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Relationships of the First Trimester Maternal BMI with New-born Anthropometric Characteristics and Visfatin Levels throughout Pregnancy

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ABSTRACT

Background: *Birth weight has been shown to be influenced by numerous factors including, maternal characteristics such as maternal BMI. In pregnancy, there is increased adipose tissue which can cause to maternal obesity and insulin resistance. There is visfatin expression increase specific to pregnancy.* ***Aim:*** *We planned this study to assess relationships of the first trimester maternal BMI with new-born anthropometric characteristics and visfatin levels throughout pregnancy.* ***Methods and Material:*** *This longitudinal, observational study on 100 nulliparous pregnant women carried out in Birjand, Iran, over three trimesters in 2016. The researcher asked the participants to fill out the Researcher-made questionnaire including demographic and anthropometric characteristics including first trimester BMI and then referred them to laboratory to serum sample taking from mothers and visfatin levels measurement in the three trimesters. Neonate's anthropometric measures (weight, height, head circumference) and sex of new-borns were obtained from hospital reports.* ***Results:*** *Pearson correlation test indicated significant correlation between birth weight and the first trimester maternal BMI (r= 0.27, P=0.02). Also, Spearman's correlation test showed a weak negative correlation between head circumference with mean visfatin level (r= -0.23, P=0.04). Linear regression showed that birth weight predicts 28% of variation of BMI. Also, there was significant difference between the maternal level of education and the mean of birth weight (P=0.027).* ***Conclusions:*** *Results of the present study showed that the mean of birth weight was comparable with capital cities in Iran, it is necessary to strengthen the existing mother and child health care program and to develop new approaches.*

Keywords: Birth weight, Body Mass Index (BMI), visfatin, New-born, Anthropometric, Pregnancy

INTRODUCTION

Foetal growth and metabolism that is expressed in particular as birth weight is the most sensitive and reliable indicator of health of the community [1]. Birth weight has been shown to be influenced by numerous factors including, genetic, maternal characteristics such as length of gestation, parity and maternal and foetal medical problems, placental, socioeconomic status and environmental.

Since, birth weight is important in identifying infant morbidity and mortality also, in adulthood morbidity and mortality outcome, as one of the main metrics routinely used by health providers to measure foetal wellbeing and to predict future adult health [2]. Also, maternal body mass index (BMI) is related to pregnant and neonatal outcomes as well as subsequent disease risk in the offspring and it is a modifiable risk factor therefore has attracted widespread attention worldwide [3].

As Kajanite, et al. in Finland showed that small size at birth was associated with cardiovascular related mortality in all ages in adult women also, cardiovascular diseases in men [4]. Prevalence of low birth weight (LBW) that is defined as birth weight <2500 g irrespective of the period of gestation is quite high in developing countries due to limited availability of the prenatal care and weight gain monitoring in pregnancy [5]. Data from the Perinatal Survey 2010 showed 6.4% and 6.9% of all live births in metropolitan France and UK were LBW respectively [6]. In contrast, pre-pregnancy overweight or obesity increased the risk of large for gestational age (LGA) in the meta-analysis study [7]. Whitaker, et al. reported a retrospective cohort study in 8494 children from low-income families in Ohio, USA; then a follow up survey carried out at ages 2, 3 and 4 years. This study found pre-pregnancy underweight was associated with a decreased prevalence of childhood obesity; whereas pre-pregnancy overweight or obesity was associated with an increased obesity at ages 2, 3 and 4 years [8].

Over the decades extensively has accepted that adipose tissue no longer considered only for storing of fat but it is a significant endocrine organ secreting of many different active compounds with metabolic properties including adipokines [9]. One of the adipokines is visfatin secreted from adipocytes may play a crucial role in the metabolic syndrome, insulin resistance, obesity; type 2 diabetes, gestational diabetes and altered foetal growth [10]. In pregnancy, there is increased adipose tissue which can cause to maternal obesity, insulin resistance and gestational diabetes. Thus, there is visfatin expression increased specific to pregnancy [11].

Visfatin a recently identified adipocytokine is produced in visceral adipose tissue with multiple metabolic and immunoregulatory properties are expressed in the foetal membranes and placenta during normal gestation [12]. Fasshauer, et al. reported that mean plasma maternal visfatin in third trimester was higher in foetal growth restriction (FGR) compared with adequate for gestational age (AGA) [13].

Therefore, we planned this study to assess the relationships of first trimester maternal BMI with new-born anthropometric characteristics and visfatin levels throughout pregnancy.

METHODS

Design and samples

This longitudinal, observational study on 100 nulliparous pregnant women carried out in Birjand, South Khorasan, Iran, over three trimesters in 2016 [14]. The inclusion criteria were being 18-45 years and nulliparity. Women with definitely diagnosed pregnancy complications, history of chronic disease and infectious diseases were excluded from the study.

Ethics approval

This study protocol was approved by Deputy of research and technology and the ethics committee of Birjand University of Medical Sciences, Birjand, Iran (approval code: IR.BUMS.REC1394.345). Also, at the beginning of the study, oral and written informed consent forms were obtained.

The researcher asked the participants to fill out the Researcher-made questionnaire and then referred them to laboratory to serum sample taking from mothers and visfatin levels measurement in the three trimesters that was the 6th week of pregnancy till 10th week, the 18th week of pregnancy till 20th week, and the 28th week of pregnancy till 32nd week respectively. Gestational age was determined by first trimester ultrasound for all participants.

Data collection tools

Researcher-made questionnaire was including demographic and anthropometric characteristics including mother's age, mother's weight, height, and BMI in first trimester (BMI was calculated as weight (kg)/height (m^2), maternal level of education, spouse's education, employed outside home/unemployment and smoking. Those with a BMI<18.5 kg/m^2 were classified as underweight, $18.5 \leq$ BMI ≤ 24.9 kg/m^2 normal weight, $25 \leq$ BMI ≤ 29.9 kg/m^2 as overweight, and those with a BMI ≥ 30 kg/m^2 as obese respectively. Weight was measured with a digital scale (measurement accuracy of 100 g) while women in minimum clothing and without shoes (Seca, Germany). Mother's height was measured bare foot using a Seca stadiometer to the nearest 0.1 cm. Also, type of delivery (caesarean or vaginal), neonates' anthropometric measures (weight, height, head circumference) and sex (male, female) of new-borns were obtained from hospital reports.

In addition, commercially available ELISA kits were used to measure the maternal serum level of visfatin (Zellbio GmbH, Germany, ZB-10025-H9648) according to the manufacturer's instructions. Then, the samples were read within the linear range of the assay, and the accuracy of the analysis was confirmed by controls provided in assay kit.

Statistical analysis

The data were analysed by SPSS version 16.0 (SPSS Inc, Chicago, Illinois). Descriptive analyses were used to summarize data on the variables. Kolmogorov-Smirnov test was used to determine the normality of the data's distribution. Associations between mother's anthropometric indices and new-born's anthropometric measures were obtained using linear regression, bivariate correlation, Student's t-test, and one-way ANOVA statistical tests. In all of the tests, the level of significance was considered P<0.05.

RESULTS

In the present study, 74 nulliparous pregnant women were participated and 26% drop-out over three trimesters of pregnancy. The mean maternal age was 25 ± 4.7 years with age range of 18-41 years that classified by two groups: < 25 years and ≥ 25 years. The mean of delivery age was 39 ± 1.33 weeks. Of 74 pregnant women 63 women (85.1%) were unemployed and 14.9% employed. About 18 women (24.3%) had elementary level education, 35 women (47.3%) high-school level education and 21 women (28.4%) university level education. The majority of the new-borns were male (n=41, 55.4%). The average first trimester maternal BMI was 21.9 ± 4.4 kg/m^2. The mean of visfatin level during 3 trimesters of pregnancy was 39.72 ± 57.1 (ng/ml).

In the sample, 20.3% (n=15) of mothers were underweight (defined as BMI< 18.5), 60.8% (n=45) were normal weight (18.5 ≤ BMI ≤ 24.9), 13.5% (n=10) were overweight (25 ≤ BMI ≤ 29.9) and 5.4% (n=4) were obese (BMI ≥30).

The mean of birth weight was 3084.2 ± 350.9 g; one new-born (1.4%) was LBW (i.e., <2500 g) and one new-born (1.4%) was HBW (i.e., ≥ 4000 g). The mean of new-born height and head circumference was 41.4 ± 2.1 cm and 34.1 ± 1.1 cm respectively. The mean of Apgar score was determined 8.96 ± 019 and type of delivery 26 (35.1%) of 74 women was caesarean.

First trimester maternal BMI showed a positive correlation with birth weight(r=0.39) and this was statistically significant (P<0.001) and linear regression showed that birth weight predicts 28% of variation of BMI (Table 1).

First trimester maternal BMI indicated a weak positive correlation based on sex with female new-born birth weight (r=0.39) and this was statistically significant (P<0.02) but not with male birth weight. Also, there was a weak positive correlation with new-born height (r=0.41) and this was statistically significant (P<0.001) and a strong positive correlation with head circumference (r=0.61) and this was statistically significant (P<0.001). In addition, Spearman's correlation test showed a weak negative correlation between head circumference with mean visfatin level (r= -0.23) and this was statistically significant (P=0.04) (Figure 1), however there was no correlation with birth weight (r=-0.03, P=0.77). Also, the results of Pearson correlation test indicated that there was significant correlation between birth weight and the first trimester maternal BMI (r=0.27, P=0.02) (Figure 2).

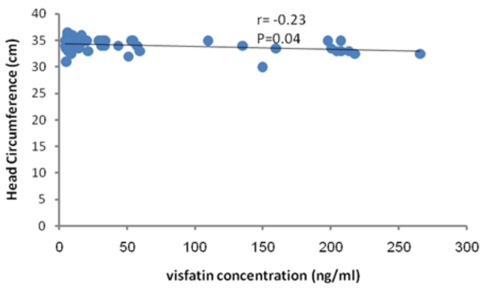

Figure 1 Correlation between Visfatin concentration and head circumference (r=-0.23, P=0.04)

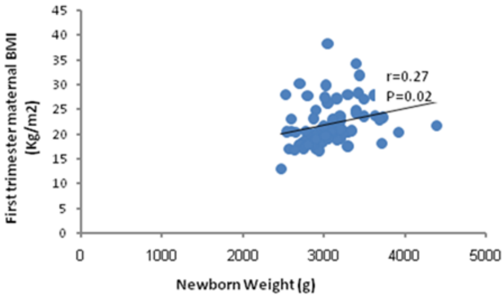

Figure 2 Correlation between new-born weight and the first trimester maternal BMI (r= 0.27, p=0.02)

Table 1 Linear regression model of BMI with birth weight and visfatin

Variables	**Pearson/Spearman Correlation**		**Linear Regression**		**Model Indicators**
	r	**P-value**	**Beta**	**P-Value**	R=0.28
Birth Weight	0.39	0.001**	0.26	0.03*	R^2=0.08
Visfatin	0.01	0.93	0.096	0.43	F=2.89
					P=0.06
*Significant was set at P-value<0.05. ** Significant was set at P-value<0.001. BMI: Body Mass Index					

In addition, the maternal level of education was significantly related with mean birth weight. The mothers with university level of education had significantly heavier babies than those primary and high school level of education. The Bonferroni post hoc test indicated a significant difference between high school and university level of education (P=0.027). Also, Student's t-test showed that the women with age of ≥ 25 years had the mean of BMI higher than <25 years (P=0.004) (Table 2).

Table 2 Comparison of BMI and birth weight mean based on mother education and mother age

Variables		**BMI(kg/m²)**		**Birth Weight (g)**	
		Frequency	**Mean± SD**	**Frequency**	**Mean± SD**
Maternal Education	Elementary (A)	18	21.7 ± 4.1	18	3049.6 ± 255.2
	High school (B)	35	21.6 ± 4.6	35	3002.4 ± 375.4
	University (C)	21	22.9 ± 3.9	21	3250 ± 3361
	P-value ANOVA	0.53		0.032*	
Maternal Age (yrs)	<25	38	20.6 ± 3.3	38	3010.1 ± 325.5
	≥ 25	36	23.5 ± 4.9	36	3162 ± 364.1
	P-value T-test	0.004*		0.06	
*Significant was set at P-value<0.05. BMI: Body Mass Index. SD: Standard deviation at 95% confidence interval.					

There was no significant difference among the mean of new-born birth weight, height and head circumference based on BMI classification (Table 3).

Table 3 Comparison of new-born weight, height and head circumference based on the first trimester maternal BMI

Maternal BMI (kg/m2)	**Frequency**	**Baby weight(g)**	**Baby Height(cm)**	**Baby head circumference(cm)**
		Mean ± SD	**Mean ± SD**	**Mean ± SD**
Under weight	15	2870 ± 304.84	49.28 ± 1.43	34.03 ± 0.78
Normal	45	3136.51 ± 352.28	49.42 ± 2.41	34.17 ± 1.24
Overweight	10	3144 ± 333.72	50.18 ± 1.88	33.95 ± 1.04
Obesity	4	3148.75 ± 347.38	48.50 ± 1.29	34.50 ± 0.57
Total	74	3084.16 ± 350.92	49.45 ± 2.13	34.13 ± 1.02
P-value ANOVA		0.06	0.56	0.82
BMI: Body Mass Index. SD: Standard deviation at 95% confidence interval				

DISCUSSION

Our study showed that the first trimester maternal BMI showed a weak positive correlation based on sex with female new-born birth weight and this was statistically significant but no with male new-born birth weight. In addition, the maternal level of education was significantly related with the mean of birth weight. The mothers with university level of education had significantly heavier babies than those primary and high school level of education. Maternal age of ≥ 25 years had mean BMI significantly higher than <25 years.

Although additional studies needed to investigate the impact of maternal BMI on new-born birth weight however, numerous factors including genetic, maternal characteristics such as maternal age, ethnicity, gestational hypertension, gestational diabetes mellitus, education and environmental factors can contribute to the impact of maternal BMI on birth weight [15,16].

In present study, of the above-mentioned factors, maternal age of ≥ 25 years, maternal education level and female new-born are associated with higher birth weight. This study's findings, are consistent with Veghari, the study reporting positive association between birth weight and birth stature with mother's BMI after 25 years [17] and Sadoh, et al. the study that found the maternal level of education was significantly related to birth weight [18] and is in agreement with Diemert, et al. study that reported progesterone in the 2nd trimester emerged as an independent predictor for birth weight in pregnancies with female but not male foetuses respectively [19]. Also, this is inconsistent with Chodick, et al. that showed birth weight in less than 25 years and over 40 years mothers were more than other age groups [20]. Also, this study's findings, however, is inconsistent with Lampl that observed a greater response to increased maternal weight and maternal height in foetal weight growth rate among males than females respectively [21].

Increasing age of mothers in turn, may be positively related to higher educational level, socioeconomic status and consequently better nutrition and growth of foetus.

In confirm of this, in the study has been showed that the mothers <20 years had significant lighter babies than older age [22].

Also, mothers with high educational level (education is as one of the socioeconomic factors) more likely attend antenatal clinics and receive prenatal care during pregnancy which leads to have bigger new-borns. In previous studies have revealed that the lower maternal educational level is related with the higher risk that she will have a low birth weight baby [6]. In our study, average birth weight was 3084.2 g that is comparable with some hospitals in Tehran 3139 g [23], Qazvin 3248.2 g [24] and China 3233 g [25].

About our finding, the first trimester maternal BMI indicated a weak positive correlation based on sex with female new-born birth weight, one explanation is adaptation of the maternal endocrine and immune system throughout gestation is important for having successful pregnancy outcome and principal part of the endocrine adaptation to pregnancy is the increase in progesterone level [26]. Since, progesterone during pregnancy in particular, the first and second trimesters acts through decrease in the resistance of the placental blood flow and reduction in blood pressure systemically therefore lower progesterone levels impair uterine blood flow, reducing foetal growth and subsequently birth weight.

This progesterone-associated promotion of foetal growth is sex specifically as in a recent study found each increase of progesterone by 1 ng/ml in the 1st trimester increased the birth weight of daughters by 10.2 g, independent of confounding factors [19,26]. Also, another explanation is profoundly different profiles of gene expression between male and female placentas for sex specific differences with regard to placental function, nutrient supply and hence, foetal growth [27].

In addition, Spearman's correlation test showed a weak negative correlation between head circumference with mean visfatin level and this was statistically significant however, there was no correlation with birth weight.

Over the decades extensively has accepted that adipose tissue no longer considered only for storing of fat but it is a significant endocrine organ secreting of many different active compounds with metabolically properties including adipokines [9]. One of the adipokines is visfatin secreted from adipocytes may play a crucial role in the metabolic syndrome, insulin resistance, obesity; type 2 diabetes, gestational diabetes and altered foetal growth [10]. In pregnancy, there is increased adipose tissue which can cause to maternal obesity, insulin resistance and gestational diabetes. Thus, there is visfatin expression increase specific to pregnancy [11].

In previous study have been demonstrated circulating maternal visfatin levels in the IUGR small-for-gestational-age (SGA) neonates is higher than normal new-borns [28,29] that in our study found as decreased head circumference that is one of the IUGR status.

One explanation is altered maternal endocrine environment following higher visfatin levels can contribute in decreased foetal growth as head circumference. Another explanation, the increasing evidence show that higher circulating visfatin levels are related with insulin resistance status that it is in turn has a strong relationship with growth retardation [28].

Limitations of the study

A limitation of this study is that we could not determine insulin levels and subsequently insulin resistance status in pregnant women. Another limitation, lack of information on IUGR state of foetuses throughout pregnancy is another limitation of present study.

CONCLUSION

In summary, foetal growth measures chief among these birth weight, is the most sensitive and reliable indicator of health of the community that in several studies has been shown to be influenced by numerous factors including maternal characteristics such as BMI. Further and comprehensive studies are essential to determine of relationship between pre-pregnancy and the first trimester maternal BMI and pathophysiology of adipose tissue and secreted adipocytokines until thereby could reduce in the inheritance of metabolic diseases by the next generation through timely intervention at the prenatal period.

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