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CORRELATION BETWEEN FOOTWEAR SUITABILITY, FEAR OF FALLING AND PHYSICAL ACTIVITY IN THE THIRD TRIMESTER

ORIGINAL ARTICLE

ABSTRACT

Purpose: Pregnancy is a time in which the biomechanics of the body changes due to intense physiological and physical changes, especially in the third trimester, when an increase in falls and a decrease in physical activity may occur. The aim of this study is to investigate the relationship between the suitability of footwear used by pregnant women, fear of falling, and physical activity in third trimester of pregnancy.

Methods: One hundred twenty-three pregnant women aged between 18-40 years with a gestational age of 28 weeks and above were included the study. The Footwear Assessment Score was used to assess the suitability of the footwear. The fear of falling of the participants was measured using the Falls Efficacy Scale-International, and the physical activity level was measured using the short form of the International Physical Activity Questionnaire.

Results: A low negative correlation ($r=-0.215; p<0.05$) was found between physical activity and fear of falling, and a low positive correlation ($r=0.256; p<0.01$) was found between footwear suitability and physical activity in pregnant women. There was no statistically significant relationship ($r=-0.120; p=0.185$) between footwear suitability and fear of falling.

Conclusion: According to the findings of the current study, it can be concluded that physical activity and a more appropriate choice of shoes based on the level of physical activity may reduce the fear of falling during pregnancy. Future studies are needed to investigate footwear suitability during pregnancy in more detail.

Keywords: Footwear Suitability, Fear of Falling, Physical Activity, Pregnancy, Third Trimester

ÜÇÜNCÜ TRİMESTERDE AYAKKABI UYGUNLUĞU, DÜŞME KORKUSU VE FİZİKSEL AKTİVİTE ARASINDAKİ İLİŞKİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Gebelik, özellikle üçüncü trimesterde yoğun fizyolojik ve fiziksel değişikliklere bağlı olarak vücut biyomekaniğinin değiştiği, düşmelerde artış ve fiziksel aktivitede azalmanın söz konusu olabildiği bir dönemdir. Bu çalışmanın amacı gebeliğin üçüncü trimesterinde gebelerin kullanmış olduğu ayakkabıların uygunluğu, düşme korkusu ve fiziksel aktivite arasındaki ilişkiyi araştırmaktır.

Yöntem: Çalışmaya 18 - 40 yaş arası, gestasyonel yaşı 28 hafta ve üzeri olan 123 gebe dahil edildi. Ayakkabı uygunluğunu değerlendirmek için Ayakkabı Değerlendirme Ölçeği kullanıldı. Katılımcıların düşme korkusu Uluslararası Düşme Etkinlik Ölçeği ile, fiziksel aktivite düzeyleri ise Uluslararası Fiziksel Aktivite Anketi - kısa form kullanılarak ölçüldü.

Sonuçlar: Gebelerde fiziksel aktivite ile düşme korkusu arasında düşük negatif korelasyon ($r=-0.215; p<0,05$), ayakkabı uygunluğu ile fiziksel aktivite arasında düşük pozitif korelasyon ($r=0,25; p<0,01$) bulundu. Ayakkabı uygunluğu ile düşme korkusu arasında istatistiksel olarak anlamlı bir ilişki ($r=-0,120; p=0,185$) yoktu.

Tartışma: Bu araştırmanın bulgularına göre gebe kadınlarda fiziksel aktivite düzeyi arttıkça ayakkabı seçiminde daha uygun ayakkabılar olacağı ve fiziksel aktivitenin gebelikte düşme korkusunu azaltabileceği sonucuna varılabilir. Gebelikte ayakkabı uygunluğunun daha detaylı araştırılması için gelecek çalışmalara ihtiyaç vardır.

Anahtar kelimeler: Ayakkabı Uygunluğu, Düşme Korkusu, Fiziksel Aktivite, Gebelik, Üçüncü Trimester

INTRODUCTION

Pregnancy is a complex period of intense physiological and bodily changes, especially in third trimester, which may have an impact on the well-being of the mother. Changes include a growing uterus, hormone fluctuations, triggering ligamentous laxity and weight gain (1,2). There are also postural changes and biomechanical adaptations that develop during pregnancy, such as moving the center of gravity forward due to the developing fetus and growing uterus, which results in increased lumbal lordosis (2,3). In order for the longitudinal arch to adapt to the increased body weight, the foot must have sufficient flexibility (4). The hormonal changes during pregnancy increase the laxity of ligaments and cause a decrease in the height of the foot arches and an increase in the foot length and forefoot width (4–6). Due to these anatomical adaptations in the foot, choosing suitable shoes during pregnancy is crucial and can be difficult. The use of appropriate shoes positively affects physical fitness and performance by supporting the arches of the foot. Kolářová et al. (7) reported that the load on the foot shifts during pregnancy in a forward medial direction and the plantar pressure values increase under the longitudinal arch and medial forefoot region. In the same study, the authors investigated the effects of biomechanical shoes, which consist of patented insoles, to promote a more balanced load on all the toes when walking and correction of the calcaneus position in pregnant women; but there was no effect of the biomechanical shoes worn at least 3 hours a day on the feet of pregnant women (7). Previous studies have also focused on special footwear designs for pregnant women as foot health is important (8,9). While most of the studies investigate the effects of special or specially designed shoes during pregnancy (8–11), there is a limited number of studies examining the shoes that women choose during pregnancy (12).

Postural and biomechanical changes occurring in the joints and soft tissues, such as ligaments, alter the postural balance and increase the risk of falling (2). According to a study conducted by Dunning et al. (13), 1070 of 3997 pregnant

women reported falling at least once during pregnancy. Falling may be due to internal factors as well as external factors, such as inappropriate shoes (14). The leading extrinsic causes of falls of pregnant women are slippery surface and carrying an object (or a child) (14). In a study, it was also reported that the risk of falling is significantly increased in pregnant women who do not participate in regular physical activity (15).

A reduction of physical activity is often observed as a result of various factors during pregnancy (16). Román-Gálvez et al. (17) reported that physical activity decreases with pregnancy, increases slightly in the second trimester but drops in the third trimester. However, regular physical activity during pregnancy improves physical conditioning, helps control maternal weight gain, improves body image, and provides psychological well-being (16). Physical activity during pregnancy can also improve cardiovascular health by reducing heart rate and blood pressure, improve pulmonary function by increasing peak flow and improving oxygen uptake, and reduce the risk of developing gestational diabetes by increasing insulin affinity (16,17). Additional advantages are reduced risk of depression, improved quality of sleep, reduced anxiety, and reduced edema in the extremities (16). Increasing physical activity during pregnancy is important for the health of the pregnant woman and the fetus considering the majority of body changes occur in the third trimester. Similarly, it is also important to know the factors that cause falling during pregnancy to reduce the risk of falling and to protect the health both of pregnant woman and the fetus. So, the aim of this study is to investigate the relationship between the footwear suitability, fear of falling, and physical activity in third trimester of pregnancy.

METHODS

This cross-sectional descriptive study was carried out in accordance with the guidelines of Declaration of Helsinki and approved by the Ethics Committee of Erciyes University under protocol number 96681246-2019/727. Written informed consent was obtained from all subjects included in the study.

Participants

The study sample consisted of 123 pregnant women followed up for antenatal care in the Kayseri City Hospital. Between October 2019 and June 2020, women aged between 18-40 years, having a spontaneous pregnancy, and with a gestational age of 28 weeks and above were included in the study. Women with high-risk pregnancies detected by the physician, with chronic (neurologic, endocrine, orthopedic, or rheumatologic) diseases, with chronic vertigo, with acute or chronic otitis media, with multiple pregnancies, and women who wore shoes other than regular daily footwear at the time of assessments were excluded.

Sample size

In the literature, a correlation coefficient 0.271 was reported for the relationship between fall risk and physical activity in women aged 20-73 years (18). In this study, we hypothesized to detect a significant relationship between fear of falling and physical activity with a correlation coefficient in pregnant women. The sample size was calculated as 123 subjects to detect this relationship with a 95% confidence level and 80% power (19).

Measurements

Socio-demographic characteristics of the participants, such as age, education level, occupation, smoking-alcohol use, medication use, previous pregnancy and number of miscarriages, gestational week, and the history of falls in current and previous pregnancies were recorded. Participants were also asked if the shoes worn at the time of assessments were their regular daily footwear.

The Footwear Assessment Score (FAS) was used to assess the suitability of the footwear. The footwear-related parameters, such as the shoe style, bending point, width, height of the toe box, slipping out of the foot when walking, the distance between the longest toe and the shoe, heel height and fixation are assessed with FAS. Scored out of 15, higher scores indicate a higher suitability level of the footwear (20,21). Although the FAS is a scale developed primarily for use in children's footwear, it is also used in

different age groups such as adults (22), older adults, (23) and elderly (24) in the literature. The Turkish version of FAS proved to be reliable (20).

The fear of falling of the participants was measured using The Falls Efficacy Scale-International (FES-I). The scale is a commonly used clinical tool for the assessment of perceived confidence in performing a range of activities (both physical and social) of daily life without falling. FES-I consists of 16 items, which are scored on a 4-point Likert scale ranging from 1 (not at all concerned) to 4 (very concerned). Response scores for all items are summed to yield a total FES-I score ranging between 16 (absence of concern) and 64 (extreme concern), with a higher sum score indicating lower self-efficacy (25). The Turkish version of FES-I proved to have reliability and validity (26).

The International Physical Activity Questionnaire (IPAQ) is a widely used standardized tool to measure the level of physical activity, with the long (27-item) and short form (7-item) versions available (27). The short form of IPAQ was used to evaluate the level of physical activity of the participants in this study. The questionnaire included questions about the frequency and duration of vigorous intensity, moderate intensity, and walking activity in the previous 7 days. The scores were calculated of the estimation of energy expenditure in metabolic equivalent (MET) (3.3 MET for walking, 4 MET for moderate activity and 8 MET for vigorous activity) (27,28)097 university students (721 women, 376 men; ages 18-32. The results of the items were summarized to determine the overall physical activity score of all categories and the participants were classified into high, moderate, and low activity groups based on their scores. In this study, high physical activity level was defined as >3000 MET-min/week, moderate physical activity level 600-3000 MET-min/week, and low physical activity level <600 MET-min/week. The Turkish version of FES-I proved to have reliability and validity (27,29)but no standardised systems exist for international surveillance. The International Physical Activity Questionnaire (IPAQ). The IPAQ also contained an item about time spent sitting, developed as a separate indicator and not

Table 1. Sociodemographic and Clinical Characteristics of the Participants

	X ± SD	MIN - MAX
Age (year)	27.41 ± 5.62	18 - 41
Gestational age (week)	36.48 ± 2.5	29 - 41
	n	%
Educational level		
Elementary school	58	47.15
High school	52	42.28
Undergraduate	11	8.94
Graduate	2	1.63
Occupation		
Housewife	103	83.74
Government official	9	7.32
Self-employed	9	7.32
Other	2	1.63
Number of previous pregnancies		
0	74	60.16
1	27	21.95
2	11	8.94
≥ 3	11	8.94
Number of miscarriages		
0	117	95.12
1	4	3.25
≥ 2	2	2.63

X ± SD = mean ± standard deviation; MIN - MAX = minimum - maximum

as part of the summed physical activity score (27,28)097 university students (721 women, 376 men; ages 18-32, and it was not included in physical activity score in this study.

Statistical analysis

Qualitative variables are presented as percentages and quantitative variables are shown as means with standard deviations. Data analyses were performed using the SPSS V.20 (SPSS Inc., USA) program. The Shapiro-Wilk test was used to evaluate whether the data had normal dis-

tribution. Spearman correlation coefficient and statistical significance were calculated for the relationships between variables, at least one of which was not normally distributed. The significance level was accepted as $p < 0.05$.

RESULTS

Nine women had a history of falling at least once in their previous pregnancies, and another seven had a history of falling at least once in their current pregnancy. There was no woman with a history of falling in both her previous and cur-

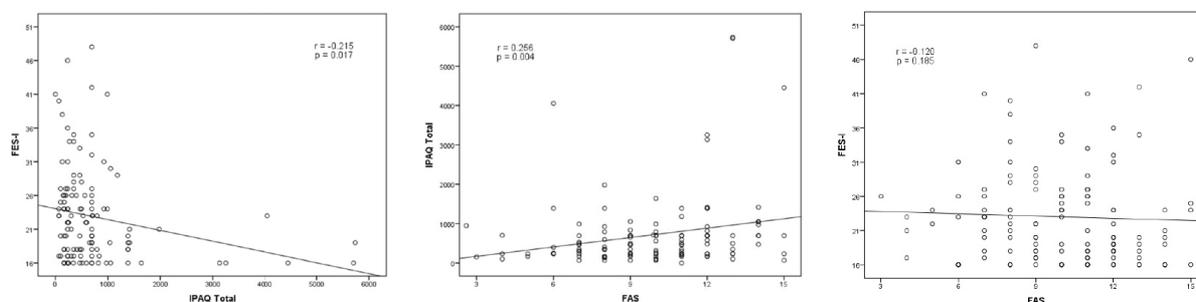


Figure 1. The Relationships Between Footwear Suitability, Fear of Falling and Physical Activity. IPAQ = International Physical Activity Scale; FES-I = The Falls Efficacy Scale-International; FAS = The Footwear Assessment Score

Table 2. The Footwear Suitability, Fear of Falling, Physical Activity Scores and Physical Activity Levels of Participants

	X±SD	MIN-MAX
FAS	9.92 ± 2.63	3 - 15
FES-I	22.61 ± 7,1	16 - 48
IPAQ (MET-min/week)		
Vigorous	0	0
Moderate	144.32 ± 482.43	0 - 3360
Walking	563.41 ± 690.8	0 - 5544
IPAQ Total	707.78 ± 949.11	0 - 5704
Sitting	420.2 ± 343	90 - 2400
	n	%
The physical activity level according to IPAQ		
Low	75	61
Moderate	42	34.1
High	6	4.9

X ± SD = mean ± standard deviation; MIN - MAX = minimum - maximum; FAS = The Footwear Assessment Score; FES-I = The Falls Efficacy Scale - International; IPAQ = International Physical Activity Questionnaire; MET = metabolic equivalent task

rent pregnancies. None of the pregnant women included in the study were on medication other than vitamin/mineral supplements taken under physician supervision during pregnancy. None of the women consumed alcohol, and 12 women declared that they smoked during their current pregnancies. Other demographic and clinical characteristics of the participants included in the study are shown in Table 1. The footwear suitability, the fear of falling, the physical activity scores and levels are shown in Table 2. The physical activity levels of the pregnant women were categorized as low (n = 75), moderate (n = 42), and high (n = 6) according to IPAQ (Table 2).

The results of the study showed a low negative correlation ($r = -0.215$; $p = 0.017$) between physical activity and fear of falling, and a low positive correlation ($r = 0.256$; $p = 0.004$) between footwear suitability and physical activity in pregnant women. There was no statistically significant relationship ($r = -0.120$; $p = 0.185$) between footwear suitability and fear of falling (Figure 1).

DISCUSSION

To our knowledge, there is no study that investigates the relationship between footwear suitability, fear of falling, and physical activity during pregnancy. In this study where we aimed to investigate the relationship between footwear suitability, fear of falling, and physical activity in the third trimester of pregnancy, a low positive

correlation was found between footwear suitability and physical activity, and a low negative correlation was found between physical activity and fear of falling in pregnant women. However, there was no relationship between footwear suitability and fear of falling in pregnant women. One of the important findings in this study is that more than half of the pregnant women had low physical activity levels according to the IPAQ.

As pregnancy progresses, physical changes occur, such as the shift of the center of gravity, increased lumbar lordosis, and a decrease in the longitudinal arch of the foot due to increased body mass and an enlarged uterus (3,4). The kinematics of gait also changes during pregnancy with the changes in pelvic tilt, increased hip flexion, stance knee and swing foot angle ranges of motion (30,31). Due to the anatomical adaptations and changes in gait kinematics, choosing suitable shoes during pregnancy is important and can be difficult. Low heel height (<3 cm), but not flat shoes, is recommended during pregnancy to avoid musculoskeletal disorders (32). Kolářová et al. (7) reported that the load of the foot shifts during pregnancy in a forward medial direction and the plantar pressure values increase under the longitudinal arc and medial forefoot region, but it has also been noted that the biomechanical shoes worn at least 3 hours a day had no effects on the feet of pregnant women. While most

of the studies investigate the effects of special or specially designed shoes during pregnancy (8–11), there is a limited number of studies examining the shoes that women choose during pregnancy (12). Most of these studies investigated the causes of falls during pregnancy and mentioned the unsuitability of the shoes at the time of the fall (12,13,33,34). In a qualitative research performed by Brewin et. al. (1), pregnant women reported wearing slippers, flip-flops, or high heels. In another study, the use of high heels during pregnancy was mentioned (32). The present research is one of the few studies in the literature investigating the shoes that women choose during pregnancy. As a result of this study, an average of 9.9 points was obtained in the suitability of shoes evaluated with the FAS, with a maximum of 15 points, which may indicate that suitable shoes were used during pregnancy by most of the participants.

A number of previous studies have evaluated postural balance and found decreased postural equilibrium and increased postural instability, especially greater antero-posterior sway, during pregnancy (35,36). Postural and biomechanical changes occurring in the joints and soft tissues, such as ligaments, alter the postural balance and increase the risk of falling during pregnancy (2). Falls are a common cause of injury during pregnancy, such as bone fractures, preterm delivery, joint and muscle injuries, and head trauma, and they potentially pose a danger to both maternal and fetal health (2,37). It was reported that falls are the second most common cause of trauma in pregnancy after traffic accidents (38). There are many risk factors for falling during pregnancy such as women ≥ 160 cm in height, young women compared to older pregnant women, walking on slippery floors, carrying an object, or having one or more toddlers (13,33,34). In a current systematic review 13 intrinsic and 11 extrinsic risk factors for falling during pregnancy were identified, including inappropriate shoes (14). It was also recommended to wear shoes to increase the shoe-floor coefficient of friction to reduce falls during pregnancy (39). In our study, no significant correlation was found between footwear suitability and fear of falling perceived by women ($r = -0.120$; $p = 0.185$). So, it can be concluded

that the choice of shoes does not affect the fear of falling during pregnancy. However, it is important to note that this result emphasizes footwear suitability and “fear of falling”, not the actual fall events in pregnancy. More studies that investigate the relationship between the history of falling in the past or current pregnancy and the suitability of footwear are needed. McCrory et al. (15) also reported that the risk of falling is significantly increased in pregnant women who do not participate in regular physical activity.

Regular physical activity during pregnancy is crucial and previous studies have focused on this topic (17,40,41). Daşikan et. al (42) reported that pregnant women had low physical activity levels in Turkey. In the present study, only 6 (5%) women had high, 42 (34%) women had moderate, and 75 (61%) had low levels of physical activity. According to a cohort study, physical activity decreases during pregnancy and critically drops in the third trimester (17). However, guidelines include recommendations to encourage pregnant women without any complications to perform moderate-intensity physical activity during pregnancy (40,41). Physical exercises were suggested as preventative strategies to increase postural stability and reduce the risk of falling among pregnant women (2,15). McCrory et al. (15) reported that sedentary pregnant women had a higher rate of falls than those who performed exercise. Similarly, there was a low correlation between physical activity and fear of falling in our study. The fear of falling in pregnant women decreased as they exercised. Physical activity, among other important and positive effects, can create a healthier pregnancy experience by reducing the fear of falling in pregnant women.

Gimunová et al. (9) reported that special footwear designed for pregnant women changes the kinematic of gait pattern with a preventive effect against the falling of the foot arches. Another study demonstrated that wearing special footwear among pregnant women may prevent venous blood velocity reduction and decrease the risk of venous disease development during advanced phases of pregnancy (10). Considering the effects of body kinematics and blood circulation on physical activity, there may be a link

between the shoes used during pregnancy and physical activity. However, in a study by Kolářová et al. (7) examining the effect of biomechanical shoes during and after pregnancy, no statistically significant difference was found between the control and experimental groups. In this study, we demonstrated a low correlation between physical activity and footwear suitability. FAS scores also increased with increasing physical activity levels. Pregnant women with high physical activity levels may be choosing more appropriate shoes. However, it should be kept in mind that a comparison based on the physical activity levels of pregnant women will present more convenient results. Based on this contentious information about the effects of shoes during pregnancy in the literature, future research can focus on this topic.

The present study also had some limitations. First, the pregnant women included in the study were asked if the shoes worn at the time of assessments were their regular daily footwear. Although the shoes that the women wore most frequently during pregnancy were evaluated, different shoes they occasionally wear may also influence the fear of falling and physical activity. Second, more than half of the participants had low physical activity levels, and only six out of 123 women had a high level of physical activity. Third, the type of shoes (e.g., sneakers or flats) used by the participants was not noted. The last limitation is that the amount of time women (mainly housewives) spend outside in the winter or the effects of environmental factors on their fear of falling due to the winter season have not been questioned. Studies are needed to be conducted with a similar number of participants from each of the three levels of physical activity.

CONCLUSION

In conclusion, there was a low positive correlation between footwear suitability and physical activity, and a low negative correlation between physical activity and fear of falling in the third trimester of pregnancy. However, no relationship was found between footwear suitability and fear of falling. According to the findings of the current study, it can be concluded that pregnant women may be choosing more appropriate shoes as the

level of physical activity increases, and physical activity may reduce the fear of falling during pregnancy. Future studies are needed to investigate footwear suitability during pregnancy.

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Author Contributions: All authors contributed to the project's initial conception. Concept – BKV, MYG, HA; Design – BKV, MYG, HA, DO, BED, GG, AS; Supervision – BKV, MYG, HA; Data collection and/or Processing – DO, BED, GG, AS; Statistical analysis and/or interpretation – BKV; Literature Research – BKV, MYG, DO, BED, GG, AS; Writing manuscript – BKV, MYG, DO, BED, GG, AS; Reviewing/editing the manuscript – BKV, MTG and HA.

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