



Original Article Cardiovascular

## Preeclampsia: Prevalence, Risk Factors, and Impact on Mother and Fetus

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Received: 05 February 2023  
Accepted: 08 April 2023  
Epub Ahead of Print: 05 May 2023  
Published: 19 June 2023

DOI  
10.25259/IJCDW\_32\_2023

**Quick Response Code:**



Audio summary available at  
[https://doi.org/10.25259/IJCDW\\_32\\_2023](https://doi.org/10.25259/IJCDW_32_2023)

### ABSTRACT

**Objectives:** Preeclampsia is one of the most common hypertensive disorders in pregnancy accounting for >50,000 maternal deaths, and over 500,000 fetal deaths worldwide. The incidence of preeclampsia is estimated to be 7 times higher in developing countries like India. Women with preeclampsia are several folds more likely to contract cardiovascular diseases such as ischemic heart disease, stroke, and thromboembolism later in life. This study aims to record the prevalence of preeclampsia, examine the incidence of various associated risk factors and document, and analyze the effects preeclampsia has on the mother and fetus.

**Materials and Methods:** A cross-sectional study was conducted. Five hundred pregnant women were randomly selected based on availability of medical records. Prevalence of preeclampsia was identified in them and the preeclamptic population was further studied for various risk factors and epidemiological factors. The impact on mother and fetus was also studied. The data obtained from the medical records were entered into MS excel and variables were expressed as frequency and proportions. Analysis was done on SPSS 26.0 and major data were subjected to Chi-square test for determining significance.

**Results:** Out of a total of 500 pregnant women, 31 developed preeclampsia; hence, the prevalence of preeclampsia was found to be 6.2%. Of the 31 preeclamptic women, majority belonged to the 20–29 age group (51.6%), 19 (61.2%) had a pre-pregnancy body mass index >23, thus being classified as overweight or obese. Thirteen of these 19 (41.9%) were obese class 1, while 5 (16.1%) were obese class 2. Only two patients were multiparous, while nulliparous and primiparous women accounted for 48.38 and 45.16% of preeclamptic women. Twenty of the 31 women had preeclampsia with severe features and this was found to be significantly associated with delivering a baby having lower birth weight ( $P < 0.05$ ). A significant 45.1% (14 of the 31 women) had to undergo preterm delivery and 48.38% of the preeclamptic women terminated pregnancy by a lower segment cesarean section. Two of the women were also diagnosed with elevated liver enzymes and low platelets syndrome. With respect to the fetal outcomes, 48.4% of infants had low birth weight. Intrauterine fetal death, fetal growth restriction, and cleft lip and palate were also documented in few neonates.

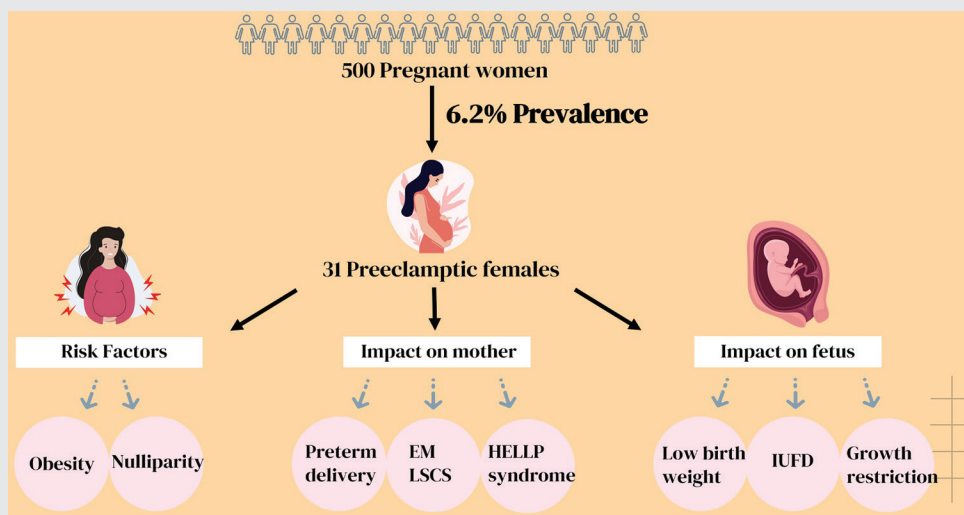
**Conclusion:** Preeclampsia has a high morbidity and mortality rate as well as an increased risk for future cardiovascular diseases. Hence, risk factors which are in an individual's self-control such as weight must be modified to prevent unfavorable complications. Pregnant women at risk of preeclampsia should be identified and high-quality antenatal care should be given to minimize the complications of preeclampsia both for the mother and the fetus. More research avenues must be explored on this subject so that enhanced treatment and management options can emerge.

**Keywords:** Preeclampsia, Obesity, Body mass index, Parity, Infant birth weight

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## ABSTRACT IMAGE



## INTRODUCTION

The most frequent medical issue that arises during pregnancy is hypertension, which continues to be a critical contributor in both maternal and fetal morbidity and mortality. Almost 10% of all pregnancies are complicated by this cardiovascular pathology. Preterm birth, intrauterine growth restriction, perinatal death, acute renal or hepatic failure, antepartum hemorrhage, postpartum hemorrhage, and maternal death are all correlated with a heightened risk in pregnancies complicated by hypertension.<sup>[1-3]</sup>

Preeclampsia is one of the most common hypertensive disorders in pregnancy accounting for >50,000 maternal deaths, and over 500,000 fetal deaths worldwide.<sup>[4]</sup> The incidence of preeclampsia is estimated to be 7 times higher in developing countries like India as compared to the rest of the world.<sup>[5]</sup>

According to the American College of Obstetricians and Gynecologists, preeclampsia is defined as a condition with hypertension (systolic blood pressure >140 mm hg or diastolic blood pressure >90 mm hg or both) and proteinuria or in absence of proteinuria, new-onset hypertension with any of thrombocytopenia, renal insufficiency, impaired liver function, pulmonary edema, and unexplained headache usually occurring at or after 20 weeks' gestation.<sup>[6]</sup>

It is well-established that preeclampsia and cardiovascular illnesses have similar risk factors. Obesity body mass index (BMI), parity, increasing age, chronic hypertension, gestational diabetes mellitus (GDM), chronic renal illness, previous preeclampsia, systemic lupus erythematosus, *in vitro* fertilization, and a family history of preeclampsia are established risk factors for preeclampsia.<sup>[7]</sup>

Preeclampsia patients are more likely to have cardiovascular illness later in life, including an almost four-fold increased risk of hypertension, a roughly two-fold greater risk of fatal and non-fatal ischemic heart disease, stroke, and venous thromboembolism. This relation can be explained by two mechanisms involving common risk factors shared by both pathologies and lipid deposition in spiral arteries of uterus resembling early stages of atherosclerosis.<sup>[8]</sup>

The overall risk of preeclampsia is roughly 2–3 times higher in people who are obese or overweight.<sup>[9]</sup> Even when BMI is within the normal range, the risk of preeclampsia gradually rises. It is significant to note that the risk is elevated for both early or preeclampsia with severe features, which is linked to higher fetal morbidity and mortality, as well as for late or mild preeclampsia.<sup>[10,11]</sup>

According to a systematic review of controlled studies, nulliparity is a strong risk factor that almost triples the risk of preeclampsia (odds ratio 2.91, 95% confidence interval [95% CI] 1.28–6.61),<sup>[12]</sup> It is estimated that two-thirds of all cases occur in first pregnancies that progress beyond the first trimester.<sup>[13]</sup>

Along with understanding the way the pathology affects the mother, it is also important to address the negative outcomes that it has on the fetus. Recent evidence suggests that infants born preterm are, in fact, physiologically immature compared to term infants.<sup>[14]</sup> Furthermore, there are several mechanisms which give preeclampsia the potential to disrupt fetal growth and development. In this study, we have also taken into account these factors and documented the distribution of the range of normal and abnormal gestational age, along with the distribution of fetal birth weight as a measure to define an underdeveloped fetus.

This research study sets out to examine the prevalence of preeclampsia in a central government funded hospital in Hyderabad and document the frequency of occurrence of this disease with major risk factors such as obesity, parity, and severity of preeclampsia. Along with this, the study reports the gestational age of the mother at time of delivery, the mode of delivery, and also documents the status of fetal development by employing fetal birth weight as a measure of the same. At the same time, the presence of any significant maternal or fetal complications has also been recorded. Based on the review of literature, there is a lacuna in the studies conducted in India focusing solely on preeclampsia rather than hypertensive disorders during pregnancy as a whole. Studies in India also lack in assessing the risk factors correlated with preeclampsia. There is less information on variation in epidemiological factors such as gestational age, mode of delivery, and the impacts preeclampsia has on a mother and fetus.

## MATERIALS AND METHODS

A cross-sectional study was carried out in the obstetrics and gynecology department of ESIC medical college and super-specialty hospital, a public funded medical college in Hyderabad. In this study, 500 pregnant women were selected at random from the period of August 2022–December 2022 on the basis of availability of medical records to conduct the study. Records regarding maternal health, pregnancy and neonatal information for all deliveries are maintained by ESIC hospital regularly. The pregnant women undergo a set of tests regularly as per routine protocol. The females that had been diagnosed with preeclampsia at or after 20 weeks of gestation among the random 500 pregnant women were the main population of the study. The inclusion criteria included pregnant women with gestational age more than 20 weeks, while women who had developed eclampsia or gestational hypertension throughout their gestational age were excluded from the study.

The study variables chosen to be investigated were maternal age, pre-pregnancy BMI, parity, severity of preeclampsia, presence of GDM, maternal height, hemoglobin levels, mode of delivery, gestational age, infant birth weight, and maternal/fetal complications. All the information on patients was retrieved from the medical records maintained by the hospital after thorough approval and permission from the concerned department and faculty. The medical staff and faculty were instructed to enquire and record in the case sheet the pre-pregnancy BMI of the pregnant women on their first antenatal visit. The study was conducted after approval from the Institutional Ethics Committee.

### Statistics

The data collected were entered into Microsoft Excel. Categorical variables were expressed in frequencies and

**Table 1:** Distribution of specific variables among the preeclamptic females ( $n=31$ ).

|                                    | Number of patients | Percentage |
|------------------------------------|--------------------|------------|
| Maternal age (years)               |                    |            |
| ≤19                                | 1                  | 3.22       |
| 20–29                              | 16                 | 51.6       |
| 30–34                              | 11                 | 35.48      |
| >35                                | 3                  | 9.67       |
| Maternal height (cm)               |                    |            |
| ≤154                               | 16                 | 51.6       |
| 155–174                            | 14                 | 45.1       |
| ≥175                               | 1                  | 3.22       |
| Hemoglobin                         |                    |            |
| Normal (>10.1 g/dL)                | 25                 | 80.6       |
| Mild/Moderate anemia (8.1–10 g/dL) | 6                  | 19.4       |
| Gestational diabetes mellitus      |                    |            |
| Yes                                | 10                 | 32.3       |
| No                                 | 21                 | 67.7       |
| Preeclampsia subtype               |                    |            |
| Non severe                         | 11                 | 35.4       |
| Severe                             | 20                 | 64.6       |

**Table 2:** Association between pre-pregnancy BMI and preeclampsia among selected pregnant women ( $n=31$ ) (according to Asian pacific guidelines).

| Maternal pregnancy BMI    | Number of patients | Percentage |
|---------------------------|--------------------|------------|
| Underweight (<18.5)       | 4                  | 12.9       |
| Healthy (18.5–22.9)       | 8                  | 25.8       |
| Overweight (23.0–24.9)    | 1                  | 3.2        |
| Obese class 1 (25.0–29.9) | 13                 | 41.9       |
| Obese class 2 (>30)       | 5                  | 16.1       |

BMI: Body mass index

**Table 3:** Distribution of parity among the preeclamptic females ( $n=31$ ).

| Parity (P)            | Number of patients | Percentage |
|-----------------------|--------------------|------------|
| Nulliparous ( $P=0$ ) | 15                 | 48.38      |
| Primiparous ( $P=1$ ) | 14                 | 45.16      |
| Multiparous ( $P>2$ ) | 2                  | 6.45       |

proportions. Analysis was conducted in SPSS 26.0. Association tables were made between variables and major parameters like severity of preeclampsia were subjected to Chi-square test, along with other variables to determine significance of the collected data.  $P < 0.05$  was considered statistically significant.

## RESULTS

Out of the 500 pregnant women selected in the specified time frame, 31 women had developed preeclampsia at or after 20 weeks of gestation. This brings the prevalence of

**Table 4:** Distribution of gestational age and mode of delivery among the preeclamptic females (n=31).

| Gestational age  | Number of patients | Percentage |
|--|--------------------|------------|
| Extreme preterm: <28 weeks                             | 4                  | 12.9       |
| Very preterm: 28 <sup>0/7</sup> –31 <sup>6/7</sup>     | 2                  | 6.45       |
| Moderate preterm: 32 <sup>0/7</sup> –33 <sup>6/7</sup> | 1                  | 3.22       |
| Late preterm: 34 <sup>0/7</sup> –36 <sup>6/7</sup>     | 7                  | 22.5       |
| Term: 37 <sup>0/7</sup> –41 <sup>6/7</sup> weeks       | 17                 | 54.8       |
| Mode of delivery                                       |                    |            |
| NVD  | 7                  | 22.5       |
| RMLE-aided NVD   | 7                  | 22.5       |
| Emergency LSCS   | 13                 | 41.93      |
| Elective LSCS  | 2                  | 6.45       |
| Spontaneous vaginal delivery                           | 2                  | 6.45       |

NVD: Normal vaginal delivery, RMLE: Right mediolateral episiotomy, LSCS: Lower segment caesarean section

preeclampsia among pregnant women at 6.2%. Coming now to the general maternal characteristics, [Table 1] shows that more than half of the preeclamptic population belong to the 20–29 age group (51.6%, 16 out of 31). It is also depicted that most of the women were having a height below 154 cm. However, neither age nor height had a significant impact on the occurrence of preeclampsia. According to the collected data, the mean maternal age was 28.7 years during the study period. The data also reveal that most of the women had normal hemoglobin levels (80.6%, 25 of 31) and did not have GDM (67.7%, 21 of 31) in our population. The severity of preeclampsia diagnosed also is of vital importance as it is a major determinant of disease prognosis. In this study, we found that 20 of the 31 preeclamptic women were diagnosed with preeclampsia with severe features, while 11 had preeclampsia without severe features.

More significant and important findings involving the risk factors are shown in [Table 2], 19 out of 31 (61.2%) of the preeclamptic women were overweight or obese, that is, had a BMI>25. Out of these 19 women, 13 were obese class 1 (41.9%) and five were obese class 2 (16.1%) as well. The classification for the pre pregnancy BMI was taken in accordance to the Asian pacific guidelines.<sup>[15]</sup>

The distribution of parity among the preeclamptic women was also recorded, as presented in [Table 3], signifying that women in the study population were mostly nulliparous (48.3%, 15 of 31) or primiparous (45.16%, 14 of 31). The observation that can be drawn here is that subsequent pregnancies have lowered the risk of preeclampsia, while nulliparity has predisposed the female to a greater risk of developing preeclampsia.

The maternal outcomes presented in [Table 4] show variation in the gestational age in the women with preeclampsia. A significant 45.1% (14 of the 31 women) had to undergo preterm delivery. Preterm delivery has been classified as extremely preterm, very

**Table 5:** Distribution of infant birth weight among the preeclamptic females (n=33).

| Infant birth weight                 | Number of patients | Percentage |
|-------------------------------------|--------------------|------------|
| Normal birth weight: >2500 g        | 17                 | 51.5       |
| Low birth weight: <2500 g           | 10                 | 30.3       |
| Very low birth weight: <1500 g      | 3                  | 9.09       |
| Extremely low birth weight: <1000 g | 1                  | 3.03       |
| Micro premie: <750 g                | 2                  | 6.06       |

**Table 6:** Association between severity of preeclampsia and infant birth weight (n=33, twins).

| Infant birth weight   | Preeclampsia with severe features | Preeclampsia without severe features | P-value |
|-----------------------|-----------------------------------|--------------------------------------|---------|
| Normal (≥2500 g)      | 7                                 | 10                                   | 1 (<05) |
| Underweight (<2500 g) | 13                                | 3                                    |         |

preterm, moderately preterm, and late preterm in accordance to the classification proposed by Karnati *et al.*<sup>[16]</sup>

At the same time in this study, we have also documented the mode of delivery adopted. It was observed that majority (41.9%, 13 of 31) of the women had to undergo an emergency lower segment cesarean section.

From the data analyzed in the study, we could also observe that two of the preeclamptic women were also later diagnosed with syndrome hemolysis, elevated liver enzymes, and low platelets (HELLPs) which is associated with high maternal morbidity and mortality.

The impact of preeclampsia on fetus or infant was analyzed. In this study, we had employed infant birth weight as a measure to determine optimum fetal development. As presented in [Table 5], we can see that 48.4% of infants had low birth weight with one having extremely low birth weight <1000 g and two being even lower at 665 and 680 g, respectively, and classified as micro premie.

In this study, fetal complications were also recorded if deemed significant. Two women had developed intra uterine fetal death, while one of the male babies had cleft lip and cleft palate as a complication. Two women also presented with fetal growth restriction on a prenatal ultrasound.

Chi-square test to determine a significant P-value was incorporated only for the variables that significantly influenced preeclampsia.

In [Table 6] provided, we can see that there was a significant relationship between the severity of preeclampsia and infant birth weight. Women diagnosed with preeclampsia with



severe features were significantly more likely to give birth to a baby with low birth weight. However, the Chi-square did not show any significant relationship between other associated risk factors.

## DISCUSSION

Over the study period of our research, we documented a prevalence of 6.2% for preeclampsia. Sengodan and Sreepathi from Tamil Nadu in the year 2020 recorded the prevalence of preeclampsia as 3.4% in their hospital setting.<sup>[17]</sup> However, a study by Mou *et al.* in Bangladesh depicted a prevalence of 14% for preeclampsia<sup>[18]</sup> proving that the prevalence of the hypertensive disorder can widely vary from region to region and community to community.

In accordance to the study by Ros *et al.*,<sup>[19]</sup> general characters such as maternal age and height did not have any significant impact as risk factors for preeclampsia.

The relationship between GDM and preeclampsia has always been debated and various studies have shown varying results. The HAPO study (a large international prospective blinded cohort study) found that the occurrence of pulmonary embolism (PE) is positively associated with blood glucose level even after adjusting for various factors such as BMI and age.<sup>[20]</sup> Population-based retrospective cohort studies in several countries such as USA and Canada also showed that GDM was independently associated with the occurrence of PE.<sup>[21]</sup> However, a few studies, for instance a retrospective cohort study done in Germany, suggest that GDM is not associated with the occurrence of PE after removing the effect of pre-pregnancy BMI and other factors.<sup>[22]</sup> In our study, we were not able to establish a significant association between GDM and preeclampsia. We observed that only 32.2% (10 out of 31) preeclamptic female had GDM.

The most obvious finding to emerge from the study pointed toward the fact that women with a BMI more than 23, that is, classified as overweight or obese are more predisposed to developing a cardiovascular hypertensive disorder of pregnancy like preeclampsia in this case. In this study, 61.2% of the preeclamptic women were overweight before pregnancy. This was in line with countless other articles like the one by Shao *et al.* from China<sup>[23]</sup> or the one by Nanjundan *et al.* in North India<sup>[24]</sup> all of which concluded that higher BMI was associated with a higher risk of developing preeclampsia.

A long-term increased risk of cardiovascular disease and early death exists for women who develop preeclampsia. This can be explained by two mechanisms. The first is that preeclampsia and cardiovascular illnesses may share risk factors, such as obesity. According to the second mechanism, lipid accumulation in the walls of the spiral arteries in the mother's uterus happens frequently in preeclampsia. These arterial lesions are known as "acute atherosclerosis," and

they mirror the early stages of atherosclerosis. These "atherosclerosis-like" lesions could have some connection to trophoblast invasion as well. Many cardiovascular disorders are caused by arteriosclerosis and stenosis, which can be explained in part by the transitory occurrence of acute atherosclerosis of the uterine wall spiral arteries in preeclampsia and the molecular interaction between trophoblast, smooth muscle, and vascular cells.<sup>[25]</sup>

Luo *et al.*, in his study, hypothesized that there is a lower risk of preeclampsia in multiparous women that have been attributed to desensitization of tissue after exposure to paternal antigens in the placenta during previous pregnancies.<sup>[26]</sup> This hypothesis holds good in our study as well since most of the women who had developed preeclampsia in this study were either nulliparous (15 out of 31, 48.3%) or primiparous (14 out of 31, 45.1%). Duckitt and Harrington, in his study, showed that nulliparity is strong risk factor that almost triples the risk of preeclampsia.<sup>[12]</sup>

A high number of women with preeclampsia delivered a baby before full term (45.1%, 14 out of 31). This has been consistent with the findings of many other studies like that of Davies *et al.* where she found a significant association between preeclampsia and preterm birth (adjusted odds ratio 4.43; 95% CI 3.80–5.16).<sup>[27]</sup> In our study, we have further also classified the preterm births into late preterm, moderately preterm, very preterm, and extreme preterm, as shown in [Table 4].

In the present study, we found that most pregnant women with preeclampsia terminated pregnancy by cesarean section (48.38%). Kim *et al.* conducted a retrospective study where he illustrated that regardless of maternal age or parity, or whether the fetus was full-term or not, the cesarean section rate was still higher in pregnant women with preeclampsia than in those without. This observation by Kim *et al.* has been justified by the explanation that pathophysiologic changes in preeclampsia like vascular spasms can lead to decreased placental perfusion, and, thus, a lengthy vaginal delivery may intensify fetal hypoxia. Cesarean section can instead deliver the baby rapidly and remove it from the adverse intrauterine environment as soon as possible.<sup>[28]</sup>

In this study, maternal complications like HELLP syndrome which is widely recognized to be a severe complication of preeclampsia were also diagnosed in two women.

The impact of preeclampsia on the fetus can be explained by the "ischemic model" which is widely accepted theory explaining the genesis of preeclampsia. It is believed that reduced uteroplacental perfusion is the first step in the onset of preeclampsia and this reduced placental blood flow is the main cause of decreased fetal growth, with an increased risk of intrauterine growth restriction and low birth weight. Requirement of a preterm delivery is also accounted by the same pathogenesis.<sup>[29]</sup>

The results of the present study also follow the above mentioned mechanism since we were able to observe that 16 out of 33 (48.4%) infants had lower than normal birth weight (<2500 g). We had also categorized the low birth weights further into low, very low, extremely low, and micro premie.<sup>[16]</sup> This study was also able to establish a significant association between preeclampsia with severe features and the higher occurrence of a lower infant birth weight through a Chi-square test of significance.

As mentioned in the results, several fetal complications were also documented in the study such as two intrauterine fetal deaths, two fetal growth restrictions, and one baby had a cleft lip and cleft palate. However, the data of the study were not enough to establish a relationship or association between the fetal abnormalities and preeclampsia.

Despite the various different determinants, this study was able to shed light on, these findings may somewhat be limited by the smaller study population of preeclampsia considered for the study. A larger preeclamptic population would have helped establish more robust and significant associations between the studied variables.

## CONCLUSION

This study was able to document the prevalence of preeclampsia in a central government hospital in Hyderabad. This study was also able to record various risk factors associated with preeclampsia and also shed light on the impact preeclampsia has on the mother and fetus.

Despite the limitations of the study, these findings though preliminary have important implications that should promote various fundamental changes in the lifestyle of an individual. For instance, weight loss before pregnancy must be encouraged in overweight and obese women to decrease the risk of adverse outcomes. Preeclampsia as mentioned earlier has a high morbidity and mortality rate as well as an increased risk for future cardiovascular diseases. Hence risk factors which are in an individual's self-control must be modified in a positive direction. Pregnant women at risk of preeclampsia should be identified and high-quality antenatal care should be given to minimize the complications of preeclampsia both for the mother and the fetus. More research avenues must be explored on this subject so that enhanced treatment and management options can emerge. A cohort investigation is needed to determine the ability of these risk factors to further predict the complications of preeclampsia at a deeper level.

## Acknowledgments

We are extremely thankful to the WINCARS association for selecting our project under the Prajwalika Scholarship (PSS) program. We would like to thank the faculty department of

obstetrics and gynecology for providing their expertise in conducting this study.

## Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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**How to cite this article:** Shandilya V, Sinha N, Rani S. Preeclampsia: Prevalence, risk factors, and impact on mother and fetus. *Indian J Cardiovasc Dis Women* 2023;8:193-9.