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Original Article

The relationship between body mass index in late pregnancy and fetomaternal blood flow parameters: A prospective cross-sectional study

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Abstract

Aim: To evaluate a possible relationship between body mass index and fetomaternal blood flow parameters in women with term pregnancy.

Material and Methods: This study was performed on pregnant women undergoing routine third trimester ultrasound scans. Women were divided into four groups [underweight (< 18.5 kg/m2), normal weight (18.5–24.9 kg/m2), overweight (25-29.9 kg/m2) and obese (≥30 kg/m2)]. The uterine artery (UtA), umbilical artery (UA) and middle cerebral artery (MCA) were examined using color Doppler according to the standard protocols. The systole/diastole (S/D) ratio, pulsatility index (PI), and resistance index (RI) values of UtA, UA and MCA were recorded.

Results: All Doppler findings were found to be similar among normal weight, overweight and obese women. There was a positive correlation between UtA-RI and maternal BMI (r=0.350; p<0.01). There was a positive association between both UA-PI and UA-RI values with maternal BMI (r=0.372; p<0.01; r=0.289; p=0.001, respectively). Also, we observed a positive association between both MCA-RI and MCA-S/D values with maternal BMI (r=0.180; p=0.04; r=0.181; p=0.04, respectively).

Conclusion: Normal weight, overweight and obese women with term pregnancy have similar maternal and fetal blood flow parameters. Obese women should be informed about the risks of obesity during pregnancy, and they should be supported to lose weight before conception.

Keywords: Body mass index; doppler ultrasonography; middle cerebral artery; obesity; umbilical artery; uterine artery

INTRODUCTION

Doppler ultrasonography provides noninvasive haemodynamic monitoring in human pregnancy. It is used to assess both the fetal and placental circulation. Also, it is used to predict adverse perinatal outcomes such as fetal growth restriction and preeclampsia. Commonly performed Doppler assessments include that of uterine artery (UtA), umbilical artery (UA), middle cerebral artery (MCA) and ductus venosus. It was reported that maternal and fetal Doppler blood flow parameters may reliably predict adverse perinatal outcomes in obstetric population (1, 2).

Body Mass Index (BMI) is a ratio of weight to height squared (kg/m2). It is widely used as a simple method to classify overweight and obesity in adults. According to the Institute of Medicine, a BMI below 18.5 is considered underweight, 18.5–24.9 is considered a healthy weight, 25.0–29.9 is considered overweight, and 30 or higher is considered obese (3). Obesity is a significant health problem in many developing countries (4, 5). Maternal obesity was reported to be associated with adverse pregnancy outcomes including gestational diabetes, postpartum hemorrhage and stillbirth (6). Also, the risk of preeclampsia was found to be positively associated with a raised BMI (7).

We hypothesized that obesity may affect the fetomaternal

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blood flow negatively. Thus, the aim of this study was to evaluate a possible relationship between BMI in late pregnancy and fetomaternal blood flow parameters in women.

MATERIAL and METHODS

Ethical approval for this study was provided by the Ethical Committee of Ataturk University, Medical Faculty, Erzurum, Turkey. Written informed consent was obtained from all participants. This cross-sectional prospective study was performed on all consecutive pregnant women undergoing routine third trimester ultrasound scans. Patients between 20-40 years with term pregnancy were included in this study. Maternal weight and height were measured, and BMI was calculated and recorded on a dedicated database (3). Women were divided into four groups (n=40, for each group) [underweight (< 18.5 kg/m2), normal weight (18.5–24.9 kg/m2), overweight (25-29.9 kg/m2) and obese (≥30 kg/m2)], according to the World Health Organization based on associated health risks (8). Inclusion criteria were as follows: singleton pregnancy, gestational age ≥ 37weeks, absence of fetal abnormalities and maternal comorbidities. Smokers, alcohol consumers, patients with multiple pregnancies, complicated pregnancies (e.g. preeclampsia, fetal malformation, gestational diabetes mellitus and placenta praevia) and chronic illnesses (e.g. hypertension, diabetes mellitus) were not included in the study.

All the women recruited underwent a feto-maternal assessment at term (≥37 weeks of gestation). Initially, last menstrual period was questioned and gestational age was confirmed according to the crown–rump length at the first ultrasound scan. At the same appointment, a fetal ultrasound examination was performed to confirm gestational age and to detect fetal abnormalities using an Aplio 300 ultrasound system (Toshiba Medical Systems, Tokyo, Japan) with a 3.5-MHz convex probe. The estimated fetal weight (EFW) was calculated from the biparietal diameter, head and abdominal circumference, and femur length using the Hadlock formula (9). Also, the UtA, UA and MCA were examined using color Doppler according to the standard protocols (10-12). To minimize the inter-operator variability, all ultrasonographic scans were performed by the same radiologist (E.G.G.). The radiologist had 5 years of experience in performing obstetric doppler ultrasound examinations. All measurements were made during fetal inactivity, during periods of apnea, and in the absence of uterine contractions, and data was obtained by averaging the value of three consecutive measurements. In all cases, UtA on each side was visualised at the point just distally to the crossover with the iliac artery. Umbilical artery was examined on a free loop of the umbilical cord and MCA was visualised in a transverse axial view of the fetal head. Socio-demographic information (age, body mass index, gravidity, parity, gestational age, weight gain during pregnancy), EFW and amniotic fluid index values were recorded. Also, the systole/diastole (S/D) ratio, pulsatility index (PI), and resistance index (RI) values of UtA, UA and MCA were recorded.

A power analysis for this study was calculated using Russ Lenth's Power and sample size calculation application (13). We aimed to detect a mean difference between the two groups at least as 0.1 SD on Doppler index values. Accordingly, we determined that the number of patients required in every group was 33, based on the power of 95% at 5% significance level. Statistical analysis was performed using Statistical Package for Social Sciences 13.0 for Windows package software (SPSS Inc., Chicago, IL, USA). Data were shown as means ± error standards or number. The normality of variables was tested with the Kolmogorov-Smirnov test. Because of the distribution of all data is normal, one-way ANOVA test with a Bonferroni correction was used to assess the differences in blood flow parameters among groups. A Pearson correlation analysis was performed to detect the relationship between blood flow parameters and maternal BMI, demographic-clinical data and P value <0.05 was considered statistically significant.

RESULTS

One hundred and twenty-three singleton pregnancies were included in this study. Three women were underweight, 40 normal weight, 40 overweight, and 40 obese. Because of the number of underweight pregnant women was

Table 1. Demographic properties of patients in groups

Baseline characteristics	Normal weight	Overweight	Obese	P value
Maternal age (year)	28.22±6.03	29.09±6.08	28.25±6.46	0.834
Maternal BMI (kg/m^2)	23.67±1.05*	27.50±1.47*	31.85±1.81*	<0.01
Gestational age (week)	37.47±0.78	37.70±0.99	37.67±0.84	0.445
Gravidity	2.45±1.37	2.60±1.51	2.40±1.29	0.802
Parity	1.32±1.24	1.47±1.35	1.37±1.16	0.864
Weight gain in pregnancy (kg)	10.65±3.66	12.17±4.49	14.25±6.01**	0.005
Amniotic fluid index	128.77±42.38	116.37±45.76	142.50±56.23	0.059
Estimated fetal weight (g)	3127±292.23	3149±320.19	3286±333.01	0.055

*p<0.01, compared with other groups; **p=0.03, compared with normal weight patients; normal weight: 18.5–24.9 kg/m2; overweight: 25-29.9 kg/m2, and obese: ≥30 kg/m^2

extremely low, we excluded them from the statistical analysis. Demographic and clinical data of groups were presented in Table 1. It was observed that obese pregnant women gained more weight during pregnancy compared to normal weight pregnancies (14.25±6.01, 10.65±3.66; p=0.03, respectively) (Table 1)

As seen in Table 2, all Doppler findings were found to be similar among normal weight, overweight and obese women.

There was a positive correlation between UtA-RI and maternal BMI (r=0.350; p<0.01; Figure 1). There was a positive association between both UA-PI and UA-RI values with maternal BMI (r=0.372; p<0.01; r=0.289; p=0.001, respectively) (Figure 2, 3). Also, we observed a positive association between both MCA-RI and MCA-S/D values with maternal BMI (r=0.180; p=0.04; r=0.181; p=0.04, respectively) (Figure 4, 5). There was no correlation between maternal-fetal Doppler findings and demographic-clinical data.

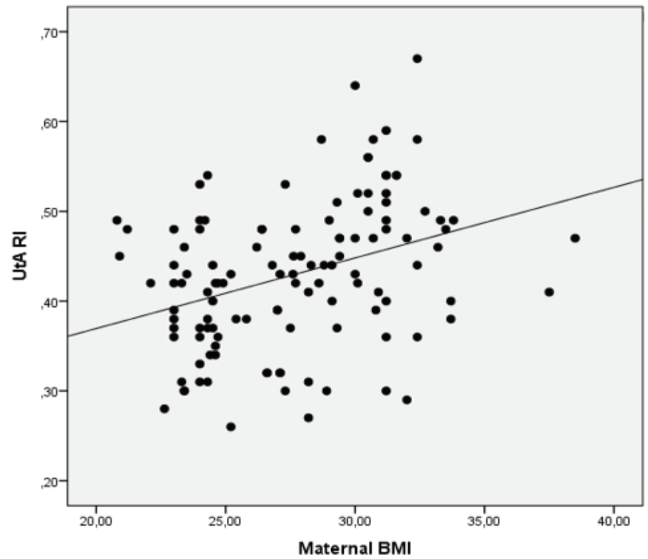

Figure 1. Correlation between Ut-A RI and maternal BMI

Table 2. The comparison of Doppler findings in study groups

	Normal weight	Overweight	Obese	P value
UtA PI	0.92±0.64	0.74±0.30	0.73±0.30	0.106
UtA RI	0.42±0.07	0.44±0.09	0.42±0.08	0.377
UtA S/D	1.82±0.35	1.58±0.50	1.67±0.37	0.964
UA PI	0.95±0.34	0.97±0.20	1.01±0.35	0.530
UA RI	0.57±0.08	0.58±0.08	0.57±0.08	0.306
UA S/D	2.43±0.51	2.56±0.52	2.50±0.71	0.929
MCA PI	1.26±0.43	1.24±0.41	1.22±0.55	0.835
MCA RI	0.72±0.06	0.69±0.09	0.74±0.16	0.107
MCA S/D	3.46±0.87	3.57±1.37	3.82±1.79	0.602

UA: Umbilical artery, MCA: Middle cerebral artery, UtA: Uterine artery

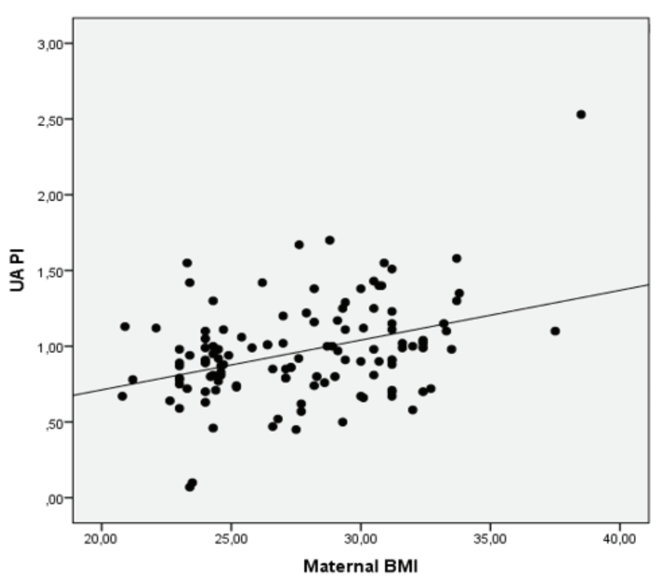

Figure 2. Association of UA-PI with maternal BMI

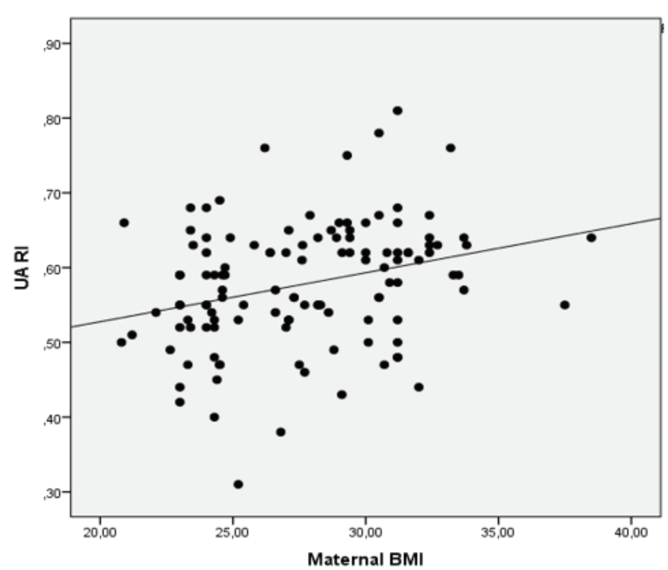

Figure 3. Association of UA-RI with maternal BMI

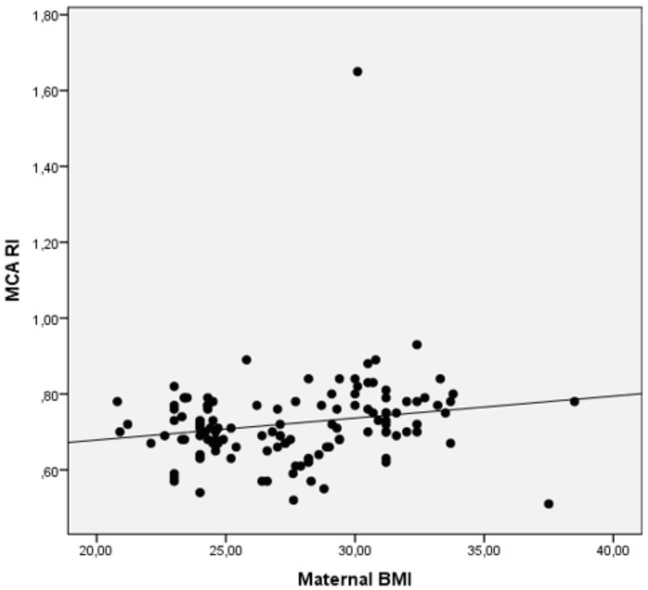

Figure 4. Correlation between MCA-RI values and maternal BMI

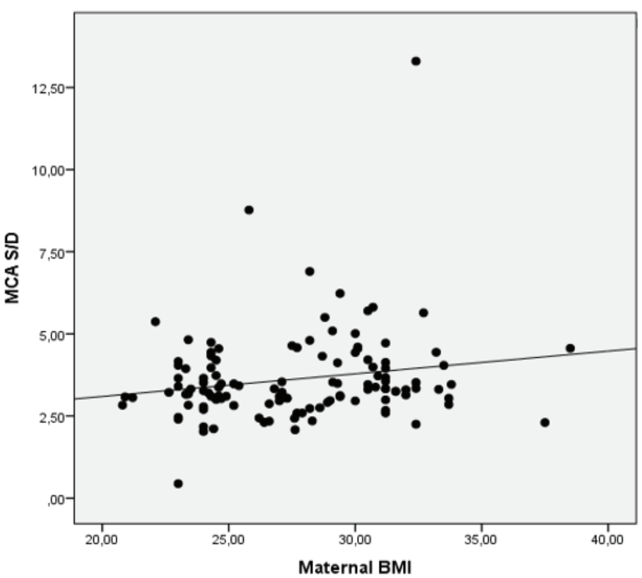

Figure 5. Correlation between MCA-S/D values and maternal BMI

DISCUSSION

In this study, we investigated a possible relationship between BMI in late pregnancy and fetomaternal blood flow parameters in women. All Doppler findings were were found to be similar among normal weight, overweight and obese women. On the other hand, we found a positive association between UtA-RI, UA-PI, UA-RI, MCA-RI and MCA-S/D values with maternal BMI.

Obesity is a significant public health concern and it has increased substantially over the past few decades (4,5). Maternal obesity has been shown to be associated with a higher risk of pregnancy complications such as gestational diabetes mellitus, gestational hypertension, preeclampsia, pre-term delivery and cesarean section and increased neonatal morbidity and mortality (14). Cedergren (6) investigated an association between maternal morbid obesity in early pregnancy and adverse perinatal outcomes. It was reported that morbidly obese mothers (BMI greater than 40) have an increased risk of adverse perinatal outcomes including preeclampsia, antepartum stillbirth, cesarean delivery, instrumental delivery, shoulder dystocia, meconium aspiration, fetal distress, early neonatal death and large-for-gestational age compared with the normal-weight mothers. Baeten et al. (15) examined the associations between prepregnancy weight and the risk of pregnancy complications and adverse outcomes among nulliparous women. They found that compared with lean women, both overweight and obese women had a significantly increased risk for gestational diabetes, preeclampsia, eclampsia, cesarean delivery, and delivery of a macrosomic infant. Studies showed that ultrasound and Doppler parameters may predict adverse perinatal outcomes in the third trimester of pregnancy (16,17). Chalouhi et al. (18) compared umbilical artery blood gas parameters (BGP) and Apgar scores between lean (<25 kg/m2) and obese (≥30 kg/m2) women. They found no significant differences between groups in terms of BGP or Apgar scores. Also, they reported no significant correlation between BMI and BGP/Apgar score in groups. They suggested that obesity may not affect fetal well-being in patients with no comorbidities such as gestational diabetes or hypertension. Similar to their results, we found similar maternal and fetal blood flow parameters among normal weight, overweight and obese women with term pregnancy.

The prevalence of overweight and obesity has increased in many developing countries over the past twenty years (4, 5). There is evidence for increases the risk of pregnancy complications such as gestational diabetes, preeclampsia and infections among obese women (14,15). Sarno et al. (19) evaluated a possible relationship between BMI and UA-PI in physiologic pregnancies. They reported a positive correlation between BMI and pulsatility index of umbilical artery at 32 weeks of gestation. Consistent with their results, we observed a positive association between both UA-PI and UA-RI values with maternal BMI. We suggested that obesity leads to negative effects on feto-placental vessels. Indeed, it was shown that maternal nutritional status and adipose tissue metabolism have direct impact on placental function by modulating placental nutrient transport (20, 21).

In this current study, a positive association was found between UtA-RI, UA-PI, UA-RI, MCA-RI and MCA-S/D values with maternal BMI. Maternal health and microenvironment have direct and significant impacts on the fetal development (22). The maternal microenvironment is influenced by a number of factors including maternal metabolic status, amount of body fat, hormones, cytokines, endothelial cell function and adipokines. Increasing BMI correlates with increased adipose tissue mass (23). Adipose tissue secretes prothrombotic and proinflammatory substances e.g. leptin, endothelin-1, tumour necrosis factor, plasminogen activator inhibitor, interleukins and adiponectin (24). These substances may affect homeostatic regulation of uteroplacental vascular tone. Maternal obesity leads to the endothelial cell dysfunction increasing fat-derived metabolic products and cytokines (25). It was reported that placental function influences by the maternal BMI (26). These findings may explain the reason the higher UtA-RI, UA-PI, UA-RI, MCA-RI and MCA-S/D values in the group of women with higher BMI.

To the best of our knowledge, this is the first study investigating the relationship between BMI in late pregnancy and fetomaternal blood flow parameters. There are some drawbacks to our study. The first limitation is the lack of pregnancy outcomes of the women included in this study. Most of the patients gave birth in different hospitals. That's why, we don't have data about pregnancy outcomes. It would be valuable to evaluate a relationship between fetomaternal Doppler flow parameters with birth weight and APGAR scores of neonates and the placental weight in obese women. Also, it would be interesting to observe the histopathological examination of placenta in groups. However, there are many studies in the literature evaluating the relationship between obesity and pregnany outcomes. Monaghan et al. (27) reported that high uterine artery PI at term is independently associated with increased risk of adverse perinatal outcome regardless of fetal size. In another study, Sebire et al. (28) investigated the pregnancy outcomes in obese women compared to those of normal weight by reviewing a large number of singleton pregnancies. They reported that gestational diabetes mellitus, proteinuric pre-eclampsia, induction of labour, delivery by emergency cesarean section, postpartum haemorrhage, genital tract infection, urinary tract infection, wound infection, birthweight above the 90th centile and intrauterine death were significantly more common in obese pregnant women compared to women with normal BMI. A second limitation was our relatively small patient population.

CONCLUSION

In conclusion, normal weight, overweight and obese women with term pregnancy have similar maternal and fetal blood flow parameters. But, there was a positive association between UtA-RI, UA-PI, UA-RI, MCA-RI and MCA-S/D values with maternal BMI. We concluded that obese women should be informed about the risks of obesity during pregnancy and weight gain during pregnancy should be kept within certain limits. Also, the weight to be gained during pregnancy should be predicted at the beginning of pregnancy and the pregnant woman should be referred to a dietitian if necessary. Large prospective clinical studies are required to evaluate the effects of the obesity on fetomaternal blood flow parameters and fetal development.

Competing interests: The authors found that the conflict of interest did not fully coincide.

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Ethical approval: Ethical approval for this study was provided by the Ethical Committee of Ataturk University, Medical Faculty, Erzurum, Turkey (30.11.2017,Approval number:14).

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