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Investigation of Balance, Pulmonary Function and Low Back Pain in Pregnant and Non-pregnant Women: Case Control Study

Gebe Olan ve Olmayan Kadınlarda Denge, Solunum Fonksiyonları ve Bel Ağrısının İncelenmesi: Vaka Kontrol Çalışması

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ABSTRACT Objective: Balance and pulmonary function could be affected during pregnancy. Low back pain (LBP) is one of the most common health problems in pregnant women. Thus, this study aimed to investigate balance, pulmonary functions and LBP in pregnant and non-pregnant women. **Material and Methods:** This case-control study was conducted at the obstetrics and gynecologic clinic. Thirty-nine pregnant women (pregnant group) and 36 non-pregnant women (control group) were included in this study. Balance was measured with One-Legged Balance Test while the eyes open and closed, pulmonary functions with a spirometer, and LBP with Visual Analog Scale (VAS). **Results:** It was found that the One-Legged Balance Test scores with eyes closed, forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), and peak expiratory flow (PEF) values were found lower in the pregnant group compared to the control group ($p < 0.05$). Twenty-one (53.8%) of the pregnant women and 10 (27.8%) of the non-pregnant women had LBP. The findings showed that LBP was higher in the pregnant group compared to the control group ($p < 0.05$). **Conclusion:** Pregnant women had poor balance with eyes closed and pulmonary functions and more LBP than non-pregnant women. It may be important that these results should be taken into account in pregnancy training programs to increase balance, improve pulmonary functions and reduce LBP during pregnancy.

Keywords: Postural balance; respiratory function tests; low back pain; pregnancy

ÖZET Amaç: Gebelik boyunca denge ve solunum fonksiyonları etkilenebilmektedir. Bel ağrısı gebe kadınlarda en yaygın görülen sağlık sorunlarından biridir. Bu nedenle, bu çalışma gebe olan ve olmayan kadınlarda denge, solunum fonksiyonları ile bel ağrısını araştırmayı amaçlamıştır. **Gereç ve Yöntemler:** Bu vaka kontrol çalışması kadın hastalıkları ve doğum kliniğinde yapıldı. Otuz dokuz gebe kadın (gebe grubu) ve 36 gebe olmayan kadın (kontrol grubu) bu çalışmaya dahil edildi. Denge, gözler açık ve kapalı Tek Bacak Denge Testi ile, solunum fonksiyonları spirometre ile, bel ağrısı Görsel Analog Skala (GAS) ile değerlendirildi. **Bulgular:** Gebe grubunda kontrol grubuna göre gözler kapalı Tek Bacak Denge Test skorları, zorlu ekspiratuar hacim 1. saniye (FEV_1), fonksiyonel vital kapasite (FVC), tepe ekspiratuar akım (PEF) değerlerinin daha düşük olduğu bulundu ($p<0,05$). Gebe kadınların 21 (53,8%)'i ve gebe olmayan kadınların 10 (27,8%)'u bel ağrısına sahipti. Kontrol grubuna kıyasla gebe grubunda bel ağrısının daha fazla olduğu bulundu ($p<0,05$). **Sonuç:** Gebe kadınlar gebe olmayan kadınlara göre zayıf gözler kapalı denge ile solunum fonksiyonlarına ve daha fazla bel ağrısına sahiplerdi. Gebelik sırasında dengeyi arttırmak, solunum fonksiyonlarını iyileştirmek ve bel ağrısını azaltmak için bu sonuçların gebelik eğitim programlarında dikkate alınması önemlidir.

Anahtar Kelimeler: Postüral denge; solunum fonksiyon testleri; bel ağrısı; gebelik

Pregnancy is a physiological process and during pregnancy anatomical, physiological and hormonal changes occur in a woman. These changes alter by advancing gestational age; therefore, low back pain (LBP) may develop, and balance and pulmonary patterns may change during pregnancy.[1-3]

Postural control and balance of women during pregnancy are adversely affected. Recent studies

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have reported that postural instability may increase during pregnancy.[4,5] Changes in the spinal curve, laxity in the ligaments and joints, weight gain, particularly in the abdomen due to the growing fetus, shift the centre of gravity of the body, which in turn result in poor balance.[6,7] Although there are many studies associating balance with different clinical conditions, such as neck pain, LBP, and fibromyalgia as well as with elderly individuals, few findings have been reported regarding the balance of pregnant women.[5-8]

Moreover, some changes also occur in the pulmonary system during pregnancy. These changes in the pulmonary system may develop at an early period due to the effects of progesterone and at a late period due to the enlarging uterus. Progesterone stimulates the respiratory center of the medulla during respiration.[9] The diaphragm elevates by up to 4 cm as the uterus enlarges and the thoracic cavity relocates upwards.[10] It has been observed that even in healthy pregnant women, the pulmonary function changes. Thus, it may be important to assess pulmonary functions in clinical and physiological manner in pregnant women.[11] However, previous studies addressing changes in the pulmonary function during pregnancy have some methodological inadequacies which may limit the validity of the results.[12] In addition, there are contradictory results in the literature related to the issue.

LBP is also a common health problem in pregnant women.[13] LBP is described as a pain localized below the ribs, but above the gluteal folds, with or without radiation down the legs.[14] Weight gain, abdominal and hip muscles dysfunction, decreased neuromuscular control, increased spinal lordosis, ligamentous laxity and core stability impairment are associated with LBP during pregnancy.[7,15] The core region is defined as the cylindrical region which provides the connection between the body and the legs and arms.[16] Main muscles of the core stability are the diaphragm with upper respiratory muscle, transverse abdominus muscle in the front, multifidus muscle in the back, and pelvic floor muscles in the bottom. [16] These muscles play a role in maintaining trunk and lumbopelvic stability.[16] Pregnancy may affect the core system due to the postural changes and growing fetus. When the core system is affected, balance may be impaired, pulmonary functions may be affected and LBP may be seen.

Therefore, this study aimed to research balance, pulmonary functions and LBP and to determine their relationship with LBP in pregnant women and non-pregnant women. The following hypothesis was investigated: 1. Balance, pulmonary functions and LBP would be different in pregnant women compared to non-pregnant women.

MATERIAL AND METHODS

STUDY DESIGN

A case-control design was used in this study. Ethics Committee of Gaziantep University approved the protocol of the study (approval date: 26.04.2017, approval number: 2017/176), and this study was accomplished in compliance with the rules of the Declaration of Helsinki.

PARTICIPANTS

For pregnant group, pregnant women in the second and third trimester, aged between 18 and 40 years, volunteering to participate in the study were assessed at the obstetrics and gynecologic clinic. Pregnant women with a high-risk pregnancy, preeclampsia, multiple pregnancies, gestational diabetes mellitus, hypertension, any physical disability, prior history of surgery related to spine or abdomen, spinal deformity, serious neurological, rheumatologic, cardiopulmonary or psychiatric diseases, malignancy, fracture history, or those having any exercise program or sport activity in the last 3 months were excluded from the study.

For control group, non-pregnant women, volunteering to participate in the study, aged between 18 and 40 years, were randomly selected from a healthy life centre. Participants with any physical disability, spinal or abdominal surgery, spinal deformity, serious neurological, rheumatologic, cardiopulmonary and psychiatric diseases, malignancy, or fracture history, or those having any exercise program or sport activity in the last 3 months were excluded from the study. After all participants were informed as to the aims of the study, their written informed consent was acquired.

EVALUATIONS

Demographic and physical characteristics data were collected for all participants. The assessment form included age, weight, education level, exercise habit, smoking and alcohol consumption. Participants' body mass index (BMI): body weight (kilograms)/height (meters) was calculated from the formula.[2] The gestational weeks of the pregnant women were questioned. All evaluations related to balance, pulmonary function, and LBP were carried out by the same physical therapist.

Balance was evaluated with one-legged balance test, eyes open and closed. Each woman was asked to stand on the dominant leg with the arms crossed on the chest. She then lifted one foot by bending the knee joint at an angle of about 45° and the time was started with a stopwatch. The test was performed for 30 seconds. The stopwatch was stopped and the time was recorded in seconds in case of any support using the arms or the opposite leg. Three repetitions were performed and the best result was recorded. The same test was performed on the non-dominant leg.[17,18]

Pulmonary function was measured using a spirometer (MIR Spirobank Hand-Held Spirometer, Italy) in conformity with the criteria of American Thoracic Society and European Respiratory Society.[19] Age, height and weight of all participants were recorded before measurement. Pulmonary function tests were performed by a physical therapist using the previously described methods. All measurements were taken with the participant seated and in the resting state, at least three hours postprandial. Before starting the test, the nose latch was attached to prevent air leakage. A challenging expiration maneuver was followed by challenging inspiration. For the correctness of the measurements, the test was performed 3 times and the best configuration within the 3 measurements was recorded. Forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), and peak expiratory flow (PEF) values were recorded.

LBP intensity was assessed with the visual analog scale (VAS). The VAS is a horizontal line with a length of 10 cm.[20] On this scale, 0 means "no pain", 10 means "insufferable pain". All participants were asked to show their LBP intensity on the horizontal line.

SAMPLE SIZE AND STATISTICAL ANALYSES

Before the present study, ten participants from two groups were randomly selected for the pilot study. The necessary sample size calculation was determined using G*Power package software program (G*Power, Version 3.0.10, Franz Faul, Universität Kiel, German).The results of FEV_1 parameters was used to estimate the sample size. We calculated that a sample consisting of 72 individuals (36 per group) was needed to obtain 90% power with d=0.78 effect size, $\alpha = 0.05$ type I error, and $\beta = 0.10$ type II error.[21]

All data analyses were performed via IBM SPSS Statistics 21.0 (IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.). Visual (histograms, probability plots) and analytical methods (Shapiro-Wilks test) were used to specify whether or not the variables were normally distributed. Descriptive analyses were calculated for all variables and normally distributed data were indicated as mean and standard deviation, non-normally distributed data were indicated as median, minimum and maximum, ordinal variables were indicated as frequency.

Normally distributed numeric variables related to age, BMI, balance scores, pulmonary function scores, and non-normally distributed variables related to pain intensity were assessed with the independent sample t test and the Mann-Whitney U test, respectively. The Spearman's correlation test was used to assess the relationship among LBP intensity, balance scores, and pulmonary function scores in pregnant women. An overall P-value<0.05 was accepted as statistically significant.

RESULTS

Forty-six pregnant women and fifty non-pregnant women were assessed. In total, 39 (30 pregnant women in 2nd trimester (76.9%), 9 pregnant women in 3rd trimester (23.1%)) pregnant women in the pregnant group and 36 non-pregnant women in the control group women were included. Details of included and excluded participants were provided as a flowchart (Figure 1).

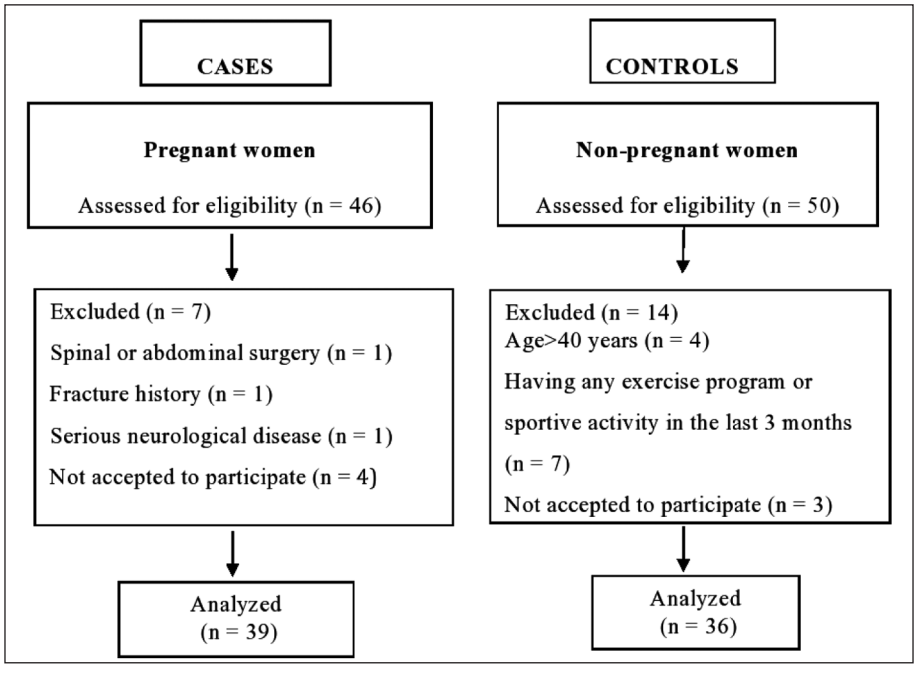

FIGURE 1: The flowchart diagram for the participants.

The mean gestational week of the pregnant women in the second trimester was 20.53±3.99, while the mean gestational week of the pregnant women in the third trimester was 28.70±1.56. No significant differences between groups were noted in baseline physical characteristics, except for the BMI ($p<0.05$) (Table 1). None of the participants had exercise, smoking, and alcohol consumption habits.

It was found that the right leg balance scores with eyes closed ($p=0.001$), the left leg balance scores with eyes closed ($p<0.001$), and FEV_1 ($p=0.002$), FVC ($p=0.022$), PEF ($p=0.001$) values diminished in the pregnant group compared to the control group (Table 2). In addition, the percentage predictive values of FEV_1, FVC and PEF in pregnant women were 75.59±20.48; 88.4±20.55 and 47.48±2.88, respectively; while, the percentage predictive values of FEV_1, FVC and PEF in non-pregnant women were 88.13±10.81; 91.14±17.69 and 80.12±21.55, respectively.

In this study, it was observed that 21 (53.8%) of the pregnant women and 10 (27.8%), of the non-pregnant women had LBP complaint. In addition, it was detected that LBP intensity increased in the pregnant women compared to non-pregnant controls ($p=0.034$) (Table 2).

DISCUSSION

In the present study, the following findings were observed: (i) In pregnant women, balance scores decreased with eyes closed compared to non-pregnant women. (ii) Pulmonary functions (FEV_1, FVC and PEF values) of the pregnant women decreased. (iii) When the two groups were compared, the existence and intensity of LBP was significantly higher in pregnant women.

Pregnancy might have a negative effect on balance. A previous study showed that the balance of pregnant women is adversely affected more than that of non-pregnant women, which increases the risk of falls and injuries.[5,22] Falls or injuries during pregnancy might also lead to maternal and fetal complications, such as bone fractures, joint sprains, muscle injuries, head trauma, rupture of visceral organs, internal hemorrhage, premature delivery, abruption placenta, uterine rupture, premature rupture of membranes, and maternal and fetal deaths during pregnancy.[8] Most of the studies indicated that postural balance, as indicated by static or dynamic with clinic

TABLE 1: Demographic and physical characteristics of the participants.

Characteristics	Pregnant group (n=39)	Control group (n=36)	p
Age (years,X± SD)	28.46±5.18	29.00 ± 6.05	0.752[a]
BMI (kg/m²,X± SD)	26.53±4.48	22.68 ± 4.35	<0.001[a*]
Education [years, Median (Min-Max)]	15.0 (5.0-15.0)	15.0 (5.0-15.0)	0.624[b]

*p < 0.05, X: Mean, SD: standard deviation, Min: minimum, Max: maximum, BMI: body mass index, a: Independent sample t test, b: Mann-Whitney *U* test.

TABLE 2: Differences between balance, pulmonary function and LBP scores of the groups.

Values	Pregnant group (n=39)	Control group (n=36)	p
Balance (s, X±SD)			
Right leg balance scores with eyes open	29.74±1.60	29.72±1.66	0.955[a]
Left leg balance scores with eyes open	29.38±2.76	29.72±1.67	0.529[a]
Right leg balance scores with eyes closed	22.58±7.68	27.88±4.82	0.001[a*]
Left leg balance scores with eyes closed	19.15±8.73	26.36±5.80	<0.001[a*]
Pulmonary function (X±SD)			
FEV_1 (lt)	2.34±0.62	2.85±0.72	0.002[a*]
FVC (lt)	3.17±0.73	3.52±0.54	0.022[a*]
PEF (lt/s)	3.23±1.47	4.53±2.21	0.001[a*]
Pain Intensity [cm, Median (Min-Max)]			
LBP	3.2 (0.0-7.6)	0.0 (0.0-5.8)	0.034[b*]

* p < 0.05, X: mean, SD: standard deviation, Min: minimum, Max: maximum, FEV_1: forced expiratory volume in one second, FVC: forced vital capacity, PEF: peak expiratory flow, LBP: low back pain, a: Independent sample t test, b: Mann-Whitney *U* test.

tests or balance devices, decreases during pregnancy, with the lowest balance values obtained in the third trimester.[3,5] Butler et al. observed that balance was equal between the pregnant and non-pregnant groups in the first trimester, and started to decrease in the second trimester.[4] Within our knowledge, there exist no sufficient results regarding balance with eyes closed in pregnancy, although the visual system is an important factor for balance control.[3,5,7] We also evaluated balance with the one-legged balance test with eyes open and closed in two groups and found a decrease in balance with eyes closed in the pregnant women. In the study of Bohannon et al., balance scores with the one-legged balance test with eyes open and closed in the individuals between the ages of 20-39 were found to be 30±0 and 27.8±5 seconds, respectively.[23] Springer et al. found that normative values for the one-legged balance test with eyes open of women (18-39 years) were 45.1±0.1 second.[24] It was determined that these values were less in pregnant women of similar age group in our study. Moreover, Springer et al. detected the one-legged balance test values with the eyes closed of women (18-39 y) as 13.1±12.3 second.[24] In this study, 1 trial with eyes open followed by 1 trial with eyes closed equaled 1 trial set. A total of 3 trial tests were performed. In our study, these values were detected as 22.58±7.68 for the right leg balance scores and 19.15±8.73 for the left leg balance scores. We performed 3 consecutive tests with eyes open and closed; therefore, the pregnant women may have adapted better to one-legged balance test with eyes closed. Relying on the results of the present study, balance training with eyes open and closed may be a good way for the prevention of falls and injuries caused by poor balance in pregnant women in the clinics.

During pregnancy, hormonal changes and progressive increase in abdominal diameter may lead to mechanical and functional effects on the pulmonary system.[12] Inadequate respiratory functions may lead to preeclampsia, preterm birth, low birth weight and intrauterine growth retardation.[25,26] Previous studies related to pulmonary functions in pregnant women put forward contradictory results. For this reason, it

may be crucial to observe pulmonary functions physiologically and clinically. Some studies concluded that pulmonary functions did not change in pregnancy, compared with a non-pregnant group and during pregnancy.[27,28] However, Grindheim et al. reported differences in FVC and PEF values.[12] Gupta and Dixit observed a significant decrease in all pulmonary function test parameters such as FEV_1, FVC and PEF in all trimesters of healthy pregnant women compared to non-pregnant women.[29] Pastro et al. found that FEV_1 and FVC values decreased significantly in the third trimester.[30] Brancazio et al. reported no change in PEF; whereas, Zannat and Nessa, detected that PEF significantly decreased both in the first and third trimesters of pregnancy compared to non-pregnant women.[31,32] Our findings pointed out a significant decrease in FEV_1, FVC, and PEF values in pregnant women compared to non-pregnant women. These results inferred that maternal pulmonary alterations could affect the metabolism and well-being of the fetus through their influence on placental gas exchange.[33] Pulmonary function is considered to be normal when FEV_1, FVC and PEF are ≥80% of predictive values in studies.[34,35] As a result, in pregnant women a clinically significant decrease was found in FEV_1 and PEF values compared to normal values. According to our results, the pulmonary function test should be evaluated during the routine antenatal examination, and breathing exercises might be added to the pregnant training program for improving maternal and fetal health in the pregnancy.

Pregnancy-related LBP is a common, mild, moderately disabling, and treatable complication of pregnancy.[36] In the study of Al-Sayegh et al., 31.8% of women reported that LBP started in the first trimester of pregnancy.[37] Sencan et al. showed that about 1 in 2 pregnant women in Turkey had LBP at any trimester of pregnancy.[36] Similarly, in our study, approximately 54% of the pregnant women in the second and third trimesters had LBP and also the pregnant women had more LBP compared to non-pregnant women. These results may be due to the hormonal changes in pregnancy begin before significant weight gain and postural adaptations. Pregnant women should be performed different exercise approaches, manual techniques and various physical therapy agents for LBP.

Our study had some limitations. First, there was no homogeneity of the trimesters. The pregnant women in the second and third trimester were included in our study. In future studies, it may be important to evaluate these parameters focusing on the trimester. Another limitation was that we evaluated static balance with eyes open and closed in pregnant women. However, the dynamic balance of pregnant women with eyes open and closed should be evaluated in future studies because these individuals are functional.

CONCLUSION

In this study, a decrease in balance with eyes closed and in pulmonary functions, and an increase in LBP were observed in pregnant women. According to these results, balance training to increase balance, breathing exercise programs to increase pulmonary capacity, various physical therapy agents (e.g. cold application, kinesio taping, manual therapy, massage) and exercise approaches for LBP can be suggested in the pregnant women. The awareness of the health professionals related to this issue should be increased.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Clinical Trial Number

The study protocol was registered at http://clinicaltrials.gov (NCT03467321).

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

***Idea/Concept**: Şeyda Toprak Çelenay, Yasemin Karaaslan; **Design:** Şeyda Toprak Çelenay, Yasemin Karaaslan, Mete Gürol Uğur; **Control/Supervision:** Şeyda Toprak Çelenay, Yasemin Karaaslan, Mete Gürol Uğur; **Data Collection and/or Processing:** Şeyda Toprak Çelenay, Yasemin Karaaslan, Mete Gürol*

*Uğur; **Analysis and/or Interpretation:** Şeyda Toprak Çelenay, Yasemin Karaaslan, Mete Gürol Uğur; **Literature Review:** Şeyda Toprak Çelenay, Yasemin Karaaslan, Mete Gürol Uğur; **Writing the Article:** Şeyda Toprak Çelenay, Yasemin Karaaslan, Mete Gürol Uğur; **Critical Review:** Şeyda Toprak Çelenay, Yasemin Karaaslan, Mete Gürol Uğur; **References and Fundings:** Şeyda Toprak Çelenay, Yasemin Karaaslan, Mete Gürol Uğur; **Materials:** Şeyda Toprak Çelenay, Yasemin Karaaslan, Mete Gürol Uğur.*

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