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Original Article

Obstetrics and Gynaecology Section

Impact of Body Mass Index and Height on Hypertensive Disorders in Pregnancy

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ABSTRACT

Introduction: Hypertension is common cause of morbidity and mortality in pregnant females. Hence, prevention and management of preeclampsia is necessity. Maternal Body Mass Index (BMI) and preeclampsia are inter-related. South Asian females are prone to obesity.

Aim: To find relation among maternal BMI, height and gestational hypertension or preeclampsia, and to assess the severity of hypertensive disorders during pregnancy and maternal and foetal outcomes.

Materials and Methods: This prospective observational cohort study was conducted in Department of Obstetrics and Gynaecology in Vardhman Mahavir Medical College and Safdarjung Hospital (tertiary care hospital), Delhi, India, from September 2013 to December 2014. The study involved pregnant women with gestational age less than 14 weeks. After registration, body weight and height of all the subjects were measured during the first prenatal visit and recorded. Blood pressure was measured at every antenatal visit. The subjects were followed-up once monthly till 32 weeks, every 15 days till 36 weeks and weekly thereafter till delivery. To compare the baseline parameters between the two groups of patients, Chi-square test was used for categorical variables. A two-sided p-value <0.05 was statistically significant. To find out the correlation between BMI and height with pregnancy Pearson correlation coefficient test was used.

Results: Total 375 consecutive pregnant women, 44 were lost to follow-up, hence, 331 were followed-up. Obese group constituted 21.8%, majority (38.1%) had normal BMI. Overweight/obese women suffered hypertensive complications more than normal and underweight women (p-value=0.001). Short height (<150 cm) pregnant females were more prone to develop hypertensive complications (p-value=0.03). The BMI (as continuous variable) was positively correlated with Pregnancy Induced Hypertension (PIH) (r=0.351; p-value <0.0001). As BMI increases, the PIH severity increases (p-value <0.0001). However, height (as continuous variable) of the patients was negatively correlated with PIH severity (r=-0.170; p-value=0.002) and as the height of patient decreases, risk of PIH severity increases.

Conclusion: Short stature and high BMI pregnant females are more prone to develop hypertensive disorders and preeclampsia. Preconception prior counselling regarding weight optimisation is must.

Keywords: Blood pressure, Foetal outcome, Intrauterine growth retardation, Obesity, Preeclampsia

INTRODUCTION

Hypertension is one of the most common medical complications during pregnancy and it is a leading cause of maternal and perinatal mortality and morbidity. Preeclampsia affects 2-8% of all pregnancies [1]. Globally, more than 287,000 women die each year due to pregnancy related causes 10-15% of the mortalities are due to preeclampsia [2]. Maximum number of these deaths occur in low and middle income countries, hence both prevention and management of preeclampsia in pregnancy plays a crucial role in reducing maternal mortality [3]. The effects of hypertensive disorders are not only on mother but also on foetuses leading to Intra Uterine Growth Retardation (IUGR) or intrauterine death. Hypertensive Disorders of Pregnancy (HDP) predisposes to an elevated risk of hypertension, cardiovascular diseases and metabolic diseases later in life [4]. The HDP has been associated with various other metabolic alterations in body leading to cardiovascular and metabolic complications later in life [5].

Obesity has also been associated with Cardiovascular Disease (CVD). Studies have shown that maternal weight and preeclampsia has progressive risk and varies from 4.3% in women with a BMI <19.8 kg/m^2, up to 13.3% for women with a BMI ≥35 kg/m^2 [6-8]. Developing countries are increasingly vulnerable to worldwide epidemic of obesity [9]. Several studies have stated that evaluation of CVD risk factors before pregnancy predict preeclampsia [10]. There are many studies in high income countries showing that maternal prepregnancy obesity is associated with adverse pregnancy-related outcomes such as hypertension, preeclampsia, gestational diabetes, more frequent caesarean delivery, delivery of large-for-gestational age infants, and stillbirths [11-13]. However, very few studies in low-middle income countries have evaluated the impact of BMI on pregnancy outcomes [14,15].

Evidence shows that short stature is a risk factor for CVD [16]. Thus, short stature may also be a risk factor for preeclampsia. However, only few studies have assessed the association between height and risk of preeclampsia [17]. It would be clinically beneficial to evaluate the role of short stature in risk assessment for preeclampsia [18].

Height and weight being important anthropometric measurements, have been used to assess the risks associated with being overweight and underweight and are important in various screening and monitoring programmes [19]. Evidences have shown that South Asian women when compared with European women have increased abdominal obesity in spite of being within normal range of BMI [20]. An association between maternal BMI and preeclampsia has been studied but whether BMI has an effect on development of gestational hypertension or preeclampsia is debated [21]. Studies have shown that the South East Asian women have an overall shorter height than the Caucasian population [22]. Correlation between BMI and hypertensive disorders in pregnancy thus have important implications for pregnancy outcome and there are only few studies in Indian population [14,15,23]. Perhaps no study has

been done on north Indian population depicting any impact of BMI on hypertensive disorders in pregnancy.

Aim of this study was to find the correlation of maternal BMI and height in development of gestational hypertension and preeclampsia or eclampsia during pregnancy.

MATERIALS AND METHODS

This was a prospective observational cohort study conducted in Department of Obstetrics and Gynaecology from September 2013 to December 2014 in Vardhman Mahavir Medical College (VMMC) and Safdarjung Hospital, Delhi, India, which is a tertiary care academic institute. Ethical clearance was obtained from Institute Ethics Committee (IEC/VMMC/SJH/38) and followed Helsinki guidelines and its later recommendations for recruiting patients. Informed consent was taken from patients before recruitment of the patients.

Inclusion criteria: All pregnant females attending the antenatal clinic of the hospital with aged between 20-30 years, singleton pregnancy, having period of gestation less than 14 weeks, who were willing to participate, who wanted to continue the pregnancy, who were willing for institutional delivery at term were included in the study.

Exclusion criteria: Antenatal women with multiple gestation, molar pregnancy, history of chronic hypertension, history of systemic disorders like diabetes mellitus, renal disease, and thyroid disorders were excluded from the study.

Procedure

After registration, body weight and height of all the subjects were measured during the first prenatal visit and recorded. If the first visit was after 14 weeks gestation, any proven record of prepregnancy weight or weight up to 14 weeks was noted. These were noted in predesignated proforma and BMI calculated. According to World Health Organisation (WHO) criteria, women's BMI was categorised as Underweight (<18.5 kg/m^2),

- Normal (18.5-25.0 kg/m^2),
- Overweight (25.1-30.0 kg/m^2) and
- Obese (>30.0 kg/m^2) [24].

However, due to ethnic variations and higher prevalence of diabetes and cardiovascular diseases in Indian populations, BMI guidelines were revised [25,26]. The revised guidelines categorise overweight as a BMI of 23-24 kg/m^2 and obesity as a BMI ≥25 kg/m^2 using values lower than the ethnic specific BMI previously advocated for Indians [27]. The revised guidelines for BMI were used in this study. All women were subjected through a detailed history, general, systemic, and obstetric examination, and routine blood investigations. The subjects were followed-up once monthly till 32 weeks, every 15 days till 36 weeks and weekly thereafter till delivery.

Blood pressure was measured at every antenatal visit. Blood pressure (≥140/90 mmHg) after 20 weeks of gestation with proteinuria ≥300 mg/24 hours or ≥1+ dipstick in previous normotensive and non proteinuric patients was considered to have preeclampsia [28]. (Mild Preeclampsia BP ≥140/90-159/109. Severe Preeclampsia BP ≥160/110).

Onset of preeclampsia was classified as: early onset preeclampsia (<34 weeks) and late onset preeclampsia (>34 weeks) [29]. Severity of preeclampsia was recorded as mild and severe as per standard definitions [28].

Outcome measures: The outcome of interest was development of gestational hypertension, preeclampsia and eclampsia.

- The primary outcome of interest was development of gestational hypertension, preeclampsia and eclampsia.
- Secondary outcomes measured were associated maternal morbidity like abruptio- placentae, Haemolysis, Elevated Liver enzymes, and Low Platelet count (HELLP) Syndrome, preterm labour and mode of delivery.

STATISTICAL ANALYSIS

The baseline data were recorded as number (%) or mean±SD or median (range) as appropriate. To compare the baseline parameters between the two groups of patients, Chi-square test was used for categorical variables. A two-sided p-value <0.05 was statistically significant. To find out the correlation between BMI and height with pregnancy Pearson correlation coefficient test was used. Data were analysed using IBM Statistical Package for the Social Sciences (SPSS) Statistics software (version 21.0, Chicago, IL, USA).

RESULTS

A total of 375 consecutive women attending Outpatient Clinic who met all inclusion criteria were recruited in the study. The results are from 331 patients as 44 were lost to follow-up.

Out of 331 patients, a total of 73 (22.1%) were underweight, 60 (18.1%) were overweight, 72 (21.8%) were obese and remainder 126 (38.1%) had normal BMI. Most of the study subjects who were in the age group of 21-30 years had normal BMI, in the age group of less than or equal to 20 years had low BMI, and in the age group of more than 30 years had high BMI. Most of the women in the lower socio-economic group were underweight. Those who were normal or underweight had more chances of delivery at term as compared to underweight or obese patients and the result was statistically significant (p-value=0.007) [Table/Fig-1].

Variables	Body Mass Index (BMI) category				p-value
	Underweight (n, %)	Normal (n, %)	Overweight (n, %)	Obese (n, %)	
Age					
≤20 years	11 (34.4%)	10 (31.2%)	7 (21.9%)	4 (12.5%)	0.055
21-25 years	41 (21.9%)	81 (43.3%)	30 (16%)	35 (18.7%)	
26-30 years	19 (20.2%)	32 (34%)	18 (19.1%)	25 (26.6%)	
>30 years	2 (11.1%)	3 (16.7%)	5 (27.8%)	8 (44.4%)	
Education status					
Illiterate	3 (11.5%)	7 (26.9%)	10 (38.5%)	6 (23.1%)	0.077
Primary	23 (25.6%)	32 (35.6%)	14 (15.6%)	21 (23.3%)	
High school	38 (21.8%)	74 (42.5%)	24 (13.8%)	38 (21.8%)	
Graduate	9 (22%)	13 (31.7%)	12 (29.3%)	7 (17.1%)	
Socio-economic status					
Lower	9 (27.3%)	6 (18.2%)	7 (21.2%)	11 (33.3%)	0.065
Upper lower	21 (16.9%)	57 (46.0%)	19 (15.3%)	27 (21.8%)	
Lower middle	35 (27.8%)	41 (32.5%)	23 (18.3%)	27 (21.4%)	
Upper middle	8 (16.7%)	22 (45.8%)	11 (22.9%)	7 (14.6%)	
Upper	0	0	0	0	
Parity					
Primigravida	43 (24.9%)	67 (38.7%)	33 (19.1%)	30 (17.3%)	0.39
Second gravida	21 (17.6%)	46 (38.7%)	22 (18.5%)	30 (25.2%)	
Multigravida	9 (23.1%)	13 (33.3%)	5 (12.8%)	12 (30.8%)	
Period of gestation					
Term	69 (94.5%)	114 (90.5%)	53 (88.3%)	55 (76.4%)	**0.007**
Preterm	2 (2.7%)	3 (2.4%)	1 (1.7%)	10 (13.9%)	
Posterm	2 (2.7%)	9 (7.1%)	6 (10.0%)	7 (9.7%)	
Mode of delivery					
Vaginal delivery	69 (94.5%)	121 (96.0%)	57 (95.0%)	54 (75.0%)	**0.001**
Caesarean	2 (2.7%)	5 (4.0%)	2 (3.3%)	13 (18.1%)	
Instrumental	2 (2.7%)	0	1 (1.7%)	5 (6.9%)	

[Table/Fig-1]: Distribution of study subjects according to their demographic profile and BMI (N=331).

The IUGR was more common in obese as well as underweight. The NICU admission was also more in obese patient as compared to patients with normal BMI, and the result was statistically significant

(p-value=0.001) [Table/Fig-2]. It was seen that overweight and obese women had more tendency to develop hypertensive disorders in pregnancy as compared to normal and underweight women and the result was statistically significant (p-value=0.001) [Table/Fig-3]. There is an association between maternal BMI and preeclampsia. Maternal complications like abruption and PPH was found more in obese whereas preterm labour pains were found more in underweight patient and the result was statistically significant (p-value=0.03) [Table/Fig-4].

Body Mass Index (BMI) category	Foetal outcome				p-value
	Normal	Low birth weight	IUGR	NICU admission	
Underweight	63 (86.3%)	1 (1.4%)	8 (11.0%)	1 (1.4%)	0.001
Normal	119 (94.4%)	4 (3.2%)	2 (1.6%)	1 (0.8%)	
Overweight	59 (98.3%)	0	1 (1.7%)	0	
Obese	57 (79.2%)	4 (5.6%)	7 (9.7%)	4 (5.6%)	

[Table/Fig-2]: Association between BMI of study subjects and the foetal outcome (N=331).
IUGR: Intrauterine growth retardation; NICU: Neonatal intensive care unit

Variables	Status of hypertensive disorders				p-value
	No HDP	PIH	Mild PE	Severe PE	
Body mass index category					
Underweight	70 (95.9%)	2 (2.7%)	1 (1.4%)	0	0.001
Normal	109 (86.5%)	9 (7.1%)	6 (4.8%)	2 (1.6%)	
Overweight	51 (85.0%)	5 (8.3%)	4 (6.7%)	0	
Obese	45 (62.5%)	16 (22.2%)	7 (9.7%)	4 (5.6%)	
Height					
<150 cm	57 (74.0%)	11 (14.3%)	5 (6.5%)	4 (5.2%)	0.03
≥150 cm	218 (85.8%)	21 (8.3%)	13 (5.1%)	2 (0.8%)	

[Table/Fig-3]: Association of BMI and height with development of hypertensive disorders in pregnancy (N=331).
HDP: Hypertensive disorders of pregnancy; PIH: Pregnancy induced hypertension, PE: Preeclampsia

Variables	Complication associated with pregnancy				p-value
	No complication	Abruption	PTLP	PPH	
Body mass index category					
Underweight	67 (91.8%)	1 (1.4%)	4 (5.5%)	1 (1.4%)	0.03
Normal	114 (90.5%)	6 (4.8%)	2 (1.6%)	4 (3.2%)	
Overweight	57 (95.0%)	0	1 (1.7%)	2 (3.3%)	
Obese	57 (79.2%)	6 (8.3%)	2 (2.8%)	7 (9.7%)	
Height					
<150 cm	63 (81.8%)	4 (5.2%)	3 (3.9%)	7 (9.1%)	0.056
≥150 cm	232 (91.3%)	9 (3.5%)	6 (2.4%)	7 (2.8%)	

[Table/Fig-4]: Association between BMI and height of study subjects and the complications during their pregnancy (N=331).
*p-value less than 0.05 is significant

It was found that women above 150 cm had less chances of developing hypertensive disorders in pregnancy as compared to women with height less than 150 cm and the result was statistically significant (p-value=0.03) [Table/Fig-3]. It means shorter height is a significant risk factor for development of hypertensive disorders in pregnancy. Short statured women had slightly more maternal complications like PPH and abruption but it was not statistically significant [Table/Fig-4]. No significant relation found between short heighted women and foetal complications in pregnancy [Table/Fig-5]. BMI (as continuous variable) was positively correlated with pregnancy induced hypertension (r=0.351; p-value <0.0001). As BMI increases, the PIH severity increases (p-value <0.0001). However, height (as continuous variable) of the patients was negatively correlated with PIH severity (r=-0.170; p-value=0.002) and as the height of patient decreases, risk of PIH severity increases [Table/Fig-6].

Height	Foetal outcome				p-value
	Normal	Low birth weight	IUGR	NICU admission	
<150 cm	67 (87.0%)	2 (2.6%)	6 (7.8%)	2 (2.6%)	0.5
≥150 cm	231 (90.9%)	7 (2.8%)	12 (4.7%)	4 (1.6%)	

[Table/Fig-5]: Association of height with foetal outcome in study subjects (N=331).
*p-value less than 0.05 is significant

PIH categories	No. of patients	Height (cm)	r-value, p-value	BMI (kg/m^2)	r-value, p-value
No HDP	275	1.48±.07	-0.170, **0.002**	21.64±4.27	0.351, **<0.0001**
PIH	32	1.47±.06		25.90±6.34	
Mild PE	18	1.44±.10		26.55±6.91	
Severe PE	6	1.42±.11		28.03±7.33	
Total	331	1.48±.07		22.47±5.09	

[Table/Fig-6]: Correlation of BMI and height with development of hypertensive disorders in pregnancy (N=331).
HDP: Hypertensive disorders of pregnancy; PIH: Pregnancy induced hypertension; PE: Preeclampsia

DISCUSSION

Obesity has large impact on pregnancy outcome and this study provides better understanding of the impact of obesity on maternal and newborn health in Indian population [11]. Obesity increases the risk of preeclampsia 2 to 3 folds [30]. With the increasing BMI risk of preeclampsia increases significantly concurrence with this study [31]. In this study, the incidence of developing any form of HDP was more in overweight and obese women as compared to women with normal BMI, and this result was statistically significant (p-value=0.001). Similarly in a cohort study done by Baeten JM et al., in 2001, it was found that in women with BMI more than 30 kg/m^2 were 3.3 times more likely to develop preeclampsia as compared to women with BMI less than 20 kg/m^2 [32]. In a systematic review, it was seen that the risk of preeclampsia was doubled for each 5-7 unit increase in prepregnancy BMI [33].

The caesarean section rate increased, along with maternal BMI, as shown in most studies including the present study. The fact that obesity is now more frequent in the obstetric population has resulted in a renewed interest in the effects of weight on the risk of caesarean delivery. Liu X et al., was found that when compared with women of normal BMI, the risk of caesarean section {1.47 (1.27-1.70), 2.51 (1.97-3.20)} was significantly increased in overweight and obese women and expressed as {adjusted RR (95% confidence interval)}, respectively [34]. In another meta-analysis the effect of obesity on the risk of caesarean section was seen and compared with women with normal BMI, overweight, obese and morbidly obese women were 1.53 (95% CI: 1.48-1.58), 2.26 (95% CI: 2.04-2.51) and 3.38 (95% CI: 2.49-4.57) times more likely to have a caesarean section, respectively [35].

The IUGR was more common in overweight as well as underweight in the present study. In another Indian study by Sahu MT et al., it was found that the occurrence of IUGR had no specific relation to any BMI group although it was more common in underweight group [36]. The NICU admission and other foetal and neonatal complications were also more in obese patient as compared to patients with normal BMI in the present study. Studies have found an association of intrauterine death, birth asphyxia and other neonatal complications among obese pregnant women [37,38].

The present study showed that, the chances of maternal complications were less in normal patients as compared to obese patients [Table/Fig-4]. Abruptio placentae and PPH was found more in the obese, whereas preterm labour was found more in underweight patient and was statistically significant (p-value=0.03). This was concurrent with other studies [16,19].

In this study, height was also studied as an independent risk factor for development of HDP. Only 23.3% patients belonged to height

less than 150 cm, rest 76.7% were above 150 cm height. We found that height less than 150 cm is a risk factor for development of hypertensive disorders in pregnancy and the result was statistically significant (p-value=0.003). Studies have reported association between short stature and increased risk of severe preeclampsia especially in multiparas [22]. But in the present study, no such relation of severe preeclampsia in short statured women who were multipara was found.

In a retrospective case control study, it was found that increased BMI lead to subsequent development of gestational hypertension and the severity of preeclampsia increased with increased BMI [18]. They found no association between short stature and risk of preeclampsia. However, in this study short stature has been shown to be a risk factor for preeclampsia and these women are at elevated risk of developing CVD.

This study showed that IUGR was found in 7.8% of short statured women and 4.7% of women with height more than150 cm, but these results were not significant (p-value=0.5) [Table/Fig-5]. Thus, no relation was found between short heighted women and foetal complications in pregnancy. In 2006, a study found that being underweight was correlated more with foetal growth restriction (p-value=0.001) but not being under height [39].

Limitation(s)

This study was done in a tertiary care hospital. More studies involving bigger population needs to be done for defining exact correlation between BMI and its impact on pregnancy outcomes and making strategies for preventing maternal and foetal complications. Ideally, BMI is calculated using the prepregnancy weight, however such data are often missing in the routine antenatal records and this leads to recall bias. In this study, weight recorded in the early pregnancy has been taken for calculating the BMI to overcome this bias as far as possible.

CONCLUSION(S)

High BMI and short stature is a significant risk factor for development of hypertensive disorder of pregnancy. It seems reasonable to suggest that prepregnancy counselling regarding maternal weight should be done, regarding weight loss or gain. Further, those pregnant women below 150 cm height should alert the physician to be on constant vigil. Since prepregnancy counselling is not much popular, BMI should be calculated at booking for every pregnant lady and watchful care should be provided to both lean and obese. Women should be encouraged to optimise weight prior to conception.

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