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# Effect of Flexible Pes Planus on Postural Stability in Adolescent Females

**Fayiz F. El-Shamy[1], Anees S. Ghait[2]**

[1]Department of Physical Therapy for Woman Health, Faculty of Physical Therapy, Kafrelsheikh University, Egypt

[2]Department of Biomechanics, Faculty of Physical Therapy, Kafrelsheikh University, Egypt

**Abstract:** ***Aim:*** ***to evaluate response of postural control and balance in adolescent females with flexible pes planus during luteal phase of menstruation. Study design: A case control study. Place and Duration of study: Biomechanics lab, Faculty of physical education-Kafrelsheikh University, Egypt, between June 2014 to July 2014. Methodology: A total of 30 adolescent females, were selected randomly, divided into 2 equal groups. Group (A):15 Participants with normal arch foot, group (B): 15 Participants with flexible pes planus. Their age was ranged from 15 to 18 years. Their body mass index between 18-25 kg/m2. The dynamic balance parameters (Anterior posterior, Mediolateral and Overall stability indices) measured by Biodex Balance System at stability level -8 and 6. Results: Comparing between the mean values of participant's stability indices (OA,AP and ML) at stability level-8 and 6 within the same group (A or B),there was no statistical significant difference (P> 0.05),But there was statistical significant difference between both groups(A&B)(P< 0.05). Conclusion: It could be concluded that there is decrease in balance parameters including (OA , AP and ML indices) at eight and six levels of stability during the dynamic balance test in flexible pes planus group compared with normal subjects.***

**Keywords:** Postural Stability; Balance; pes planus; adolescent; Luteal phase

## 1. Introduction

Balance is defined as the process of maintaining the center of gravity within the body's base of support. To maintain upright stance, the central and peripheral components of the nervous system are constantly interacting to control body alignment and the center of gravity over the base of support[1].Peripheral components in balance include the somatosensory, visual, and vestibular systems. The central nervous system incorporates the peripheral inputs from these systems and selects the most appropriate muscular responses to control body position and posture over the base of support[1]. Flat foot as a type of foot deformity common in adolescent females, as a consequence of various factors such as hypo kinesis, obesity or hereditary factors, represents a current problem [2].Because balance is maintained in the closed kinetic chain (the foot being fixed beneath the base of support) and relies on the integrated feedback and movement strategies among the hip, knee, and ankle, balance can be disrupted by diminished afferent feedback or deficiencies in the strength and mechanical stability of any joint or structure along the lower extremity kinetic chain[1].The foot is the most distal segment in the lower extremity chain and represents a relatively small base of support upon which the body maintains balance , it seems reasonable that even minor biomechanical alterations in the support surface may influence postural-control strategies. Specifically, excessively supinated or pronated foot postures may influence peripheral (somatosensory) input via changes in joint mobility or surface contact area or, secondarily, through changes in muscular strategies to maintain a stable base of support [3].In normal pattern of gait during each gait cycle , the subtalar joint pronate after the heel strike of stance phase until the metatarsal head contacts the ground, where upon the subtalar joint starts to supinate and converts the foot into a rigid structure for propulsion in the late part of stance phase [4].In subjects suffering from flexible flatfeet, the foot become in pronated position without turning to supination early enough during the late part of stance phase [5]. An excessive or prolonged pronation of the foot is often linked to excessive or prolonged tibial rotation and larger valgus at the knee [6].Which is not efficient for completing the push-off during normal pattern of gait cycle [7,4,8].Among many factors, like advanced age, low physical fitness level, unhealthy body composition, musculoskeletal trauma or impaired vestibulo-cerebellar control, contributing to poor postural balance, the changes in female hormonal profile were also considered as risk factor for injuries in them [9].Female hormones have a positive effect on various body tissues that play a significant role in maintaining postural balance (e.g. skin, eye, ear and brain tissues). As, estrogen receptors are found in most of the major components of these tissues [10].Overall stability index (OSI) in adolescent females was higher during the follicular phase compared to luteal one and this means lower postural stability [11].The aim of this study was to evaluate response of postural control and balance in adolescent females with flexible flat feet

## 2. Materials and Methods

A total of 30 nulliparous adolescent females during the luteal phase of menstruation, were selected randomly from students of physical education, Kafrelsheikh University, Egypt, divided into 2 equal groups (A&B). Group (A):15 Participants with normal arch foot, group (B): 15 Participants with flexible pes planus. Their age ranged from 15 to 18 years. Their body mass index between 18-25 kg/m$^2$. Females with polycystic ovarian syndrome, irregular menstruation, follicular phase with normal menstruation, diabetes, varicose veins, cardiopulmonary diseases, severe hypo or hypertension, visual and vestibular system affection, marked skeletal deformities, pes cavus, previous surgeries at their back and/or lower limbs were excluded from this study.

All females did not take hormonal replacement therapy (HRT) or any medications that may affect the neuromuscular functions at least three months before and/or during the study. The design of this study was a case control study. Informed consent form had been signed from each participant before the study. The study was done in biomechanics lab. at faulty of physical education , kafrelsheikh university from June 2014 to July 2014. The dynamic balance parameters(Anterior posterior (AP), Mediolateral (ML) and Overall (OA) stability indices) measured by Biodex Balance System, It is a balance screening and training tool Biodex Medical System( Inc, Shirley New York, U.S.A) . It consists of a movable balance platform, which provides up to 20 degree of surface tilt in 360$^{o}$ range. The stability levels available by the system range from a completely firm surface (Stability level-8) to a very unstable surface (Stability level-1). The biodex balance assessment was performed in standing position. The subject was instructed to focus on the visual feedback screen directly in front of patient and attempt to maintain the cursor at the center of the screen while standing on the unstable platform (either stability level -8 and 6).Statistical Analysis: Means and standard deviations were calculated for each variable using descriptive statistics. Paired t-test was used to analyze and compare the gained results within each group and Independent t-test was carried out to assess differences in the balance parameters between both groups(A&B). All statistical analyses were performed using SPSS (Statistical package for social sciences, Version 18.0). The significance level was set at P<0.05.

## 3. Results

All data had been collected and statistically analyzed and presented under the following headings;

**Physical characteristics of the patients:**

In this study, 30 participants were divided randomly into two equal groups (A&B). Group (A): 15 participants were included in this group; the mean age and BMI were (16.66±1.06) years and (21.39±3.15) Kg/m2. Group (B): 15 participants were included in this group; the mean age and BMI were (15.56±1.05) years and (22.23±2.01) Kg/m2.There was no significant difference (P< 0.05) between both groups (A&B) regarding their ages and BMI respectively.

**Stability Indices (OA, AP and ML) :**

***<u>Stability level -8</u>***

There were statistical significant differences in participant's stability indices (OA,AP and ML) at level-8 between both groups(A&B)(P< 0.05), as the mean values of stability indices (OA,AP and ML) in group A were 2.35± 1.12, 2.12± 1.11 and 2.14± 0.73 respectively, while in group B were 6.4± 1.44, 5.39± 1.25 and 5.19± 1.14 respectively (Table 1&Figure 1).

**Table 1:** Mean values of Stability Indices (SI)for participants in both groups(A&B) at stability level -8.

| Stability Index (SI) | | Mean±SD | P-value | Significance |
|---|---|---|---|---|
| OA | Group A | 2.35±1.12 | P<0.05 | Significant |
| | Group B | 6.4± 1.44 | | |
| AP | Group A | 2.12±1.11 | P<0.05 | Significant |
| | Group B | 5.39±1.25 | | |
| ML | Group A | 2.14± 0.73 | P<0.05 | Significant |
| | Group B | 5.19 ±1.14 | | |

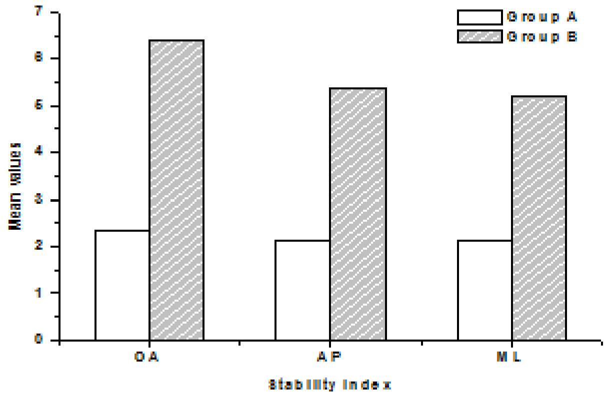


**Figure 1:** Mean values of Stability Indices (SI) for participants in both groups(A&B) at stability level -8

***<u>Stability level -6</u>***

There were statistical significant differences in participant's stability indices (OA,AP and ML) at level-6 between both groups(A&B)(P< 0.05), as the mean values of stability indices (OA,AP and ML) in group A were 2.57± 1.17, 2.7± 1.15 and 2.5± 0.71 respectively, while in group B were 7.73± 1.39, 6.6± 1.23 and 6.4± 1.19 respectively (Table 2&Figure 2).

**Table 2:** Mean values of Stability Indices(SI)for participants in both groups(A&B) at stability level -6

| Stability Index (SI) | | Mean±SD | P value | Significanc |
|---|---|---|---|---|
| OA | Group A | 2.57±1.17 | P<0.05 | Significant |
| | Group B | 7.73± 1.39 | | |
| AP | Group A | 2.7±1.15 | P<0.05 | Significant |
| | Group B | 6.6±1.23 | | |
| ML | Group A | 2.5± 0.71 | P<0.05 | Significant |
| | Group B | 6.4± 1.19 | | |

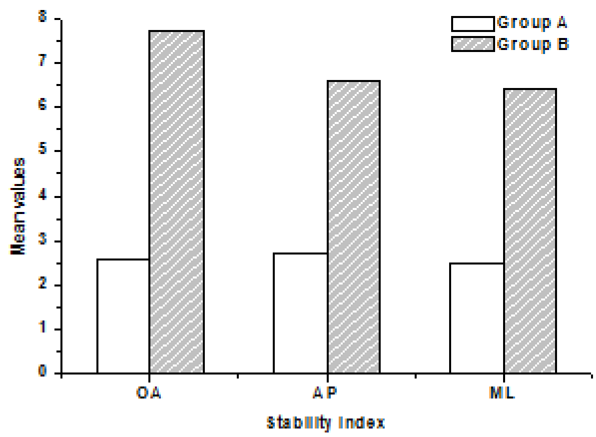


**Figure 2:** Mean values of Stability Indices(SI)for participants in both groups(A&B) at stability level -6

When comparing between the mean values of participant's stability indices (OA,AP and ML) at stability level-8 and 6 within the same group (A or B),there was no statistical significant difference (P> 0.05).

## 4. Discussion

The prevalence of flexible flat-foot correlates with general development, including joint laxity and poor physical performance and flat foot must be regarded not only as a problem of static alignment of the ankle and foot complex, but also as a dynamic functional abnormality of the lower extremity [12].In our study, there was statistical significant difference when comparing the mean values of participant's stability indices (OA,AP and ML) at level 8 and 6 for the study group compared with the control group indicating that there is disturbance in postural control and balance in patients suffering from flexible flat-foot compared with the normal subjects. From biomechanical point of view ,the foot as a last part of a close kinematic chain has very important role in dynamic and static balance position. So, when a part of this chain debilitate or damage, it can affect other parts of the chain. So, it is logical if flat footedness influences static and dynamic characteristics of lower extremities[13].The findings of our study could be confirmed by another study done by Nakhostin-Roohi et al[14]. who examined the effect of Flexible Flat-footedness on Selected Physical Fitness Factors in Female Students Aged 14 to 17 years, they observed significant differences in agility and static balance, as well as a trend of lower speed record in Flatfoot students. So they said that, flat footedness has damaged static and dynamic function of lower extremities. In another study done by Mosca[15]. who study the deleterious effect of flexible flat foot in children and adolescents on the mechanics of human body, he said that greater intrinsic muscle activity is required to stabilize the transverse tarsal and subtalar joints in a flatfooted individual than in one with an average height arch, this might be expected to lead to foot fatigue and pain .The significant disturbed standing balance seen in the present study which was reported by elevated stability indices values in flat foot group might result from poor foot position sense due to excessive foot pronation which is thought to hinder accommodation between the plantar surface of the foot and the support surface, thus requiring postural adjustments more proximally to maintain upright posture and balance.

The future scope of this study is to find a safe and conservative treatment for persons with flexible pes planus to increase their postural stability, decrease foot pain and muscle fatigue. A major limitation of our study was the small size of the groups, recruiting subjects for this type of study was difficult due to emotional source as fear and lake of background about the scientific research. Other limitations were the psycho physiological, social and culture level of each adolescent.

## 5. Conclusions

It could be concluded that there was decrease in postural stability in adolescent females with flexible pes planus compared with normal subjects.

## 6. Acknowledgement

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## Authors Profile

**Fayiz F. Elshamy** received the B.Sc., M.Sc. and Ph.D. degrees in Physical therapy from Cairo-University in 1995, 2002 and 2008 respectively. During 1997-2013, he worked at Faculty of physical therapy-Cairo University, Egypt as demonstrator, Assist. Lecturer and Lecturer. He now worked as Assist. Professor of physical therapy for women health in additional to working as vice dean for education and students affairs at Faculty of physical therapy-Kafelsheikh University, Egypt.

**Anees S. Ghait** received the B.Sc, M.Sc. and Ph.D. degrees in Physical therapy from Cairo-University in 1996, 2002 and 2008 respectively. During 1997-2013, he worked at Faculty of physical therapy-Cairo University, Egypt as demonstrator, Assistant Lecturer and Lecturer. He now worked as Lecturer of biomechanics at Faculty of physical therapy-Kafelsheikh University, Egypt