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Correlation of Pre-pregnancy Body Mass Index, Prenatal Weight Gain and Gestational Diabetes – A Case-Control Study

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ABSTRACT

Introduction: Obese and overweight women are more prone to gestational diabetes mellitus (GDM). Body mass index and weight gain during pregnancy play an important role in pregnancy and are considered important indicators of maternal and neonatal health. Because of the prevalence of obesity in Yazd, we studied the relationship between GDM with pre-pregnancy BMI and prenatal weight gain in pregnant women in Yazd.

Methods: This case-control study was conducted on 336 pregnant women who had just given birth, consisting of 168 pregnant women with GDM and 168 healthy pregnant women as case and control group, respectively. We gathered data from the information recorded in the health information system. In this study, the chi-squared, independent t-test and correlation test were used to analyze the data using $SPSS_{23}$ software.

Results: The present study showed that the average pre-pregnancy BMI and the average weight gained during pregnancy until screening for GDM were significantly higher in cases than controls ($P < 0.05$). Also, there was a significant reverse correlation between pre-pregnancy BMI and weight gain during pregnancy ($r = -0.27$, $P < 0.001$).

Conclusion: Since BMI is an avoidable risk factor, we should give all women good dietary training for proper weight before pregnancy and appropriate weight gain during pregnancy.

Keywords: Weight Gain, Body Mass Index, Gestational Diabetes

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Introduction

Diabetes is one of the most common non-communicable diseases in the world [1]. The prevalence of diabetes among various ethnic groups is between 7.8%–15.5% worldwide [2]. This disorder is a chronic disease that occurs due to the absolute deficiency of insulin or the relative reduction of its secretion from the pancreas, with some degree of resistance to insulin [3]. Gestational diabetes mellitus (GDM) is the type of diabetes that is characterized by some degree of intolerance to glucose that is first diagnosed during pregnancy [4]. It not only affects the pregnancy, but also increases the likelihood of complications in mother and newborn [4]. The criteria for screening and diagnosis of GDM are one-step test (GTT (Glucose tolerance test) after two hours, ingestion of 75 gram oral glucose) according to the World Health Organization instruction [5]. GDM occurs in 2–9 % of the total pregnancy in the world [6]. Women with a history of GDM are more likely to have hypertension, abortion, preeclampsia and macrosomal newborn births [7]. Obese and overweight women are more prone to GDM [8].

Based on body mass index (BMI), it is recommended during pregnancy that the weight gain is 12.5–18 kg for lean women, 11.5–16 kg for average women, 7–11.5 Kg for overweight women and less than 7 kg for obese women, for whom added weight is most likely to lead to GDM [9]. Pregnancy is one of the most important and most dangerous moments of a mother and fetus's life. Health or maternal illness during this period not only affects the quality of a mother's life, but also affects the health and life of the fetus.

In other parts of the world, diabetes has been controlled, especially GDM, but in Iran, the incidence of this disease has not been controlled. Overall, the prevalence of GDM in Iran varies from 1.3% to 8.9% [10]. Yazd Province has reported a prevalence of GDM of 10.2% [11]. Also, the incidence of obesity in women in Yazd is high; the prevalence of overweightness and obesity are 38% and 30%, respectively [12]. The study conducted by Bafghi reported that increasing obesity has a significant relationship with the risk of diabetes mellitus, and high weight gain during pregnancy is effective in impaired glucose tolerance [13]. BMI and weight gain during pregnancy play an important role in the outcome of pregnancy and they are an important indicator for the health of mother and the baby [14].

Since the relationship between GDM mellitus with overweight and obesity during pregnancy has not been studied in this region and since that GDM is a symptom-free illness, knowing about this disorder and its risk factors can lead to self-care and prevention. Therefore, we studied the relationship between GDM with obesity and weight gaining during pregnancy in pregnant women in Yazd.

Methods

This case-control study was conducted on 336 pregnant women who had given birth during one year. We used a multi-stage sampling method among the comprehensive health centers of Yazd in five geographical regions: north, south, east, west, and central. We took two centers from each location, randomly. To estimate the sample size, the sample size estimation formula was used for case-control studies with 95% confidence interval level and 80% power and exposure ratio (37%) in the case group and 23% in the control group, (pre-pregnancy overweight) [15]. From each center, 17 pregnant women with GDM were selected as a case group and 17 pregnant women without a GDM were selected as control group. For every patient, we identified another woman with matching age and location to serve as a control. Cases were selected randomly from the health care registry in which mothers with GDM had been registered. The inclusion criteria for these pregnant women were being reproductive age (15–49 years old), confirmed GDM up to 30 weeks of pregnancy, and at least 5 years' residence in Yazd. The exclusion criteria include being non-native, younger than of 15 years old and older than 49 years old and having diabetes mellitus before pregnancy. We gathered data from the information

recorded in the health information system on demographics, anthropometrics, and medical history. In this study, the principles of confidentiality of data were respected. The chi-square test, independent t-test and correlation test were used to analyze the data using $SPSS_{23}$ software.

Results

In this case-control study, 168 pregnant women with GDM and 168 pregnant women without GDM were included. The mean age in the case group was 30.2 ± 5.9 years and the mean age in the control group was 29.1 ± 5.7 years, which was not significantly different (p = 0.1). Most pregnant women with GDM were over 30 years old and had greater instances of family history of diabetes and high blood pressure however; there was no significant diffrence between two groups. The demographic characteristics of people with GDM and the control group shows in Table 1.

Table 1. Demographic characteristics of subjects in two study groups

Variables		Frequency and percentage in case group	Frequency and percentage in control group	P-value
Age	15-19	4(2.3)	8(4.8)	0.28
	20-29	90(53.2)	100(59.5)	
	30-39	65(39.3)	52(31)	
	40-49	9(5.2)	8(4.7)	
	Total	168(100)	168(100)	
Education level	Under diploma	41(24.3)	30(17.9)	0.47
	Diploma	80(47.4)	82(48.8)	
	Academic	47(28.3)	56(33.3)	
	Total	168(100)	168(100)	
Job	Housewife	138(81.5)	148(88.1)	0.09
	Employee	30(18.5)	20(11.9)	
	Total	168(100)	168(100)	
Family history of diabetes	No	107(63.7)	120(71.4)	0.1
	Yes	61(36.3)	48(28.6)	
	Total	168(100)	168(100)	
History of high blood pressure	No	165(98.3)	167(99.4)	0.22
	Yes	3(1.7)	1(0.6)	
	Total	168(100)	168(100)	

*Significant at 95% confidence level

The average pre-pregnancy BMI was significantly different in women with GDM from non-GDM women. Also, the average weight gain during pregnancy until screening for GDM in pregnant women with GDM was significantly more than the control group. However, after the diagnosis of GDM, weight gain of pregnant women with GDM significantly differed from that of pregnant women without GDM. That is, the weight gain of pregnant women without GDM was significantly more than pregnant women with GDM. Table 2 shows the mean and standard deviation of anthropometric indices in the two study groups.

In this study, there was a significant reverse correlation between pre-pregnancy BMI and weight gain during pregnancy (r = -0.27, P < 0.001). Also, there was a significant correlation between pre-pregnancy BMI and parity in pregnant women (r = 0.22, P < 0.001). In addition, there was a significant reverse correlation between parity and weight gain during pregnancy (r = -0.23, P < 0.001).

Table 2. Mean and standard deviation of anthropometric and quantitative variables in the two study groups

Variables	Mean±SD in cases	Mean±SD in controls	P-value
Weight of the pregnant woman in first visit	68.4±14.1	63.3±13.4	0.001*
Height	159.2±7.6	160.1±5.6	0.22
Parity	2.1±0.9	1.9±0.8	0.08
Pre pregnancy BMI	27.03±5.6	24.6±4.8	<0.001*
Weight gain during pregnancy until 24-28 week	7.3±5.8	6.1±5.8	0.001*
Weight gain from 24-28 weeks of pregnancy to the end of pregnancy	9.6±5.8	11.3±5.8	0.01*

*Significant at 95% confidence level

Discussion

The present study showed that the average pre-pregnancy BMI, the average weight gain during pregnancy until screening for GDM and also average weight gain until the end of pregnancy were significantly different in women with GDM and those without.

Also, there was a significant reverse correlation between pre-pregnancy BMI and weight gain during pregnancy until screening for GDM. In the present study, the mean of pre-pregnancy BMI in pregnant women with GDM is significantly higher than that of without GDM. Similar studies have reported similar results [16, 17]. But in the study conducted by Kristensen et al, there was no significant relationship between BMI and the risk of GDM, which was contradicts with our results [18].

Also, the average weight gain during pregnancy until screening for GDM in pregnant women with the condition was significantly more than the control group. This suggests a strong correlation between being overweight during pregnancy and in impaired glucose tolerance. Therefore, obesity and overweightness are one of the most important risk factors for GDM [19]. Since the role of pre-pregnancy BMI in preventing GDM is an important one, it should be an important public health priority for controlling the growing trend of GDM.

Also, in the present study, after the diagnosis of GDM, weight gain of pregnant women with GDM significantly differed from that of pregnant women without GDM. That is, weight gain of pregnant women without GDM was significantly more than pregnant women with GDM, which can be attributed to the proper training and appropriate dietary practices of pregnant women with GDM by health workers.

In the present study, an inverse correlation was found between maternal BMI at the beginning of pregnancy and weight gain during pregnancy. Mothers with lower BMIs had gained more weight during pregnancy. Similar studies confirm our results [20]. It is also expected that mothers who are thin rather than mothers with a higher BMI, have more weight gain during pregnancy, which allows them to give birth children of suitable weight. In numerous studies, it has been shown that in low-birth-weight women, the probability of having newborn with low birth weight is higher, and adding proper weight during pregnancy can greatly reduce the birth of low birth weight newborns [20].

In the present study, there was no significant relationship between the parity with risk of GDM in the two study groups. Results of similar studies differ from our study [15].

In this study, we did not find a direct correlation between BMI in pregnant women and the parity, but the study conducted by Benner has reported contrary results. Benner's study showed with an increase in the number of deliveries, the maternal body mass index also increased. This can be due to the fact that mothers with more children did not have enough time to do physical activity [21].

Also, in the present study, there was an inverse correlation between the parity in pregnant women with their weight gaining during pregnancy. Their weight gain decreased with increasing number of

pregnancies in women. Such studies have reported similar results [21, 22]. This could be due to the lack of attention of mothers to themselves due to mental and physical challenges.

In the present study, there was no significant relationship between occupation, education level, history of hypertension and the risk of GDM in the two study groups. However, similar studies have reported different results. They have shown that having a history of hypertension has a direct relationship with the incidence of GDM. They show that the association between blood pressure and GDM was stronger among women who were overweight (BMI $\geq$ 25.0 kg/m^2) [21, 23]. Such studies have also shown that having less than 12 years' worth of education [23] and being employed [24] increase the chance of developing GDM. In the present study, contradict with study conducted by Hedderson et al.[15], there was not a significant relationship between the family history of diabetes and the incidence of GDM.

Family history of diabetes is one of the predictors of GDM. This and other risk factors are un-modifiable, and such factors frequently are strong indicators that a pregnant woman will develop GDM. Therefore, it is possible and recommended to focus on mitigation strategies for such women.

This study had some limitations, especially in the design of case-control, which may result in some systematic error. We suggest that subsequent research feature a cohort design that could result in stronger correlation recognition.

Conclusion

Pre-pregnancy BMI is one of the modifiable risk factors of GDM. It is suggested that for promoting proper weight before pregnancy and appropriate weight gain during pregnancy, we should give all women good training on the quality of their diet and their number of appropriate meals and physical activity which has an effective role in the health of the mothers and their fetuses.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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