Maternal Obesity and Energy Intake as Risk Factors for Pregnancy Induced Hypertension among Iranian Women

Elham Kazemian¹, Gity Sotoudeh², Ahmad Reza Dorosti-Motlagh³, Mohammad Reza Eshraghian¹ and Minoo Bagheri²

¹Department of Nutritional Sciences, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
²Department of Nutritional Sciences, School of Public Health, Tehran University of Medical Sciences, Poursina Avenue, Tehran, 14155-6446, Iran
³Department of Statistics and Epidemiology, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

Abstract

**Background:** Pregnancy induced hypertension is an abnormality causing striking maternal, fetal and neonatal mortality and morbidity in the world. The aim of present study was to assess pre pregnancy BMI and gestational weight gain beside energy intake during pregnancy as risk factors for developing gestational hypertension.

**Methods:** A case-control study was conducted at Shahid Akbarabadi Hospital of obstetrics and gynecology in south of Tehran

**Results:** Women who were obese (Odds Ratio (OR): 4.44; 95% Confidence Intervals (CI): 1.84-10.72) before pregnancy were more likely to develop gestational hypertension compared with women who had normal pre-pregnancy BMI. Also having excessive gestational weight gain proportion was positively and significantly associated with development of gestational hypertension (OR, 2.70; 95% CI: 1.96-3.21). Furthermore, findings of present study revealed that women who were in highest quartile of energy intake positively related with increased risk of gestational hypertension (OR, 9.66; 95% CI: 3.30-28.21).

**Conclusion:** The results of present investigation suggest pre pregnancy obesity, excessive gestational weight gain and increased intake of energy as potential risk factors for developing gestational hypertension.

**Keywords:** Gestational hypertension; Gestational weight gain; Pre-pregnancy Body Mass Index; Pregnancy; Energy intake.

Introduction

Pregnancy Induced Hypertension (PIH) is an abnormality causing striking maternal, fetal and neonatal mortality and morbidity both in developed and developing countries [1]. PIH is observed in forms of gestational hypertension, preeclampsia and eclampsia [1]. Preeclampsia and gestational hypertension are found in 5-10% of pregnancies in the world [2]. Increase in cesarean section, premature placenta abruption, preterm delivery, low birth weight, stillbirth, acute renal failure and intravascular coagulation were more frequently observed in women who developed hypertensive disorders of pregnancy [3,4]. Recent studies have indicated higher risk of PIH among women with family history of hypertension, previous history of pregnancy induced hypertension, pre-existing diabetes, gestational diabetes mellitus, maternal age ≥ 40, multiple pregnancies, nulliparity and pre pregnancy obesity [5-10].

Some Prior studies have suggested that higher pre pregnancy body mass index is associated with increased risk of gestational hypertension and preeclampsia [11-15]. However there are few studies in which this association were not observed [16]. Also, excessive gestational weight gain has been proposed as a risk factor for hypertensive disorders of pregnancy in some studies [17-20]. PIH is accompanied by endothelial dysfunction, oxidative stress and inflammatory responses [1]. It has been claimed that plasma C-reactive protein concentration, which may be involved in etiology of hypertensive disorder of pregnancy increased in obesity. Furthermore, some evidence has indicated that obesity increased endothelial function and prompted systematic inflammatory responses associated with atherosclerosis which could play a role in PIH [21]. However, previous studies are limited by improper classification of gestational weight gain sometimes by restricting study population to subjects of same BMI category and also none of these studies evaluate energy intake of subjects alongside other measurements which defantly lead to more accurate determination [19,20]. Although risk factors for developing gestational hypertension may differ among various ethnic groups [22] there are few data with regard to this issue in Iranian population. So the aim of existing observational study was to compare pre pregnancy body mass index, mid arm circumference, gestational weight gain and energy intake of women who developed gestational hypertension with those of healthy pregnant women.

Materials and Methods

Subjects and study design

Current research was a case control study which has been carried out in Shahid Akbarabadi hospital of obstetrics and gynecology in south of Tehran (This is a referral hospital which many pregnant women have referred to this center) from January through May 2011. Patients referring to current hospital whom were diagnosed with gestational hypertension by physician were assessed to determine that whether, they had met exclusion criteria of present study or not.

*Corresponding author: Gity Sotoudeh, Department of Nutritional Sciences, School of Public Health, Tehran University of Medical Sciences, Poursina Avenue, Tehran, 14155-6446, Iran, Tel: +9821- 88951395, Fax: +9821- 88974462; E-mail: gsotodeh@sina.tums.ac.ir

Received August 03, 2012; Accepted October 18, 2012; Published October 23, 2012


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Having multiple gestations, chronic hypertension, diabetes, cardiovascular or renal diseases were considered as exclusion criteria in present investigation. Subjects who had these exclusion criteria were not allowed to enter the study. Also, pregnant women whose first prenatal care visits were after 12 weeks of gestation were excluded. Systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥ 90 mmHg which occur after 20 weeks of gestation for a first time was defined as gestational hypertension according to the National High Blood Pressure Education Program Working Group [23]. Controls were women without gestational hypertension who referred to the clinic of this hospital for their prenatal care visits or were hospitalized at prenatal section of this center for other reasons and were matched to cases for gestational age. The same procedure and exclusion criteria were applied for recruitment of cases. Sample size was calculated on the basis of one previous study assessed nutritional statuses of preeclamptic women in Iranian population. We assume that if the pre-pregnancy BMI of preeclamptic women was different from non preeclamptic women, the hypothesis suggesting equal pre-pregnancy BMI between cases and controls could be rejected with power of 80% and significance level of 1.96. Following formula was applied to calculate sample size of present study.

\[ n = \left( \frac{Z_{1-\alpha} + Z_{\beta}}{d} \right)^2 \]

Ultimately, this study has been conducted on 113 women with gestational hypertension and 150 healthy pregnant women. The study was approved by the Ethics Committee of Tehran University of Medical Sciences and all participants were informed and provided written consent. Subjects were interviewed for sociodemographic information including maternal age, gestational age, parity, abortion, gravity, Pregnancy interval, Family history of hypertension, previous pregnancy hypertension, sleep hours per day, number of prenatal care visit, education and occupation by trained interviewers.

**Anthropometric measurement**

Pre-pregnancy weight was self reported and patients were asked to report their weight at last menstrual period at the time of data collection. Weight at first prenatal care visit was registered from medical record and compared with pre pregnancy weight. If subjects did not meet the criteria of 0.2-3.8 kg weight gain during first four-week period of pregnancy reported by previous research [24], they were excluded from the study. Height was measured by Seca stadiometer in a position which person was standing directly, feet together and without shoes. Heels, buttocks and upper back were in contact with the wall when the measurement was made. Pre-pregnancy BMI (weight/height (m)²) was calculated based upon measured height and self-reported pre-pregnancy weight. BMI was categorized according to 2009 IOM classification: Underweight (BMI < 18.5), normal weight (BMI 18.5–24.9), overweight (BMI 25.0–29.9), and obese (BMI ≥ 30.0) [25]. In addition, weight was measured at the time of data collection by Portable digital Seca scale in condition which subject was without shoes and minimally clothed. Gestational weight gain was calculated by subtracting pre-pregnancy weight from the weight which was measured at the time of data collection. Also gestational weight gain proportion was derived by observed gestational weight gain divided by expected weight gain at the moment of gestational age. According to 2009 IOM guidelines a weight gain of 0.44 to 0.58 kg/wk for women with a pre-pregnancy BMI of less than 18.5 kg/m²; 0.35 to 0.50 kg for women with a pre-pregnancy BMI of 18.5 to 24.9 kg/m² and 0.23 to 0.33 kg for women with a pre-pregnancy BMI of 25.0 to 29.9 kg/m² are suggested. The recommendation for obese women (BMI > 29.9 kg/m²) is 0.17 to 0.27 kg/wk. It should be noted that recommended weight gain at first trimester for women with a pre-pregnancy BMI of less than 30 kg/m² and women with a pre-pregnancy BMI of more than 30 kg/m² are 2 kg and 1.5 kg respectively [25]. Mid arm circumference is the circumference of the left upper arm, measured at midpoint of the distance from the acromion process of the shoulder to the tip of the olecranon process of the mid-elbow.

**Energy intake assessment**

A Semi-Quantitative Food Frequency Questionnaire (SFFQ) was utilized to assess energy intakes of subjects. The average frequency consumption of food "during three months before", coinciding with their first mid pregnancy, were asked. The SFFQ used consisted of 148 items food with standard serving size validated in the Tehran lipid and glucose study [26]. Finally, energy intakes of participants were calculated by nutritionist III software modified for Iranian foods.

**Statistical analysis**

Mean levels of quantitative variables were estimated for women developing gestational hypertension and healthy pregnant women. Normal distribution of each variable was assessed by Kolmogorove-smirnov test. Quantitative variables between groups were compared by Student t test or Mann-whitney U test whereas chi-square test was used to compare qualitative variables. Multivariable logistic regression was used to determine an association of pre-pregnancy BMI, gestational weight gain, mid arm circumference and energy intake with development of gestational hypertension. Any covariate that showed significant difference between two groups retained in the final model. Indeed, Estimates were matched for Age, abortion, gravity, Pregnancy interval, Family history of hypertension, previous pregnancy hypertension and education and matched Odds ratios (ORs) and 95% confidence intervals (CIs), as well as the P value were reported. Age, abortion, gravity, Pregnancy interval, pre-pregnancy BMI, family history of hypertension, previous pregnancy hypertension and education were included as covariates in the final model. All data analysis was performed by using SPSS version 11.5 (SPSS Inc, Chicago IL, Version 11.5).

**Result**

Sociodemographic features of participant are shown in table 1. The mean age, parity, abortion, gravity and Pregnancy interval of healthy pregnant women were significantly lower than women with gestational hypertension (p value<0.05). Women developing gestational hypertension were more prone to have family history of hypertension and previous history of gestational hypertension (p value<0.001). We found that 34% of women developing gestational hypertension and 23% of healthy pregnant women were illiterate or had primary education (p value<0.05). Number of prenatal care visits, sleep hours, occupation and nulliparity were not significantly associated with risk of gestational hypertension.

Table 2 shows Anthropometric measurements and energy intake of subjects. All anthropometric measurements, excluding height, in women who developed gestational hypertension were significantly higher than healthy pregnant women (p value<0.05). Also higher intake of energy was observed in case group compared with controls (p value<0.05).

Adjusted odds ratio in the different pre-pregnancy BMI groups as well as different gestational weight gain proportion groups, mid arm circumference and energy intake quartile are shown in table 3. Women of normal weight were considered as the reference group. Women who...
were obese (OR, 4.44; 95% CI: 1.84-10.72) before becoming pregnant were more likely to develop gestational hypertension compared with those who had normal pre-pregnancy BMI. Additionally, having excessive gestational weight gain was positively and significantly associated with development of gestational hypertension (OR, 2.70; 95% CI: 1.19-6.13). Furthermore, findings of present study revealed that women who were in highest quartile of mid arm circumference had an almost 9-fold increased risk of gestational hypertension compared with women in lowest quartile (OR, 8.93; 95% CI: 2.16-36.93). Regarding energy intake, the study revealed that women of highest quartile of energy intake were approximately 9 times more likely to develop gestational hypertension as opposed to women in lowest quartile (OR, 9.66; 95% CI: 3.30-28.21).

### Discussion

In this case control study we found that patients with pre pregnancy BMI more than 30 kg/m² had a nearly 4.5 -fold risk to develop gestational hypertension compared with pregnant women whose pre pregnancy BMI were in the normal range. Furthermore, subjects with gestational weight gain more than recommended amount had an approximate 3-fold risk of gestational hypertension compared to those who had normal gestational weight gain. Also the result of present study revealed a somewhat higher risk of gestational hypertension with increased mid arm circumference and energy intake during pregnancy. Totally our findings have suggested obesity as a risk factor for development of gestational hypertension.
Furthermore, we found mean maternal weight gain of 1.9 kg (data not shown) by Oken et al. [24]. However, a lot of interindividual coefficient of 0.99 between self-reported and measured pre-pregnancy weight. An overall correlation nearly 4 and 3 fold respectively [20].

Women from Latin America observed that excessive gestational weight gain was assessed for each group. Moreover, Fortner et al. in a study which was conducted on weight gain and gestational hypertension and preeclampsia [16-20]. Researches have indicated the direct association between gestational gain and hypertensive disorders of pregnancy. However some previous studies have investigated obesity as a potential risk factor for developing gestational hypertension was energy intake of participants which assist us to draw a conclusion. We found that Not only did higher gestational weight gain proportion increase the risk of pregnancy induced hypertension but also women who were in highest quintile of energy intake had increased risk of developing this syndrome. This result directed us to conclude that observed higher gestational weight gain proportion among cases were originated from higher intake of energy during pregnancy supporting that increase of maternal fat or muscle contributed in etiology of gestational hypertension.

The results of present research associated with pre pregnancy BMI are in the same direction with the observed relationship between pre-pregnancy BMI and PIH in other studies which were performed in different countries [12,13,15,17,19-21,27,28]. However, In one study conducted by Tabandeh et al. [16] in Iranian population no significant association was found between pre-pregnancy BMI and the risk of preeclampsia [16]. Inadequate number of patients developing preeclampsia was one of the main limitations of this study. In a great number of studies, BMI was classified according to those issued in 1990 IOM guidelines which differ in BMI categories with the new guidelines of this Institute. Also newly published guidelines of IOM recommend relatively narrow range of gestational weight gain for obese women. In present investigation BMI classification and gestational weight gain judgment was made in accordance with the recently published guidelines of IOM and afterwards the risk of developing gestational hypertension was assessed for each group.

Few studies have investigated the association of gestational weight gain and hypertensive disorders of pregnancy. However some previous researches have indicated the direct association between gestational weight gain and gestational hypertension and preeclampsia [16-20]. Chen et al. reported women with a gestational weight gain of 0.50 kg per week or greater were at increased risk of gestational hypertension [19]. Moreover, Fortner et al. in a study which was conducted on women from Latin America observed that excessive gestational weight gain increased the risk of gestational hypertension and preeclampsia nearly 4 and 3 fold respectively [20].

We calculated gestational weight gain by using measured weight and self-reported pre-pregnancy weight. An overall correlation coefficient of 0.99 between self-reported and measured pre-pregnancy weight was noted by Oken et al. [24]. However, a lot of interindividual variations account for the validity of self-reported pregravid weight. Furthermore, we found mean maternal weight gain of 1.9 kg (data not shown) during the early stages of pregnancy, calculated by self reported pregravid weight and measured weight at first prenatal care visit which was between 8-12 weeks of gestation. Pregnant women were reported to have gained anything from 0.2 kg to 3.8 kg during first four-week period of pregnancy by studies that measured pre-pregnancy weight [29]. Thus, mean maternal weight gain of 1.9 kg (data not shown) in early pregnancy in present investigation was within the range of mean weight gain in early pregnancy reported by previous studies [29]. Indeed, mixture of methods was utilized to minimize this bias.

It could not be decided that whether edema contributed in observed increased gestational weight gain and mid arm circumference in patients developing gestational hypertension or not. Since that, edema has also been observed in up to 80% of normal pregnancies, edema as a criterion for diagnosing hypertensive disorder of pregnancy were eliminated [30-34]. However we did not weight subjects prior the outset of gestational hypertension nor information with regard to presence of edema in cases and controls were available. In view of the fact that this study had case control designs and cause and effect relationship is scarcely determined in case control studies. So it is rather difficult to interpret that whether observed increased gestational weight gain and mid arm circumference among hypertensive women was resulted from fluid retention or increase of fat or muscle.

A highly important factor assessed in present study which has not been investigated in prior study inspecting obesity as a potential risk factor for developing gestational hypertension was energy intake of participants which assist us to draw a conclusion. We found that Not only did higher gestational weight gain proportion increase the risk of pregnancy induced hypertension but also women who were in highest quartile of energy intake had increased risk of developing this syndrome. This result directed us to conclude that observed higher gestational weight gain proportion among cases were originated from higher intake of energy during pregnancy supporting that increase of maternal fat or muscle contributed in etiology of gestational hypertension.

Mahomed et al. reported that women in highest quintile of mid arm circumference (28–39 cm) were more likely (4.4 times) to develop preeclampsia compared with women in lowest quintile (21–23 cm) which is consistent with the result of present study [28].

The possible mechanisms by which obesity could induce hypertensive disorders of pregnancy are not well understood. Nevertheless, some predictable mechanisms through which hypertension were prompted might be due to unfavorable effects of changes such as insulin resistance and elevation of cholesterol and leptin levels which have been observed in obese persons on blood pressure. [35,36]. In addition, both obesity and hypertensive disorders of pregnancy accompanied with oxidative stress, elevated inflammatory markers and dislipidemia [37].

One limitation of present study is its case control design in which cause and effect relationship is not distinguished. Also, we have not measured pregravid weight objectively and we relied on self reported pre-pregnancy weight. An important strength of present investigation was to assess energy intake of subjects as well as anthropometric measurement which help us to interpret result of study more precisely. In addition, in this study both pre pregnancy BMI and weight gain during pregnancy were assessed that were conducted in few previous studies. Additionally, the new guidelines of IOM were used to classify pre pregnancy BMI and interpret gestational weight gain. To conclude, pre pregnancy obesity, excessive gestational weight gain and higher energy intake during pregnancy were noted as modifiable risk factors.

### Table 3: Adjusted odds ratio (OR)* for the effect of Pre pregnancy BMI, gestational weight gain proportion, mid arm circumference and energy intake on development of gestational hypertension.

<table>
<thead>
<tr>
<th>Variable</th>
<th>gestational hypertension vs. normal</th>
<th>Odds ratio</th>
<th>95% confidence interval</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre pregnancy BMI (kg/m²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal weight (18.5–24.9 kg/m²)</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under weight (&lt;18.5 kg/m²)</td>
<td>0.10</td>
<td>0.01-0.94</td>
<td>0.044</td>
<td></td>
</tr>
<tr>
<td>Over weight (25.0–29.9 kg/m²)</td>
<td>1.69</td>
<td>0.79-3.60</td>
<td>0.171</td>
<td></td>
</tr>
<tr>
<td>Obese (&gt;30.0 kg/m²)</td>
<td>4.44</td>
<td>1.84-10.72</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Gestational weight gain proportion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate</td>
<td>0.38</td>
<td>0.10-1.42</td>
<td>0.152</td>
<td></td>
</tr>
<tr>
<td>Excessive</td>
<td>2.70</td>
<td>1.19-6.13</td>
<td>0.017</td>
<td></td>
</tr>
<tr>
<td>Mid arm circumference (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;26</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.1-29</td>
<td>1.86</td>
<td>0.60-5.76</td>
<td>0.280</td>
<td></td>
</tr>
<tr>
<td>29.1-32</td>
<td>4.30</td>
<td>1.18-15.67</td>
<td>0.027</td>
<td></td>
</tr>
<tr>
<td>&gt;32</td>
<td>8.93</td>
<td>2.16-36.93</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>Energy intake (kcal)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2154</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2154-2561</td>
<td>0.652</td>
<td>0.26-1.73</td>
<td>0.575</td>
<td></td>
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<tr>
<td>2562-3036</td>
<td>1.14</td>
<td>1.04-1.25</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td>&gt;3036</td>
<td>9.66</td>
<td>3.30-28.21</td>
<td>&lt;0.001</td>
<td></td>
</tr>
</tbody>
</table>

* Estimates are adjusted for Age, abortion, gravity, Pregnancy interval. Family history of hypertension, previous pregnancy hypertension and education. Adjusted odds ratio for Pre pregnancy BMI, gestational weight gain proportion and mid arm circumference is resulted from separate model.

for development of gestational hypertension in current investigation. It can be suggested that experimental research should be designed to examine that whether improvement of these factors can reduce the risk of gestational hypertension.

Acknowledgment

The present study was supported by the Tehran University of Medical Sciences, Iran, Tehran. We gratefully acknowledge the contributions made to the research by Shahid Akbarbadi hospital staff. We are also thankful to the women who participated in the survey.

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