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Pilates workouts can improve the labor and newborn outcomes: A case control study

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Ethics Committee Approval
The study was approved by the Non-Interventional Clinical Research Ethics Boards of the Adıyaman University (approval number 2019/8-11).
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.
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Abstract

Background/Aim: Physical activity during pregnancy assumes an important role in the health of both the pregnant and newborn. Our study aims to evaluate the effects of Pilates workouts on labor and newborn outcomes.

Methods: This retrospective case control study was conducted with the nulliparous pregnant women admitted to our obstetrics clinic. We evaluated the effects of a Pilates workout program for 70-80 minutes per day, once a week for eight weeks, on the labor and newborn outcomes. We defined the labor outcomes as the type of delivery and the gestational age at delivery and the newborn outcomes as one-minute (APGAR-1) and five-minute Apgar scores (APGAR-5).

Results: The incidences of episiotomy, vacuum-assisted vaginal delivery, and cesarean section (CS) were significantly lower in pregnant women who participated in Pilates workouts ($P<0.001$). Pilates workouts increased the chance of normal vaginal delivery. The gestational age at delivery was significantly lower, and the APGAR-1 and APGAR-5 scores were significantly higher among those in the Pilates group ($P<0.001$).

Conclusion: A supervised Pilates workout is an effective and achievable exercise method decreasing cesarean delivery and assisted vaginal delivery. It also has no negative effects on newborns, supported by the higher APGAR scores of babies whose mothers were in the Pilates group.

Keywords: Pilates, Pregnancy, Pregnant women, Normal delivery, Cesarean delivery, Newborn

Introduction

The worldwide rate of cesarean delivery has increased since 2000, and Turkey has one of the highest rates of cesarean-section, reported as over 50% [1, 2]. This rise in C-sections (CS) is a global phenomenon, which is an issue of concern as a cesarean delivery is not without risk to the mother and fetus [2, 3]. Maternal risks during a CS are major abdominal surgery complications, placental problems during future pregnancies, respiratory complications, reaction to anesthesia, and longer hospitalization. Besides, neonatal respiratory difficulties and poor sucking reflex are known risk factors for the newborn [3-5].

Exercise during pregnancy contributes to feeling healthy by improving fitness, reducing symptoms of depression, and decreasing gestational weight gain [6, 7]. The strengthening of the muscle of the area involved in regulating labor reduces the pain and the effort needed to give birth [8]. In the absence of complications, pregnant women should be encouraged to join recommended physical activities, which appear to be helpful and reliable for both the mother and fetus [6]. The American Congress of Obstetricians and Gynecologists (ACOG) recommends that all pregnant women should be engaged in moderate-intensity exercise for 30 minutes or more per day on most—if not all—days of the week [9-11].

Among exercise methods, the Pilates workout has become more popular worldwide than other physical activities [12]. For both healthy and unhealthy adults, modern Pilates workout programs are useful and beneficial for increasing feelings of happiness and well-being, reducing anxiety and stress, gaining muscular strength and flexibility, and improving posture [12-15]. Considering that pregnancy leads to several changes in a woman's body, participating in a Pilates workout not only leads to the benefits mentioned, but it also helps the pregnant woman adapt to the physical changes within her body [16, 17].

While there are no international clinical guidelines for Pilates exercises during pregnancy, brief unauthorized recommendations exist in the literature [11, 14]. Several studies investigate the effects of physical exercise on weight gain, type of delivery, and birth outcomes, and a few studies were found in the literature involving a physical exercise program using the Pilates method [16, 17]. The aim of the present study is, therefore, to assess the potential effects of Pilates workouts during the 24th and 40th gestational weeks on labor and newborn outcomes.

Materials and methods

Study design and setting

This retrospective case control study was conducted under the Declaration of Helsinki, and according to the STROBE guidelines [18]. The study was approved by the Non-Interventional Clinical Research Ethics Boards of the Adıyaman University (approval number 2019/8-11) and is based on the obstetric registry data from our hospital between 01.01.2017 and 30.09.2019. Ours is a tertiary care hospital with an obstetrics and gynecology bed capacity of 110. Our obstetric registry includes maternal demographics, medical and obstetric history, obstetric follow-up visit information, labor and delivery outcomes, and

post-natal outcomes for the mothers and the newborns. Because of the nature of our study, we were not required to obtain informed consent from participants.

Study size and participants

We intended to include all pregnant women who met the inclusion criteria for the study, which included (1) being aged 18 years and older, (2) having visited our obstetrics clinic in the first trimester of a nulliparous pregnancy, and (3) having delivered at our hospital. The exclusion criteria were as follows: (1) Having obstetric complications such as preeclampsia, placental anomalies, or fetal anomalies, (2) having a herniated lumbar disk, (3) having a chronic illness such as hypertension, diabetes mellitus, thyroid diseases, rheumatic diseases, chronic hematologic diseases, or chronic obstructive pulmonary disease (COPD), or (4) having had uterine surgery.

This study was performed with the data of the pregnant women admitted to our obstetrics clinic (OC) who gave birth in our hospital. We assessed 9,220 pregnant women for eligibility for the study. After excluding 8,680 women, 540 pregnant women were included in the analyses. We further divided the study cohort into two groups based on their participation in the workout program (Pilates group vs. control group). Of the 540 women in the study, 220 pregnant women (40.7%) participated in the Pilates workout program (Figure 1).

Figure 1: Flow diagram of the study
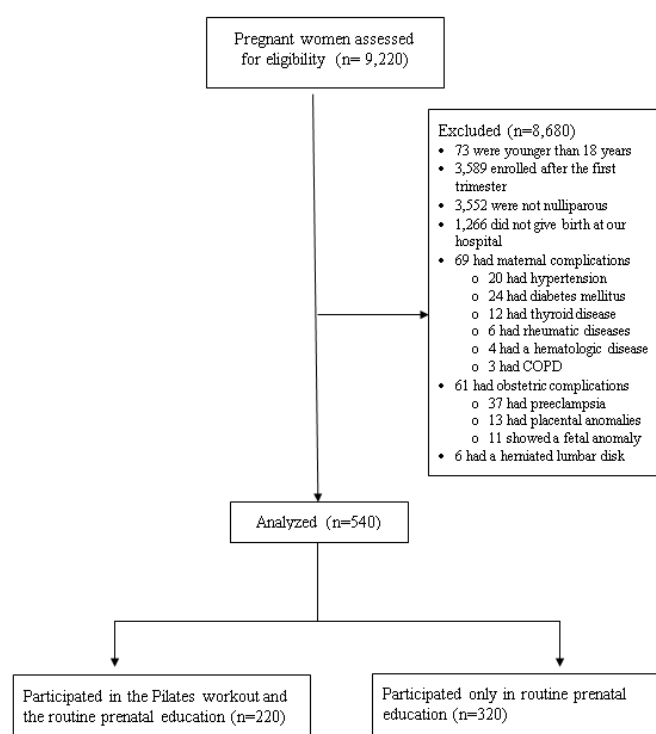
As a standard procedure, all pregnant women who register at our clinic get prenatal education on topics such as medications, dental care, nutrition, weight gain, exercise, and workplace practices. The exercise topic includes describing which physical activities are safe and unsafe, evaluating the patient for any medical conditions that would lead to having to avoid exercise, and recommending appropriate physical exercises. Also, we started a Pilates exercise program modified for pregnancy on January 1, 2017. The Pilates instructors were trained by a senior Pilates instructor, an obstetrician, and a midwife to ensure that the modified exercise program would be safe for pregnant women. Any pregnant women followed up at

our clinic may voluntarily participate in this Pilates exercise program.

The pregnant women participated in the exercise program for 70-80 minutes a minimum of once a week for 8 weeks between the 24th and 40th gestational weeks. The daily workout was designed as a 10-minute warm-up routine, a main exercise session of 50-60 minutes, and a 10-minute cool-down routine. This program was based on official Pilates methods used by the New York Pilates Academy International (PAI) and the San Francisco Balanced Body University (BBU) [19]. It is used to promote good posture and alignment, strengthen the legs to help carry the increased body weight, prevent edema and pain from varicose veins, strengthen the abdominal muscles, protect the cardiovascular system, strengthen the pelvic floor muscles to be used during labor, and strengthen the arms for childcare after childbirth.

Data and variables

We obtained the following data: Age, occupation, education, height and weight, obstetric and medical history, due date, whether they smoked or not, whether they had consulted with a prenatal dietician (in addition to our prenatal education program), previous Pilates experience, their participation in our Pilates exercise program, and the maternal and newborn outcomes from the hospital registry system. Using a three-step control mechanism, the data was compared against the hospital registry for errors including incorrect entries, duplicate records, and user errors. The hospital data processing unit checked the system daily, and the medical service and statistics units checked it monthly. During the final step, the provincial health authorities checked the data and registries and the ministry of health checked the records four times a year.

We calculated pregestational body mass index (BMI), and based on these calculations, we categorized them as underweight (less than 18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), and obese (30.0 kg/m^2 and over). We defined the weight gain during pregnancy as the difference between the weight at labor and the weight on conception.

There are four primary outcomes of the study, of which two are labor outcomes, and two are newborn outcomes. The labor outcomes are the delivery method and the gestational age at delivery. We defined the delivery as normal vaginal delivery (with/without episiotomy or vacuum assistance) and cesarean delivery. The ACOG guidelines were used for selecting the delivery at our hospital [20-22]. We categorized the gestational age at delivery as preterm (less than 37 0/7 weeks), early-term (37 0/7-38 6/7 weeks), full-term (39 0/7-40 6/7 weeks), late-term (41 0/7-41 6/7 weeks), and post-term (42 0/7 weeks and beyond).

The newborn outcomes are based on one-minute (APGAR-1) and five-minute APGAR scores (APGAR-5). A pediatrician calculated the APGAR scores for all newborns one and five minutes after birth.

Statistical analysis

Statistical analyses were conducted using SPSS Statistics version 20.0 (IBM Corp., Armonk, NY). Descriptive data are presented as median with interquartile range (IQR) for numerical variables, and as frequency and percentage for categorical variables. The Shapiro–Wilk and Kolmogorov–Smirnov tests were used to evaluate the distribution of the numerical data. The Mann–Whitney U test was used to compare non-normally distributed numerical data between two study groups. Pearson's chi-squared (χ^2) and Fisher's exact tests were used for comparing categorical variables. We used univariate logistic regression analysis to assess the effect of Pilates on the delivery. Also, we built three multivariate logistic regression models for adjusting covariates (occupation, education level, pregestational BMI, weight gain during pregnancy, previous Pilates experience, and prenatal dietician consultation) to analyze the effect of the Pilates workouts on the delivery. $P<0.05$ was considered statistically significant.

Results

The median age was 26.0 years in each study group. Of those in the Pilates group, almost half were housewives, while 63.7% of the control group were housewives. Among these pregnant women, 48.2% of the Pilates group and 44.7% of the control group had an education level of university or higher. Of the Pilates group, 2.7% were underweight and 9.1% were overweight; however, there were no underweight women among the controls while 10.6% of the women in that group were overweight. The median weight gain during pregnancy within the groups was 9.0 kg and 12.0 kg, respectively. Of these pregnant women, 18.6% and 23.5% were smokers in the Pilates and control groups, respectively. The incidences of episiotomy, vacuum-assisted vaginal delivery, and CS were significantly lower among the Pilates group than the control group ($P<0.001$). Among the Pilates group, 31.8% of the women had previous experience with Pilates, while no one in the control group had had previous experience doing Pilates exercises. Women in the Pilates group consulted with a prenatal dietician nearly five times more than the women in the control group. The median gravida was 1, and there had been zero abortions in either study group (Table 1).

Table 1: Characteristics of the pregnant women

Characteristics	Pilates group n= 220 (40.7%)	Control group n= 320 (59.3%)	P-value
Age (years), median (IQR)	26.0 (23.0-29.0)	26.0 (23.0-29.0)	0.753
Occupation, n (%)			0.026
Housewife	116 (52.7)	204 (63.7)	
Blue-collar worker	32 (14.5)	42 (13.1)	
White-collar worker	72 (32.7)	74 (23.1)	
Level of education, n (%)			0.006
Secondary school	11 (5.0)	3 (0.9)	
High school	103 (46.8)	174 (54.4)	
University	106 (48.2)	143 (44.7)	
Pregestational BMI, n (%)			0.009
Underweight	6 (2.7)	0 (0.0)	
Normal weight	194 (88.2)	286 (89.4)	
Overweight	20 (9.1)	34 (10.6)	
Weight gain during pregnancy (kg), median (IQR)	9.0 (8.0-10.0)	12.0 (11.0-14.0)	< 0.001
Type of delivery, n (%)			< 0.001
NVD	142 (64.6)	44 (13.8)	
NVD with episiotomy	61 (27.7)	144 (45.0)	
NVD with vacuum extraction	6 (2.7)	54 (16.9)	
CS	11 (5.0)	78 (24.4)	
Smokers, n (%)	41 (18.6)	75 (23.5)	0.176
Previous Pilates experience, n (%)	70 (31.8)	0 (0.0)	< 0.001
Prenatal dietician consultation, n (%)	106 (48.2)	32 (10.0)	< 0.001
Gravida, median (IQR)	1.0 (1.0-2.0)	1.0 (1.0-2.0)	
Abortions, median (IQR)	0.0 (0.0-1.0)	0.0 (0.0-1.0)	

IQR: Interquartile range, BMI: Body mass index

The odds ratio of Pilates workouts to the routine prenatal education was 6.1 (95% CI: 3.2-11.8) for the chance of normal delivery compared to the cesarean delivery in the univariate analysis. In the multivariate analyses, we also found

the Pilates workout to significantly affect the type of delivery independent from demographics, pregestational BMI, weight gain during pregnancy, previous Pilates experience, or prenatal dietician consultation (OR (95% CI): 3.2 (1.5-6.8) and P= 0.003) (Table 2).

Table 2: Univariate and multivariate logistic regression analysis for the effect of the Pilates workout participation on the type of delivery

Delivery type	Pilates group n (%)	Control group n (%)	Univariate analysis			Multivariate model 1*			Multivariate model 2**			Multivariate model 3***		
			P	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P	OR	95% CI
Normal	209 (95.0)	242 (75.6)	<0.001	6.1	3.2-11.8	<0.001	5.5	2.6-11.6	0.001	3.6	1.7-7.7	0.003	3.2	1.5-6.8
Cesarean	11 (5.0)	78 (24.4)												

ORs show the chance of the normal delivery (with/without episiotomy and/or vacuum aid) compared to cesarean delivery. * Adjusted for occupation, education level, pregestational BMI, and weight gain during pregnancy. ** Adjusted for occupation, education level, pregestational BMI, weight gain during pregnancy, and previous Pilates experience. *** Adjusted for occupation, education level, pregestational BMI, weight gain during pregnancy, previous Pilates experience, and prenatal dietician consultation.

The gestational age at delivery was significantly lower in the Pilates group compared to the control group ($P<0.001$). However, there was neither preterm nor post-term labor in either group. In the Pilates group, the rates of newborns with birth weights of 2500-3000 gr and 3000-3500 gr were significantly higher when compared to the control group ($P<0.001$) (Table 3).

The one-minute and the five-minute APGAR scores were significantly higher in the Pilates group than the control group ($P<0.001$ and $P<0.001$, respectively) (Table 4 and Figure 2).

Table 3: Comparison of gestational age on delivery and birth weight among the study groups

	Pilates group n= 220 (40.7%)	Control group n= 320 (59.3%)	P-value
Gestational age at delivery, n (%)			
Early term	60 (27.3)	30 (9.4)	<0.001
Full term	159 (72.3)	227 (70.9)	
Late term	1 (0.4)	63 (19.7)	
Birth weight, n (%)			
2500-2999 gr	79 (35.9)	59 (18.4)	<0.001
3000-3499 gr	120 (54.5)	132 (41.2)	
3500-3999 gr	20 (9.1)	117 (36.6)	
≥ 4000 gr	1 (0.5)	12 (3.8)	

Table 4: Comparison of one-minute and five-minute APGAR scores of the newborns among the study groups

APGAR score		Pilates group n= 220 (40.7%)	Control group n= 320 (59.3%)	P-value
One minute	Mean (SD)	7.8 (0.6)	7.0 (0.7)	< 0.001
	Median (IQR)	8.0 (8.0-8.0)	7.0 (6.0-8.0)	
Five minutes	Mean (SD)	9.3 (0.5)	8.8 (0.5)	< 0.001
	Median (IQR)	9.0 (9.0-10.0)	9.0 (9.0-9.0)	

Figure 2: Distribution of (a) one-minute and (b) five-minute APGAR scores of the newborns
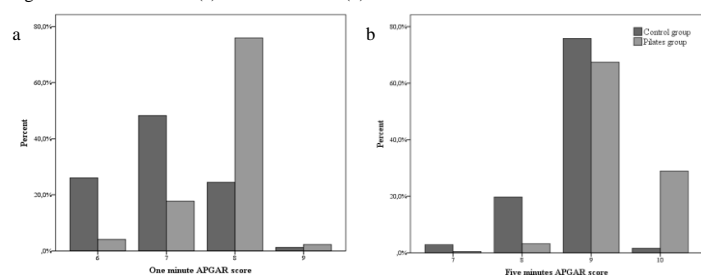
Discussion

Our study includes a relatively large number of pregnant women in both intervention and control groups, when compared to similar studies focusing on the benefits of exercise [8, 13]. Our study demonstrated that Pilates workouts significantly decrease the rate of cesarean and instrumented vaginal deliveries. We performed additional models for adjusting covariates to analyze the effect of the Pilates workouts on the type of delivery, finding that the Pilates workout was associated with a significantly higher incidence of vaginal delivery, and a significantly lower incidence of cesarean delivery independent of demographics, pregestational BMI, weight gain during

pregnancy, previous Pilates experience, and prenatal dietician consultation. No adverse events were noted during or after the Pilates sessions in our study.

To date, several studies investigating the effects of physical exercise on type of delivery have been found in the literature. While some of the studies report that physical exercise does not affect the type of delivery [23, 24], other studies state that physical exercise during pregnancy decreases the risk of Cesarean delivery and increases the likelihood of vaginal delivery [3, 25, 26]. Also, several recently published reviews agree on the effects of physical activity on type of delivery; however, a general lack of consensus exists because the individual trials included in these reviews differ somewhat in terms of how they define exercise, the intensity of exercise, time, and duration of exercise [4, 27-31]. Also, the focus of those authors was not on the type of delivery; hence, detailed information on the indications for performing the cesarean section was rarely reported [4, 24]. The researchers of those studies also stated that lots of confounding factors may affect the main conclusions such as which type of physical activity was carried out, and how the participants were assessed [26].

Several studies were based on data from self-administered questionnaires [6, 24], which are not objective assessment tools. There is little information in the studies on a supervised exercise program, and many studies report observations on leisure time and physical activity related to occupation [3, 24]. Besides, the period of physical activity in these studies varies. While some include early pregnancy through the third trimester, others include only the second or third trimester [3, 6].

Excessive gestational weight gain is associated with an increased risk of complications such as instrumental vaginal delivery and cesarean delivery [25, 32]. Excessive weight gain during pregnancy is also related to an increased risk of weight retention after delivery, with approximately 25% of women experiencing weight retention of 4.5 kg or more [32, 33]. Linne et al. [34] showed that 45.6% of women of normal weight who gained too much weight during pregnancy (an average of 18.8 kg) shifted from normal weight to overweight during a 15-year follow-up period. However, a combined intervention including dietary counseling and physical exercise during pregnancy showed a significantly higher probability of returning to pregestational weight at 6 months postpartum [35, 36]. Therefore, preventive strategies among pregnant women are needed to prevent excessive weight gain during pregnancy. This could help fight the obesity epidemic, because the pregnant women who participated in Pilates workout gained less weight than those in the control group.

Recently, many reports have emphasized that moderate exercise does not increase the risk of preterm delivery [6, 25, 27, 28]. In our study, there was neither preterm nor post-term labor in either group. By using the global-standard APGAR score of the newborns, one- and five-minute APGAR scores of newborns whose mothers participated in Pilates workouts were significantly higher than those in the control group, showing that the overall health status of the newborn was not adversely affected by the Pilates workouts. Moreover, newborn baby weights were significantly higher in the control group. It has

been stated that moderate exercises that start after the 20th gestational week can positively affect fetal development and APGAR scores of these newborns compared to newborn babies of women who do not exercise [37]. Contrary to this study, there was no significant difference between the 1st and 5th minute APGAR scores in a previous study [38].

Several studies are investigating the effects of Pilates exercises on pain control, type of delivery, or strengthening the pelvic floor muscles of pregnant women. Dias et al. [13] investigated the effects of a Pilates exercise program on pelvic floor muscle strength in pregnant women. They found that the program was not able to change pelvic floor muscle strength but emphasized that small sample size (24 pregnant women in the Pilates group and 12 in the control group) may have limited their findings. Rodriguez-Diaz et al. [8] similarly conducted a study of 105 pregnant women (50 in the Pilates group and 55 in the control group) to assess the effectiveness and safety of the Pilates method on functional and labor parameters. They concluded that a Pilates routine increases the rate of normal birth and decreases the need for an episiotomy or a CS.

For many women, it is difficult to find the motivation to start a physical exercise program [4]. It was demonstrated that the percentage of pregnant women who participated in a physical activity program during pregnancy was low [9, 25]. Besides, women who engaged in an exercise program stopped exercising, particularly in the third trimester as they found it difficult to move due to their increased body mass [39]. However, several studies have stated that pregnancy represents a "teachable moment" to adopt healthy behaviors as gravid women are often young and reliably seek healthcare [33, 40].

We believe that the increasing popularity of Pilates workouts over the last few decades may contribute to a greater adherence to Pilates exercises among pregnant women compared to other exercise programs. Domenjos et al. [4] state that pregnancy could be a critical moment to cease the sedentary life if physical exercise is approved to be effective and beneficial for pregnancy outcomes for both mother and fetus. Dias et al. [13] suggested that their Pilates group had good compliance with the intervention. All pregnant women in the Pilates group had completed the program through the last trimester of pregnancy, and that supports this approach.

Limitations

The main limitation of this study was its retrospective design, and the gathering of the data from the hospital registry. However, we have a three-step quality control system to prevent errors and account for missing data. Another limitation is having no data on the dietary habits of the participants, which is an important confounding variable between exercise and its outcomes on health. Furthermore, the baseline characteristics of the pregnant women such as occupation, education level, and pregestational BMI were not balanced among the study groups; however, we performed additional multivariate logistic regression models for adjusting these covariates to analyze the effect of the Pilates workouts on the type of delivery. Also, we used only APGAR-1 score, APGAR-5 score, and birth weight as newborn outcomes, though there are many other outcomes such as the need for intensive care and the neonatal death rate that can demonstrate the health and well-being of the newborns.

Conclusion

In conclusion, the results of our study demonstrate that a supervised Pilates workout is an effective and achievable exercise method decreasing cesarean delivery and assisted vaginal delivery with episiotomies or vacuum extraction. Such an exercise program also has no negative effects on newborns, as supported by the higher APGAR scores. More comprehensive and prospective studies should be conducted to generalize these results.

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