface, including increased activation of the innate immune system, enhanced natural killer (NK) and T cell activity, elevated expression of interferon-related genes, and markers associated with pregnancy complications such as pre-eclampsia. Literature [18-20] delves into the genetic associations between inflammatory-related genes and pregnancy-induced hypertension.

## 3. Diagnosis Methods

### 3.1 Standards and Techniques for Blood Pressure Measurement

Accurate blood pressure measurement is crucial in the diagnosis and management of pregnancy-induced hypertension (PIH). The following outlines the standards and commonly used techniques for blood pressure measurement. Standard blood pressure measurement typically employs non-invasive methods, with the most common being the use of cuff-style sphygmomanometers. In addition to traditional cuff-style devices, modern medical equipment widely utilizes automated blood pressure measurement technology. Automated blood pressure monitors offer rapid and accurate blood pressure measurements, featuring the following advantages:

- Automation: Automated blood pressure monitors can automatically complete the inflation, deflation, and measurement processes, reducing the potential for human-operational errors.
- Convenience: Patients can easily perform self-monitoring at home or in healthcare settings, providing the convenience of continuous blood pressure monitoring and recording.
- Comfort: Compared to traditional cuff-style devices, automated blood pressure monitors typically use smaller cuffs, enhancing patient comfort.

However, proper operating procedures and recommendations must still be followed when using automated blood pressure monitors to ensure the accuracy of measurement results. In addition to single blood pressure measurements, 24-hour ambulatory blood pressure monitoring (ABPM) is an essential tool for evaluating PIH. ABPM provides continuous blood pressure measurements and records variations in blood pressure during daily activities. 24-hour ABPM allows for a more comprehensive assessment of a patient's blood pressure control, aiding healthcare professionals in understanding daily blood pressure fluctuations and formulating more precise treatment plans.

In summary, accurate blood pressure measurement forms the foundation for the diagnosis and management of pregnancy-induced hypertension. Both traditional cuff-style sphygmomanometers and automated blood pressure monitors are commonly used techniques, while 24-hour ABPM provides more comprehensive blood pressure data. Healthcare professionals should strictly adhere to operating standards when selecting and utilizing blood pressure measurement techniques to ensure the accuracy and reliability of measurement results.

### 3.2 Determining the Clinical Features of Pregnancy-Induced Hypertension

Early diagnosis of pregnancy-induced hypertension (PIH) is crucial for preventing complications. In clinical practice, healthcare professionals need to be aware of the clinical features of PIH to enable accurate diagnosis and timely intervention. The following outlines common clinical features of pregnancy-induced hypertension:

- Elevated Blood Pressure: One of the main characteristics of PIH is an increase in blood pressure

in pregnant women. According to WHO definitions, the diagnostic criteria for PIH are a systolic blood pressure (SBP)  $\geq 140$  mmHg and/or diastolic blood pressure (DBP)  $\geq 90$  mmHg, recorded at least on two occasions with an interval of at least 4 hours [21].

- Onset after 20 Weeks of Pregnancy: Pregnancy-induced hypertension typically occurs after the 20th week of pregnancy, distinguishing it from hypertension present before pregnancy, which is often pre-existing.

- Proteinuria: Preeclampsia, a severe complication of PIH, is characterized by proteinuria. The diagnostic criteria for proteinuria include an hourly urinary protein excretion greater than or equal to 0.3 grams or a urine protein/creatinine ratio greater than or equal to 0.3 [22].

- Other Symptoms and Signs: Patients with pregnancy-induced hypertension may experience other symptoms and signs, such as headaches, blurred vision, upper abdominal pain, swelling, and edema. Severe cases may present with complications such as seizures, altered consciousness, and intrauterine growth restriction.

- Fetal Monitoring Abnormalities: PIH may adversely affect the fetus, leading to abnormalities in fetal monitoring, including reduced fetal movements, abnormal fetal heart rate, and intrauterine growth restriction.

- Blood and Urine Tests: In addition to blood pressure and proteinuria measurements, blood and urine tests can provide diagnostic information about PIH. These tests may include measurements of hemoglobin, platelet count, liver function, kidney function, and coagulation function, among others [23].

In conclusion, pregnancy-induced hypertension is characterized by a range of features, including elevated blood pressure, onset after 20 weeks of pregnancy, proteinuria, other symptoms and signs, fetal monitoring abnormalities, and abnormal blood and urine tests. Healthcare professionals should closely monitor these clinical features, combined with other assessments, to ensure accurate diagnosis and implement appropriate interventions to reduce the risk of maternal and fetal complications.

### 3.3 Importance of Laboratory Tests and Imaging Evaluation

Pregnancy-induced hypertension (PIH) is a severe pregnancy complication that significantly impacts the health of both the pregnant woman and the fetus. In the diagnosis and management of PIH, laboratory tests and imaging evaluations play crucial roles. This section will explore the importance of laboratory tests and imaging evaluations in pregnancy-induced hypertension.

#### 3.3.1 Laboratory Tests

Laboratory tests provide crucial information for assessing the physiological status of pregnant women and diagnosing pregnancy-induced hypertension. Here are some common laboratory test items:

- Urinalysis: Urinalysis can detect indicators such as proteinuria, glycosuria, and ketonuria, helping evaluate kidney function and urinary function.

- Complete Blood Count (CBC): CBC assesses parameters like red blood cell count, hemoglobin levels, and platelet count, aiding in understanding conditions such as anemia and thrombocytopenia.

- Liver Function Tests: Liver function tests, including measurement of enzymes, bilirubin, and proteins, can evaluate liver function abnormalities such as liver damage and cholestasis.

- Kidney Function Tests: Kidney function tests, including measurement of blood urea nitrogen (BUN), creatinine, and uric acid, help assess renal function abnormalities and the extent of kidney damage.

- Coagulation Function Tests: Coagulation function tests assess abnormalities in blood clotting and coagulation function, aiding in predicting the risk of bleeding or thrombosis.

These laboratory test results provide information about the overall health status of the pregnant woman, organ function, and potential complications, guiding healthcare professionals in developing personalized treatment plans.

### 3.3.2 Imaging Evaluation

Imaging evaluation plays a crucial role in the diagnosis and monitoring of pregnancy-induced hypertension (PIH). The following are commonly used imaging evaluation methods:

- **Ultrasound Examination:** Ultrasound examination is a non-invasive and safe method for assessing the fetus and uterus. Through ultrasound, healthcare professionals can evaluate indicators such as fetal growth and development, placental function, amniotic fluid levels, and blood flow in the uterine arteries.

- **Magnetic Resonance Imaging (MRI):** In special circumstances, such as when there is a critical need for imaging evaluation in pregnant women, MRI may be considered. MRI can provide detailed images to assess the conditions of the pregnant woman's brain, heart, and other organs.

Through laboratory tests and imaging evaluations, healthcare professionals can obtain more comprehensive and objective data to aid in the diagnosis and monitoring of the development of pregnancy-induced hypertension and the risk of complications. The application of these assessment methods helps in early detection of potential issues, allowing for appropriate interventions to protect the health of both the pregnant woman and the fetus.

## 4. Complications

### 4.1 Relationship between the Development of Preeclampsia and Severe Pregnancy-Induced Hypertension

Preeclampsia is a pregnancy complication that, when present, may manifest as high blood pressure, elevated levels of urinary proteins indicating kidney damage (proteinuria), or signs of organ damage. Existing literature suggests a significantly increased risk of developing preeclampsia in cases of severe pregnancy-induced hypertension accompanied by thyroid abnormalities [24], obesity [25], and cardiovascular diseases [26]. A correlation analysis between serum EGF, NT expression, and the development of preeclampsia in patients with pregnancy-induced hypertension was conducted, indicating that serum EGF and NT levels were downregulated in patients with pregnancy-induced hypertension and were closely related to the occurrence and development of preeclampsia [27]. Additionally, literature [28-30] discusses the intrinsic relationships between postpartum management, postpartum recovery, and the severity of complications associated with pregnancy-induced hypertension.

### 4.2 Harms to Mother and Fetus

Pregnancy-induced hypertension diseases, including preeclampsia and severe pregnancy-induced hypertension, pose significant risks to the health of both the mother and the fetus. This section explores the harms of pregnancy-induced hypertension diseases to both the mother and the fetus.

➤ Harms to the Mother:

- **Cardiovascular Issues:** Pregnancy-induced hypertension diseases increase the burden on the mother's cardiovascular system, leading to elevated blood pressure, increased cardiac load, and circulatory dysfunction. Severe cases may result in myocardial infarction, heart failure, and other cardiovascular complications.

- **Renal Function Issues:** Preeclampsia and severe pregnancy-induced hypertension can damage

the mother's renal function. Proteinuria is a typical symptom of preeclampsia, indicating compromised glomerular filtration function. In severe cases, renal failure and acute kidney injury may occur.

- **Central Nervous System Issues:** Pregnancy-induced hypertension diseases may cause central nervous system abnormalities in the mother, such as headaches, visual changes, and seizures. In the most severe cases, eclampsia may occur, characterized by seizures and loss of consciousness, posing a threat to the mother's life.

- **Harms to the Fetus:**

- **Fetal Growth Restriction:** Pregnancy-induced hypertension diseases affect maternal blood supply and placental function, restricting normal fetal growth and development. This may lead to low birth weight, intrauterine growth restriction, and fetal death during pregnancy.

- **Premature Birth:** Pregnancy-induced hypertension diseases are a significant cause of premature birth. Premature birth poses various risks to the fetus, including respiratory distress syndrome, infections, brain damage, and long-term developmental issues.

- **Placental Dysfunction:** Preeclampsia and severe pregnancy-induced hypertension may lead to placental dysfunction, affecting fetal oxygen and nutrient supply. This may result in intrauterine fetal distress, acidosis, and complications such as placental abruption.

## 5. Management Strategies

### 5.1 Importance of Early Screening and Preventive Measures

Early screening and preventive measures play a crucial role in the management of hypertensive disorders during pregnancy. By promptly identifying high-risk pregnant women and implementing appropriate interventions, complications can be reduced, thereby safeguarding the health of both mother and infant. This section explores the significance of early screening and preventive measures.

Early screening aids in identifying pregnant women at risk of developing hypertensive disorders during pregnancy, including advanced maternal age, multiple pregnancies, pre-existing chronic hypertension, gestational diabetes, and those with a family history. Through blood pressure monitoring, urinalysis, and other pertinent laboratory tests, elevated blood pressure and other abnormal indicators can be detected early, allowing for timely interventions. Early screening also assists in determining whether a pregnant woman exhibits signs of pre-eclampsia or other severe hypertensive disorders of pregnancy. Recognizing these signs promptly prompts healthcare professionals to take measures to manage the condition and mitigate the risk of complications.

### 5.2 Maintaining Adequate Prenatal Care and Monitoring

In the management of hypertensive disorders during pregnancy, maintaining optimal prenatal care and monitoring is of paramount importance. Regular medical surveillance and comprehensive care aid in blood pressure control, monitoring the progression of complications, and providing appropriate interventions. Examples of such interventions include routine blood pressure monitoring, urinalysis, fetal monitoring, personalized care plans, and close collaboration with the healthcare team.

### 5.3 Pharmacological Treatment and Management of Severe Cases

In the management of hypertensive disorders during pregnancy, pharmacological treatment and the management of severe cases are essential. For pregnant women with inadequate blood pressure control or a high risk of severe complications, pharmacological treatment, such as the administration of antihypertensive drugs and magnesium supplements, proves to be an effective intervention.

Additionally, preventive measures may include elective cesarean section, close monitoring, medical management, and collaborative efforts of a multidisciplinary team. The management of severe cases typically requires coordinated efforts among a multidisciplinary team, including obstetricians, hypertension specialists, internists, anesthesiologists, midwives, among other healthcare professionals, to collectively devise and execute optimal treatment plans.

## 5.4 Importance of Prenatal and Postnatal Care

Prenatal and postnatal care is crucial for the management and prevention of complications associated with hypertensive disorders during pregnancy. By offering comprehensive medical monitoring, education, and support, prenatal and postnatal care can assist pregnant women in blood pressure management, disease prevention and control, and promote the health of both mother and infant.

Prenatal care aims to ensure pregnant women receive comprehensive medical monitoring and care throughout their pregnancy. Key aspects of prenatal care include:

1) Regular medical visits: Pregnant women should adhere to regular prenatal medical visits as advised by healthcare professionals. This allows for the monitoring of blood pressure, urine protein levels, and the health of the fetus to promptly detect and address any potential issues.

2) Blood pressure monitoring: Regular blood pressure measurements are a core component of prenatal care. By monitoring changes in blood pressure levels, healthcare providers can promptly detect and control elevated blood pressure.

3) Laboratory tests: Prenatal care also involves regular laboratory tests, such as urine and blood tests, to assess kidney function, blood parameters, and other relevant indicators.

4) Nutrition and lifestyle: Prenatal care includes guidance on diet, nutrition, and healthy lifestyle choices for pregnant women. This can aid in weight control, promote cardiovascular health, and reduce the risk of hypertensive disorders during pregnancy.

Postnatal care is essential for monitoring the health of both the mother and the newborn and preventing complications. Key aspects of postnatal care include:

1) Regular medical visits: Postnatal regular medical visits are vital for evaluating the health of both the mother and the newborn. Healthcare providers can monitor blood pressure, recovery progress, and other relevant indicators, ensuring early detection and management of any complications.

2) Emotional and psychological support: Postnatal care also includes providing emotional and psychological support. Pregnant women may face challenges such as physical recovery, parenting stress, and postpartum depression, making appropriate support and education crucial for their mental health.

3) Avoiding recurrent hypertensive disorders: In postnatal care, healthcare providers should educate pregnant women about the risks of future pregnancies and offer appropriate contraception counseling and methods to prevent the recurrence of hypertensive disorders during subsequent pregnancies.

## 6. Future Research Directions

### 6.1 Development of Novel Preventive and Treatment Approaches

As medical research continues to advance, there is an ongoing evolution in preventive and treatment approaches for hypertensive disorders during pregnancy. This section will introduce some novel preventive and treatment methods aimed at enhancing the management of hypertensive disorders during pregnancy.

➤ Personalized Prevention Strategies:

In recent years, there has been a growing focus on personalized prevention strategies. By assessing specific risk factors and physiological characteristics of pregnant women, healthcare professionals can tailor preventive plans [31]. For instance, based on factors such as the woman's physical burden, family medical history, and previous illnesses, doctors can take corresponding measures such as adjusting diet, limiting salt intake, promoting exercise, and monitoring blood pressure to reduce the risk of hypertensive disorders during pregnancy.

➤ **Microbiota Regulation:**

Recent research suggests a potential link between the dysregulation of the gut microbiota and the occurrence of hypertensive disorders during pregnancy. Therefore, the modulation of microbiota has become a new research direction. Some studies explore the use of probiotics to improve the balance of the gut microbiota, aiming to prevent or alleviate hypertensive disorders during pregnancy [32]. However, further research is needed to determine the effectiveness and safety of this approach.

➤ **Vascular Function Modulators:**

In recent years, researchers have begun to focus on the potential role of vascular function modulators in hypertensive disorders during pregnancy. These drugs can improve blood pressure control by regulating vascular constriction and dilation [33]. For example, some studies indicate potential benefits of drugs such as angiotensin-converting enzyme inhibitors and angiotensin receptor blockers in reducing blood pressure and mitigating complications. However, the use of these drugs still requires further validation in clinical practice.

➤ **Genetic Testing and Personalized Treatment:**

Advancements in genetic testing techniques offer a new avenue for predicting and treating hypertensive disorders during pregnancy. By identifying genetic variations associated with the disease, healthcare professionals can better understand a patient's risk and formulate tailored treatment plans based on individual genetic backgrounds [34-38]. This facilitates personalized treatment and prevention strategies, improving the effectiveness of disease management.

It is important to note that while these novel preventive and treatment approaches show potential advantages, they are still in the research and development phase. Further clinical research and large-scale trials are necessary to validate their safety, effectiveness, and feasibility. Nevertheless, these new methods provide hope for the management of hypertensive disorders during pregnancy and pave the way for future treatment advancements.

## **7. Conclusion**

Hypertensive disorders during pregnancy represent common and serious complications in obstetrics, posing significant threats to the health of both mothers and infants. This review comprehensively discussed the etiology, diagnosis, complications, and management strategies of hypertensive disorders during pregnancy. Accurate blood pressure measurement is crucial for the diagnosis and management of hypertensive disorders during pregnancy, emphasizing the importance of standardized techniques and standards.

Recognizing the specific clinical features of hypertensive disorders of pregnancy can assist health care professionals in early detection and intervention. Laboratory tests and imaging evaluation play a vital role in assessing the status of a pregnant woman and assessing the risk of complications. Preeclampsia is a severe form of high blood pressure during pregnancy that poses a serious threat to both mother and baby. Long-term follow-up studies have shown an association between hypertensive disease during pregnancy and long-term health risks in women, such as cardiovascular disease and diabetes. Therefore, long-term follow-up and follow-up studies are crucial for prevention and management of complications.

Early screening and preventive measures are indispensable for preventing and managing



hypertensive disorders during pregnancy. Prenatal care and monitoring are key to ensuring the health of pregnant women and their infants, while the management of drug therapy and severe cases should be individualized. In the future, the development of novel preventive and treatment methods will expand the options for managing hypertensive disorders during pregnancy. Continuous long-term follow-up and subsequent research will further unveil potential impacts of the disease and optimal management strategies.

In conclusion, the diagnosis, management, and subsequent research of hypertensive disorders during pregnancy require close collaboration and ongoing attention from multidisciplinary teams. By enhancing awareness, strengthening preventive measures, and continuously improving treatment methods, we can better protect the health of pregnant women and infants, thereby reducing the risks associated with hypertensive disorders during pregnancy.

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