RESEARCH ARTICLE

An association between pre-pregnancy maternal body mass index and the risk of pre-eclampsia in the North India

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ABSTRACT

Background: High blood pressure and proteinuria are the hallmarks of pre-eclampsia, which develops after the 20th week of pregnancy. Even while pre-pregnancy body mass index (BMI) has been linked to an increased risk of pre-eclampsia in multiple studies in India, very few studies examine the condition’s causes. This kind of research is lacking among the North Indian population. This cross-sectional study examines the factors contributing to pre-eclampsia in the North Indian population. It is possible to use this study’s findings to undertake appropriate actions. Aim and Objective: We sought to determine if pre-pregnancy BMI and pre-eclampsia are linked among pregnant women in the North Indian community. Materials and Methods: Participants (n = 270) were enrolled under the inclusion/exclusion criteria. A sphygmomanometer was manually used to measure the patient’s blood pressure. A positive dipstick test or the presence of 300 mg of protein in a 24-h urine sample was used to diagnose pre-eclampsia. A person’s weight and height were used to calculate their BMI (kg/m²). In India, the new weight-for-height ranges are: Underweight (18.5 kg/m²), normal or lean (18.5–22.9 kg/m²), overweight (23.0–24.9 kg/m²), and obese (25 kg/m²). Result: There were three obese pre-eclampsia patients (23–24.9 BMI) and eight pre-eclampsia patients with pre-pregnancy BMIs of 25 or higher, including three overweight patients. There were no patients with pre-eclampsia in the pre-pregnancy BMI groups of underweight (18.5) and normal (18.5–22.9). There were three cases of mild pre-eclampsia (MP) in women with a pre-pregnancy BMI of 30 or more. Still, no cases of severe pre-eclampsia (SP) or late onset preeclampsia (LOP) and no cases of early onset preeclampsia (EOP) were documented in the category of overweight women. Seven obese (25 BMI) pre-eclamptic women developed MP, whereas one patient developed MP following delivery. Seven cases of LOP, one case of SP, and one case of EOP were found in this category. Conclusion: A high pre-pregnancy BMI was found to be an independent risk factor for pre-eclampsia, and there was a link found between pre-eclampsia and a high pre-pregnancy BMI. Maintaining a healthy weight is essential for women in their reproductive years, and a healthy BMI can be maintained with proper monitoring, nutritional counseling, and other methods.

KEY WORDS: Blood Pressure; Body Mass Index; Obesity; Pregnancy; Preeclampsia

INTRODUCTION

Obesity has become a major public health concern worldwide. A high body mass index (BMI) before pregnancy is linked to an increased risk of pre-eclampsia.¹⁻² Obesity in the mother (maternal obesity) has become one of the most prominent risk factors in obstetrics. Prenatal and postnatal
Pre-eclampsia has been the subject of numerous researches, but only a few have found a link between the condition and a low BMI before pregnancy. The previous study found that a pre-pregnancy BMI under 25, prior family history of chronic hypertension, diabetes, renal disease was all significant independent predictors of pre-eclampsia among women in the South Indian population.[19] Only a few well-documented researches in India look at the factors contributing to pre-eclampsia. However, several studies have revealed that pre-pregnancy BMI is a significant risk factor.[20-23] The North Indian population is deficient in this type of research and it is critical to look for preventative risk factors in light of this information. As a result, this research will examine the relationship between prenatal BMI and pre-eclampsia. Factor affecting the pre-eclampsia in the North Indian population is studied using this cross-sectional study. The findings of this study can be used as a guide for implementing relevant interventions.

This study aimed to determine the relationship between pre-pregnancy BMI and pre-eclampsia in women who visited the antenatal clinic at the Integral Institute of Medical Sciences and Research at Integral University, Lucknow.

### Objectives

The objectives of the study are as follows:

1. All pregnant women should have their pre-pregnancy BMI and their BP measured, respectively
2. To associate pre-pregnancy BMI with pre-eclampsia.

### Hypothesis

We assume that there is no association between pre-pregnancy BMI and pre-eclampsia, according to the null hypothesis (N0). Pre-pregnancy BMI and pre-eclampsia may be linked, according to an alternate hypothesis (N1).

### MATERIALS AND METHODS

#### The Location of the Research

The Institutional Ethics Committee approved the study, Integral Institute of Medical Sciences and Research, Lucknow with protocol number (IEC/IIMS and R/2019/30). The study was conducted in the Department of Physiology in collaboration with the Obs/Gyn of Integral Institute of Medical Sciences and Research, Lucknow. There was a 6-month period of study from January 2019 to June 2019.

#### Sample Size

The sample size was calculated using the formula:

\[ n = \frac{z^2pq}{d^2} \]

where: \( n \) = sample size, \( q = 100-P \), \( d = \) absolute precision,

\[ P = \text{prevalence} \times 5.4\% \]

If prevalence is <10%, then \( d = 1/2P \)

\[ = (1.96)^2 \times 5.4 \times (100-5.4)/(5.4 \times 5.4) \]

\[ = (3.8416 \times 5.4 \times 94.6)/7.29 \]

\[ = 270 \text{ cases} \]

#### Study Population

Antenatal care women are the population being studied. Women between the ages of 18 and 45, who visit the Obs/Gyn Outpatient Department (OPD) at the Integral Institute of Medical Sciences and Research, Lucknow, were eligible for participation in the study. A criterion for inclusion:
(i) Pregnant women between the ages of 18 and 45, (ii) a willing participants in the study, and (iii) both single and multiple pregnancies are included in this category. A criterion for exclusion: (i) Consent is not given by the participants. (ii) Participants under the age of 18 and over the age of 45. (iii) A condition that causes high BP (HTN), proteinuria, and swelling. (iv) Women for whom there is no information on their pre-pregnancy BMI.

According to the inclusion/exclusion criteria, participants were enrolled in the OBS/GYN OPD and a signed informed consent form as per the norms of Helsinki declaration. According to the form enclosed, the cases were examined.

**Collection of Data**

**Measurement of BP**

BP was measured manually using a sphygmomanometer (lifeline) with taking the necessary precautions. BP was taken from the left arm in a sitting position (arm completely supported on a flat surface at heart level). Pre-eclampsia is defined as a systolic/diastolic BP of 140/90 mmHg measured twice at a 6-h interval.

**Measurement of protein**

For proteinuria, a report of routine/microscopic tests was obtained from the Central Pathology Laboratory, Integral Institute of Medical Sciences and Research, Lucknow. Pre-eclampsia was diagnosed by a positive dipstick test or 300 mg of protein in a 24-h urine sample (≥1+ on dipstick test or ≥300 mg of protein).

**Measurement of BMI**

The most commonly used indicator of obesity is BMI. Weight (kg) and height (m) were used to compute BMI (kg/m²). Underweight (<18.5 kg/m²), normal or lean (18.5–22.9 kg/m²), overweight (23.0–24.9 kg/m²), and obese (≥25 kg/m²) are the revised standards for India.

**Statistical Analysis**

Statistical Package for the Social Science software was used to analyze the data (21.0). The data were analyzed using a Chi-square test and significance was defined as $P < 0.05$.

**RESULTS**

Frequency and Relative Percentage in the Distribution of Age Groups, Educational Background, Occupation Type, Habitat Type (Place of Residence), and Kind of Parity (%) among Participants

The summarized data are described in Table 1: The study population had been divided into four sets based on their age
range: 18 years, which has 1 participant (0.4 %), 19–25 years, which has 145 participants (53.7 %), 26–35 years, which has 115 participants (42.6 %), and 36–45 years, which has 9 participants (3.3 %), and so on. Illiterate individuals accounted for 59 (21.9 %), 5–9th grade students accounted for 72 (26.7 %), high school students accounted for 30 (11.1 %), intermediate students accounted for 36 (13.3 %), graduate students accounted for 53 (19.6 %), and postgraduate students accounted for 20 (7.4 %). Working women, who accounted for just 5 (1.9 %) of the participants in our study, were separated into two groups: 265 housewives and 5 working women (98.1 %). Participants in the study were separated into two groups: Those who lived in rural areas (83 %) and those in urban areas (47 %). Nulliparous 6 participants (17 %) made up 2 % of the total, primiparous people made up 101 participants (38 %), and multiparous 163 participants made up (60 %).

Frequency and Relative Percentage of Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP), BMI, and Pre-eclamptic among Participants

The summarized data are described in Table 1: Participants with SBP in 90–100 mmHg range are 26 (9.6 %), in 101–110 mmHg range are 147 (54.5 %), in 111–120 mmHg range are 53 (19.6 %), in 121–130 mmHg range are 30 (11.1 %), in 131–150 mmHg range are 8 (3 %), and in 151–160 mmHg range are six individuals. However, 10 (3.7 %) of participants had DBP in the 40–50 mmHg range, 44 (16.3 %) in 51–60 mmHg range, 122 (45.2 %) in 61–70 mmHg range, 66 (24.4 %) in 71–80 mmHg range, 26 (9.6 %) in the 81–90 mmHg range, and two people had in 91–110 mmHg range.

According to the pre-pregnancy BMI criterion, 27 women were underweight, 94 women were in the normal BMI range, and 45 women were overweight or obese. Pre-eclampsia was found in 11 of the 270 pregnant women in the study, but the remaining 259 women (95.9 %) were free of the condition.

Pre-eclampsia was distributed by age group, habitat, educational background, employment situation, and pre-pregnancy BMI category of participants with \( P \)-value. A summary of the findings is described in Table 2: There were no pre-eclamptic women under the age of 18, two pre-eclamptic women between the ages of 19 and 25, eight pre-eclamptic women between the ages of 26 and 35, and

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pre-eclampsia</th>
<th>Chi-square test</th>
<th>( P )-value</th>
<th>Degree of freedom</th>
</tr>
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<td><strong>Age group</strong></td>
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<td>Negative</td>
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<td></td>
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<tr>
<td>18</td>
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<td>26–35</td>
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<td></td>
</tr>
<tr>
<td>36–45</td>
<td>1</td>
<td>8</td>
<td></td>
<td></td>
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<tr>
<td><strong>Habitat</strong></td>
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<td>Negative</td>
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<td></td>
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<tr>
<td>Urban</td>
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<td>0.0009</td>
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<tr>
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<td>≥25</td>
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</table>

BMI: Body mass index
one pre eclampsia patient between the ages of 36 and 45, according to the study. The non-significant $P$-value is 0.0970.

These individuals had a rural and urban background, with six pre-eclampsia cases each. $P < 0.0009$ is considered statistically significant. Three women with pre-eclampsia were illiterate, while two others had completed up to the 5–9th grade, two others had completed high school, one woman had reached the intermediate level, and three others had earned a graduate degree. In other words, $P$-value of this study is non-significant at 0.0909.

Pre-eclampsia struck 11 women, all of whom were stay-at home moms. $P$-value of 0.6418 indicates that the results are not statistically significant. There were no pre-eclampsia cases in the pre-pregnancy BMI range of 18.5–24.9. As a result, the BMI ranges from 18.5 to 22.9 (underweight) to 18.5–22.9 (average weight). A total of three patients with pre-eclampsia had a BMI of 23–24.9, while eight were classified as obese before pregnancy. A significant $P$-value of 0.0245 was obtained.

Distribution of Subtypes of Pre-eclampsia as Per Pre-pregnancy BMI Category with $P$-value

A summary of the findings is described in Table 3: There were no pre-eclampsia patients in the underweight (18.5) and normal (18.5–22.9) pre-pregnancy BMI categories. In the overweight pre-pregnancy BMI category, three patients had mild pre-eclampsia (MP), none had SP, and three late-onset pre-eclampsia (LOP) occurrences, but no early-onset pre-eclampsia (EOP) patients were reported. In this category, seven pre-eclamptic women with a pre-pregnancy BMI of obese (25) suffered from MP, one patient with SP, one instance of EOP, and seven cases of LOP were documented. $P$-value is significant at 0.0397.

**DISCUSSION**

According to this study finding, a higher pre-pregnancy BMI of pregnant women is associated with an increased risk of pre-eclampsia. Because there is apparent weight gain during pregnancy (weight gain from adiposity in the first trimester and weight gain from edema in the second trimester), this increase in weight gain cannot be used to determine its role in the etiology of preeclampsia.

The favorable relationship between pre-pregnancy BMI and pre-eclampsia was shown to be identical for MP and SP but different for EOP and LOP, according to this study. BMI before pregnancy demonstrated a good relationship with LOP but not with EOP.

The initial stage of pre-eclampsia is improper implantation, including shallow trophoblastic invasion and poor spiral artery remodeling, or any other pathological problem resulting in diminished placental perfusion. In the second stage, the mother’s systemic inflammatory response and oxidative stress combine to cause vascular endothelium dysfunction, which leads to multiorgan damage. The maternal background associated with the second stage of pre-eclampsia may be influenced by metabolic and biochemical changes linked with overweight/obesity.

Inflammatory cytokines and C-reactive protein are elevated in the blood of obese people because of their chronic inflammation. Inflammation spreads throughout the body, which causes neutrophils to produce toxins (such as reactive oxygen species and myeloperoxidase) that target and destroy the integrity of vascular endothelial cells. This causes an inflammatory response. Pre-eclampsia’s symptoms result from this mechanism.

Our findings of the link between a higher BMI and an increased risk of preeclampsia are by those of other studies that have included Western and Asian populations. Pre-eclampsia subtypes SP, MP, and LOP but not EOP were found to be associated with higher prenatal BMIs, according to the previous studies that looked at this relationship. Our finding supports this. The modest number of EOP patients in our study ($n = 1$) could account for the lack of a significant link between pre-pregnancy BMI and EOP. EOP and LOP have different biochemical indicators, hemodynamic states, risk factors, and clinical aspects. Thus, we may conclude that they are two distinct disorders. Examples of EOP include fetal growth limitation, decreased placental volume, and unfavorable consequences for both the fetus and the mother. Pre-eclampsia cases that begin before 32 weeks gestation have a mortality rate 20 times higher than those that begin after 32 weeks gestation. There are positive outcomes for both mother and child in the LOP group: Average fetal growth, greater placental volume, and normal birth weight.

| Table 3: Pre-eclampsia subtypes and their P values as a function of pre-pregnancy BMI category |
|---------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Pre-pregnancy BMI category                  | Pre-eclampsia | MP  | SP  | EOP | LOP | Chi-square test | P-value | Degree of freedom |
| <18.5                                         | 0   | 0   | 0   | 0   | 0   | 17.630        | 0.0397  | 9               |
| 18.5–22.9                                     | 0   | 0   | 0   | 0   | 0   |               |         |                 |
| 23–24.9                                       | 3   | 3   | 0   | 0   | 3   |               |         |                 |
| ≥25                                           | 8   | 7   | 1   | 1   | 7   |               |         |                 |

MP: Mild preeclampsia, SP: Severe preeclampsia, EOP: Early-onset pre-eclampsia, LOP: Late-onset Preeclampsia, BMI: Body mass index

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This study comprised 270 pregnant women divided into different socioeconomic and demographic groups. Pre-eclampsia incidence was 4.1%, which means 11 pregnant women out of a total of 270 were diagnosed with pre-eclampsia. The study population comprises 223 participants (83%) who live in rural areas and 47 participants living in urban areas (17%). Six of the pre-eclampsia patients were from an urban background, whereas the other five came from a rural background. P-value is 0.0009, which is <0.05, making the result extremely significant.

The individuals’ pre-pregnancy BMI criteria were as follows: 27 women (10%) were underweight, 94 women (34.8%) were average weight, 45 women (16.7%) were overweight, and 104 women (38.5%) were obese. There were no pre-eclampsia patients in the pre-eclampsia BMI categories of 18 and 18.5–22.9, that is, underweight and normal BMI. Three pre-eclampsia patients were overweight (23–24.9) and eight were in the pre-pregnancy BMI level of 25, including obese people. The obtained P-value of 0.0245 is significant. There were no pre-eclampsia patients in the pre-pregnancy BMI categories underweight (18.5) and normal (18.5–22.9).

In the overweight pre-pregnancy BMI category, three patients had MP, that is, MP, none had SP, and three LOP instances, but no EOP patients were reported. Seven pre-eclamptic women in the obese (25 BMI) category pre-pregnancy developed MP, while one patient had MP after delivery. This group included seven cases of LOP, one case of SP, and one of EOP. P-value is significant at 0.0397.

Limitations
Due to a 6-month time limit, it could not collect maternal weight during different trimesters of pregnancy.

RECOMMENDATION
It is suggested that the same study be repeated with maternal weight taken into account during different trimesters of pregnancy.

CONCLUSION
This study concluded that a high pre-pregnancy BMI is an independent risk factor for pre-eclampsia and that there is a positive relationship between pre-pregnancy BMI and pre-eclampsia. Pre-eclampsia has a significant influence on women and their new-borns. According to the findings, it is critical to educate women in the fertile age group about maintaining a healthy weight. This can accomplish through adequate monitoring, nutritional counseling, and other measures that may assist in maintaining a healthy BMI and preventing pre-eclampsia and cardiovascular disease.

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