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Original Article

The effect of physical activity performed in the first trimester on the development of preeclampsia and gestational diabetes

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Abstract

Aim: We aimed to investigate the effects of physical activity performed in the first trimester on preeclampsia, gestational diabetes, and other pregnancy outcomes.

Materials and Methods: This prospective observational study included 205 healthy pregnant women with 11 to 13 weeks of gestation who applied to our gynecology and obstetrics outpatient clinic between April and July 2019. The demographic information of the patients was recorded and a short form of the International Physical Activity Questionnaire was used to determine physical activity levels. These pregnant women were followed until birth. A confounder control was performed with logistic regression.

Results: While 16 (7.8%) of the participants developed preeclampsia, 20 (9.8%) of them developed gestational diabetes. Total physical activity levels were lower in women who developed preeclampsia. In the group that developed gestational diabetes, the number of pregnant women with low physical activity levels and the number of nulliparous pregnant women were found to be significantly higher. There was no effect of daily sitting time on preeclampsia and gestational diabetes development. Second-hour blood glucose levels were found to be higher in the group with low physical activity.

Conclusion: Pregnancies complicated by gestational diabetes or preeclampsia are associated with poor pregnancy outcomes and are very important risk factors for postpartum maternal and fatal healt. Inadequate physical activity is a modifiable risk factor for the development of preeclampsia and gestational diabetes. Behavioral changes in women with insufficient physical activity levels in the first trimester may decrease the risk of gestational diabetes and preeclampsia.

Keywords: Gestational diabetes; oral glucose tolerance test; physical activity during pregnancy preeclampsia; sedentary behavior

INTRODUCTION

According to the ACOG (American College of Obstetricians and Gynecologists), physical activity (PA) during pregnancy is safe and many positive effects have been reported on women's health (1). In order to create an ideal environment for the fetus during pregnancy, intense physiological changes and morphological adaptations occur. Such rapid changes have short and long-term effects on the mother and fetus (2). There are data that PA has a protective effect on both gestational diabetes (GDM) and preeclampsia (PE) (3,4).

Some studies have suggested that the time spent by women in sedentary activity is more decisive than the PA for PE prediction (5). However, the results of the studies on the effect of PA on the mother and fetus are contradictory and not universally accepted (6-8). In some studies, it has been stated that PA can reduce the risk of GDM (9,10). There is currently no widely accepted treatment or prevention strategy for GDM treatment other than lifestyle modification and, in rare cases, insulin therapy (11,12).

PA is important for identifying potentially modifiable risk factors for PE and GDM. There are a limited number of prospective studies on PA in the first trimester. In this study, the effect of PA in the first trimester on the development of GDM and PE was investigated.

MATERIALS and METHODS

This study was planned as a prospective observational cohort study. The study included 11 to 13 weeks of healthy pregnant women who applied to our gynecology and obstetrics outpatient clinic between April and July 2019. The study had been reviewed by the appropriate ethics committee and had been performed in accordance with the ethical standards described in an appropriate version of the 1975 Declaration of Helsinki, as revised in 2000.

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The study protocol was approved by the Ethics Committee of Necmettin Erbakan University. Informed consent was obtained from all the participants. All patients were given an International Physical Activity Questionnaire-Short Form (IPAQ-SF) by the researchers (13). The Turkish validity and reliability study of this questionnaire was conducted by Sağlam et al. in Turkey (14). In this survey: low, severe, moderate activities, walking time and daily sitting time were questioned and weekly metabolic values (MET) were calculated accordingly. IPAQ evaluates many PA. These; a) PA in leisure time, b) Home and garden activities, c) PA related to work and d) PA related to transportation. On the IPAQ short questionnaire; there are specific types of three of the four activities mentioned above. When calculating the total score of walking, low PA, moderate PA and high PA, it is necessary to know the duration (minutes) and frequency (days). The scores obtained were classified as: low PA (MET ≤ 600 energy level), moderate PA (MET = 600-3000 energy level) and high PA (MET ≥ 3000 energy level) (15).

The inclusion criteria for this study were determined as: having a healthy, single pregnancy between 11 and 13 weeks, being between the ages of 18 and 40 and not having physical disability causing movement restriction. Exclusion criteria included chronic disease (Type 1 and Type 2 diabetes, chronic hypertension, etc.); multiple pregnancies; detected fetal structural and chromosomal anomalies; a history of PE; women over 40 and under 18; and women who do not speak enough Turkish. At first, 227 women participated in the study. However, 11 were excluded due to abortion or termination. Eleven of them were excluded from the study because they did not come to follow-up prenatal appointments. The remaining 205 patients were evaluated (Figure 1).

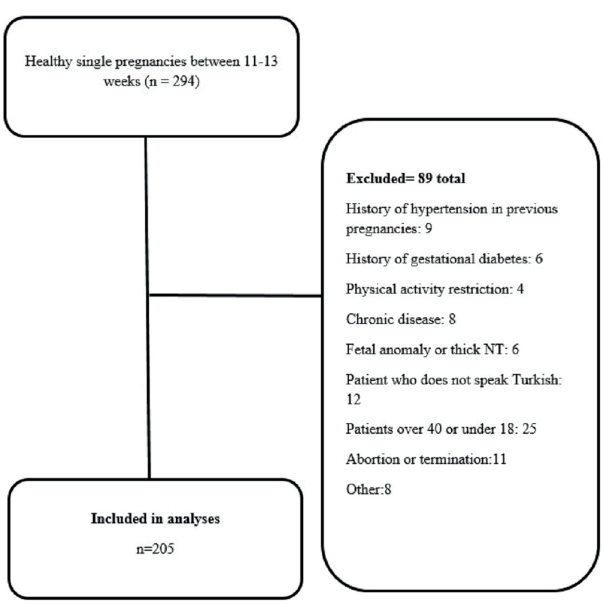

Figure 1. Patient selection

The demographic characteristics of the pregnant women such as age, body mass index (BMI), smoking status, education level were recorded. Each patient's blood pressure was measured at every visit. In the 24th week, the 75-gram two-hour oral glucose tolerance test (OGTT) was performed. The pregnant women were followed up for complications such as PE, the development of GDM and neonatal outcomes. GDM was diagnosed according to the criteria of the ADA (American Diabetes Association) (16). The diagnosis of PE was made according to the ACOG bulletin (17). Deliveries at less than 37 weeks were considered preterm births. All pregnant women participating in our study were followed until birth.

Statistical analysis

All data collected for statistical analysis were analyzed by Statistical Package for the Social Sciences, version 23, SPSS Inc., Chicago, IL (SPSS). Descriptive values of the obtained data were calculated as mean, median value, standard deviation, number and % frequencies and presented in tables. The normal distributions of the data were evaluated by the Kolmogorov-Smirnov test. Chi-square or Fisher exact test was used for categorical variables. The Student T, the Mann Whitney U, the one-way analysis of variance (ANOVA) and the Kruskal Wallis tests were performed. The Tukey test or the Mann Whitney U test with the Bonferroni correlation was used for post hoc analysis. The Spearman's correlation analysis was performed to evaluate the relationship between total PA and weight gain. In the logistic regression analysis, the Hosmer Lemeshow and the Wald tests were performed. Multicollinearity evaluation was performed for the relationships between independent variables. The statistical significance level was determined as $p \leq 0.05$.

RESULTS

A total of 205 pregnant women were evaluated in the study. According to IPAQ-SF scores, 42 (20.5%) of the pregnant women were classified as low PA, 138 (67.3%) were moderate PA and 25 (12.2%) were high PA.

PE developed in 16 (7.8%) of the pregnant women participating in the study and GDM developed in 20 (9.8%) women. BMI was significantly high and total PA levels were significantly lower in women with PE ($p < 0.001$, $p < 0.001$, respectively). There was no significant difference between the groups with and without PE in terms of smoking status, weight gain, rural living, nulliparity, income level and education level (Table 1).

In the group with GDM, the numbers of pregnant women with low PA and nulliparous pregnant women were significantly higher ($p = 0.008$, $p = 0.041$, respectively). In addition, the number of parity was lower in women with GDM ($p = 0.022$). There was no significant difference in terms of BMI, smoking status, rural living or income level between the groups with and without GDM (Table 2).

Univariate logistic regression analyses were performed for PE and GDM separately. Total PA, sitting time, BMI, weight gain during pregnancy, age, nulliparity, low socioeconomic level, rural living, number of births, number of abortions and smoking status were defined as independent variables. Multivariate logistic regression analyses were performed with significant variables. Logistic regression analysis indicated that low total PA score and high BMI were significant independent predictors of PE (OR = .998; 95% CI = 0.997–0.999; p <.05, OR = 1.182 ; 95% CI=1.067 -1.310; p<.05, respectively).

Table 1. Comparison of patients with and without preeclampsia

	PE group (n=16)	Non-PE group (n=189)	P value
Maternal age (years) ‡	30.1 ± 5.8	28.8 ± 5.5	0.357
Number of abortions *	0 (0, 3)	0 (0, 8)	0.541
Nulliparous §	2 (12.5)	41 (21.7)	0.386
Number of deliveries *	1 (0, 4)	1 (0, 4)	0.884
Maternal weight			
Weight gained (kg)*	11 (1, 22)	11 (-4, 28)	0.850
First trimester BMI (kg/m²) ‡	29.7 ± 6.3	24.8 ± 5.0	**<0.001**
I. Underweight/normal (<25) §	4 (25.0)	105 (55.6)	
II. Overweight (25- 29.9)§	4 (25.0)	57 (30.2)	0.001‖
III.Obese (≥30) §	8 (50.0)	27 (14.3)	
Physical activity levels			
Low level PA (I)	14 (87.5)	29 (15.3)	
Moderate PA (II)	2 (12.5)	136 (72.0)	**p<0.001¶**
High PA (III)	0 (0.0)	24 (12.7)	
Total PA score (MET-minutes/week) †	468 (165, 552)	2003 (924, 2379)	**p<0.001**
Sitting time (min/day) †	555 (360, 720)	479 (300, 600)	0.148

PE, preeclampsia; BMI, body mass index; PA, physical activity; MET, metabolic equivalent of task. Data are presented as median (minimum-maximum)*, interquartile range†, mean±SD ‡, or n (%)§. Statistically significant p values are shown in bold. ‖ In the Post Hoc analysis, when the Bonferroni correction was made, there was a significant difference between the 'Underweight / normal' group and the 'obese' group (p<0.001). ¶When the Bonferroni correction was made in the Post Hoc analysis, there was a significant difference in Group I (p<0.001)

Table 2. Comparison of patients with and without gestational diabetes

	GDM group (n=20)	Non-GDM group (n=185)	P value
Maternal age (years) ‡	31.1 ± 5.5	28.6 ± 5.5	0.056
Number of abortions *	0 (0, 3)	0 (0, 8)	0.735
Nulliparous §	8 (40.0)	35 (18.9)	**0.041**
Number of deliveries *	1 (0, 3)	1 (0, 4)	**0.022**
Maternal weight			
Weight gain (kg) *	11.1 (0, 25)	11.5 (-4, 28)	0.801
First trimester BMI (kg/m²) ‡	26.4 ± 5.8	25.1 ± 5.2	0.305
Underweight/normal (<25)§	8 (40.0)	101 (54.6)	0.446
Overweight (25-29.9) §	8 (40.0)	53 (28.6)	
Obese(≥30) §	4 (20.0)	31 (16.8)	
Physical activity levels§			
Low level PA (I)	9 (45.0)	33 (17.8)	**0.008‖**
Moderate PA (II)	11 (55.0)	127 (68.6)	
High PA (III)	0 (0.0)	125 (13.5)	
Total PA score (MET-minutes/week) †	965 (237, 778)	1982 (924, 1636)	**0.013**
Sitting time (min/day) †	516 (360, 600)	482 (300, 600)	0.473

GDM, gestational diabetes; BMI, body mass index; PA, physical activity; MET, metabolic equivalent of task. Data are presented as median (minimum-maximum)*, interquartile range†, mean±SD‡ or n (%)§. Statistically significant p values are shown in bold.
‖When the Bonferroni correction was made in the Post Hoc analysis, there was a significant difference in Group I (p<0.04)

In the logistic regression analysis for GDM, a high total PA level had a protective effect (OR = .999; 95% CI = 0.999-1.00; p <.0.05). There was no relationship between total PA level and gestational age at birth, preterm birth rate, admission to NICU and total APGAR scores. The birth weight of the low PA group was found to be lower than the high PA group (p = 0.035) (Table 3).

Table 3. Comparison of physical activity groups in terms of laboratory and perinatal results

	Low-PA (Group I)	Moderate-PA (Group II)	High-PA (Group III)	p value
Perinatal outcomes				
Birth weight (gr)*	2871 ± 755	3127 ± 550	3131 ±378	**0.041‡**
Gestational age at birth (week)*	37.2 ± 2.4	37.9 ± 2.9	38.2 ± 0.9	0.253
Preterm delivery†	5 (11.9)	5 (3.6)	1 (4.0)	0.111
Admission in NICU§	11 (26.2)	18 (13.0)	5 (20.0)	0.119
Total APGAR score (1-5 min) *	15.8 ± 1.8	16.2 ±1.9	16.1 ± 2.4	0.433

Laboratory findings*				
Fasting plasma glucose (mg/dL)	85.7 ± 8.5	84.4 ± 12.6	82.0 ± 0.0	0.313
One-hour plasma glucose (mg/dL)	143.0 ± 30.6	133.4 ± 26.0	132.8 ± 17.7	0.720
Two-hour plasma glucose (mg/dL)	122.5±24.2	113.0 ± 24.0	101.3 ± 24.9	**0.003§**
HbA1c (%)	5.1 ± 0.3	5.1 ± 0.3	5.2 ± 0.3	0.372

HBA1c: Hemoglobin A1c
Data are presented as mean±SD* or n(%)†. Statistically significant p values are shown in bold.
‡ An ANOVA test was performed. In the Post Hoc analysis, the difference between Group I and Group II was significant (p=0.035).
§The Mann Whitney U test and the Bonferroni correction were performed for the post hoc analysis at significant values. There was a significant difference for Group I-III (p=0.003), and Group II-III (p=0.021)

In the 75 grams two-hour oral glucose tolerance test, there was no significant difference between the fasting blood glucose, first-hour blood glucose and HBA1c values of the groups. The second-hour blood glucose of the high-PA group was significantly lower than in the low PA and moderate PA group (p = 0.003, p = 0.021 respectively) (Table 3). No correlation was observed between total PA levels and weight gained during pregnancy (rho = 0.29, p = 0.680).

DISCUSSION

In this study, the effect of PA on PE and GDM development was investigated. Since the development mechanisms of PE and GDM are similar, in many studies these two entities were evaluated together. In a study, it was stated that PA during pregnancy reduced the risk of GDM and PE in healthy women (18). However, in many studies, the effects of PA on PE and GDM were evaluated separately.

In a study by Spracklen et al. on 208 patients, it was stated that increasing PA during pregnancy and decreasing sedentary activity time may decrease the risk of PE (19). In this retrospective study, Spracklen et al. had evaluated the average PA of the participants during the entire gestation period. In the current study, we prospectively investigated the effect of PA level only in the first trimester. The fact that the placentation disorder (which plays a key role in the mechanism of PE) can originate from immunological, environmental and genetic factors in the early stages of pregnancy (20) increases the importance of PA in the first trimester. During pregnancy, PA can reduce the risk of PE by providing a decrease in the pathophysiological features of PE, including blood pressure and oxidative stress (21). In the current study, we determined that PA reduced the risk of PE, but daily sitting time in the first trimester did not affect the development of PE.

In a prospective study that examined only 189 pregnant women with pregestational diabetes, the effect of PA and sedentary behavior on the development of PE was investigated. Sedentary behaviors were more frequently observed in women who developed PE, but there was no difference between PA levels (22). In a meta-analysis evaluating a total of 5075 pregnant women in 17 studies, it was reported that performing an aerobic exercise for about 30-60 minutes 2 to 7 times a week during pregnancy generally reduced gestational hypertensive disorders (23). In the current study, it was determined that the low PA level was a weak risk factor in the development of GDM. In addition, more nulliparous pregnant women were observed in the GDM developing group. In a study on 422,672 women, nulliparity and obesity were identified as independent risk factors for GDM, consistent with our study (24).

In a meta-analysis where 26 articles were compiled, it was determined that sedentary behavior increased the frequency of macrosomic infants but did not increase the frequency of GDM. Conflicting results were found regarding hypertensive conditions and neonatal outcomes (25). Mizgier et al. did a study showing that doing PA for at least 21 minutes a day in the second half of pregnancy reduced the risk of gaining weight during pregnancy (26). In our study, no relationship was found between weight gain during pregnancy and PA levels. The reason for this difference is that our study focused on PA only in the first trimester, whereas PA in the second and third trimesters was evaluated in the Mizgier et al. study.

In their study on pregnant women, Medek et al. suggested that being physically active in the middle trimester in both overweight and obese women caused a decrease in OGTT fasting glucose levels (27). In our study, it was observed that pregnant women with high PA levels had lower glucose values in the second hour. However, there was no difference in fasting blood glucose, first-hour glucose levels and HBA1c levels. Unlike our study, the study of Medek et al. evaluated PA in the second trimester. In a large series study, women who had low PA before pregnancy had a higher risk of preterm and instrumental delivery (28). In a study on Indian women, sedentary life has been shown to increase the risk of GDM and adverse perinatal outcomes (29). However, in our study, there was no difference in adverse perinatal outcomes, although there was a lower birth weight in the low PA group.

GDM development mechanisms are complicated and probably the processes that started early in pregnancy are involved (11). Therefore, the reason for the different results in the studies may be that the studies were done in different trimesters. The mechanisms in the early stages of pregnancy are considered to be determinative in both

PE and GDM pathophysiology. Therefore, the fact that the study was conducted in the first trimester and that it was prospective is the strength of our study.

However, this study also has some limitations. Firstly, confounder factors such as occupation and stressful situations of the participants were not evaluated. Secondly, the study was conducted on a relatively limited population.

CONCLUSION

Inadequate PA is a modifiable risk factor in the development of PE and GDM. Behavioral changes in women with insufficient PA levels in the early period may decrease the risk of GDM and PE.

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