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STATIC AND DYNAMIC BALANCE IN FLAT FEET AND NEUTRAL ARCHED FEET PATIENTS ATTENDING THE TERTIARY CARE TEACHING HOSPITALS IN DERA ISMAIL KHAN

Original Research

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ABSTRACT

Background: Flat feet, medically referred to as pes planus, are a common structural deformity characterized by the collapse or underdevelopment of the medial longitudinal arch, resulting in the navicular bone coming into contact with the ground. This condition is generally asymptomatic during early life but may become symptomatic later, leading to foot pain and functional limitations. In some cases, it can cause significant disability by altering gait mechanics and postural stability.

Objective: To compare static and dynamic balance between patients with flat feet and those with neutral arched feet attending tertiary care teaching hospitals in Dera Ismail Khan.

Methods: A comparative cross-sectional study was conducted on 92 participants using a non-probability convenience sampling technique at public tertiary care hospitals in Dera Ismail Khan. Participants were divided equally into two groups, with 46 individuals each having flat feet or neutral arches. The unipedal stance test, performed with eyes open and closed, was used to assess static balance, while the Y-Balance Test measured dynamic balance using right and left leg composite score percentages. Data were analyzed using SPSS version 22, employing descriptive statistics and non-parametric tests to assess differences between groups.

Results: The sample included 50 males (54.3%) and 42 females (45.7%). The mean score for static balance with eyes open was 43.84 ± 10.86 seconds, while with eyes closed, it was 13.93 ± 25.41 seconds. Dynamic balance tests showed mean right leg composite scores of 75.45 ± 15.81% and left leg scores of 75.28 ± 17.31%. Significant differences were observed in static balance between groups ($p = 0.001$), whereas dynamic balance scores did not show statistically significant differences between the flat feet and neutral arch groups ($p = 0.093$ for the right leg; $p = 0.144$ for the left leg).

Conclusion: The findings of this study suggest that static balance is significantly affected by foot structure, with individuals having flat feet showing impaired balance compared to those with neutral arches. In contrast, dynamic balance appears to be independent of foot structure type. These results underscore the importance of targeted interventions for improving postural stability in individuals with flat feet.

Keywords: Balance tests, Dynamic balance, Flatfoot, Foot deformities, Pes planus, Postural balance, Static balance.

INTRODUCTION

Flat feet, medically known as pes planus, represent a common structural deformity of the foot characterized by the underdevelopment or collapse of the medial longitudinal arch. This collapse leads to the navicular bone coming into contact with the ground, often accompanied by associated conditions such as hallux valgus deformity and medial talar prominence (1-3). In most cases, pes planus remains asymptomatic and self-limiting during the early years of life. However, for some individuals, particularly beyond the first decade, this seemingly benign condition can evolve into a symptomatic and painful form, causing significant discomfort and functional impairment (3-5). The loss of the natural arch compromises the foot's structural integrity and can influence an individual's gait and posture, leading to secondary musculoskeletal complications. The global prevalence of flat feet varies significantly, with estimates ranging from 2.7% to 44% across adult and pediatric populations. Research indicates that flatfoot incidence fluctuates between less than 1% to 28% across various age groups, depending on genetic, environmental, and biomechanical factors (6, 8). Children aged between two to six years exhibit the highest prevalence rates, ranging from 21% to 57%, primarily due to the natural developmental stages of foot arch formation. This prevalence generally decreases as age advances, declining to 13.4% to 27.6% in primary school-aged children, and stabilizes at approximately 5% to 14% in adults (11). These variations highlight the importance of age-related physiological changes and the role of early intervention in mitigating long-term complications associated with flatfoot deformities.

The structural composition of the foot plays a critical role in maintaining postural stability and balance. As a relatively small base of support, the foot bears the responsibility of sustaining the body's alignment and facilitating efficient movement patterns. Any structural deficit, whether related to foot posture, flexibility, strength, or sensory feedback, can significantly impair this support function, increasing the risk of balance deficits and instability. The arches of the foot serve as key elements in distributing body weight evenly across the plantar surface, ensuring biomechanical efficiency and reducing strain on the lower extremities. Individuals with flat feet often experience altered weight distribution, which can lead to disruptions in normal body alignment, muscular imbalances in the ankles, legs, and hips, and heightened susceptibility to postural dysfunctions (28-30).

Despite the substantial research on foot biomechanics, limited attention has been directed toward understanding how foot structure specifically influences balance in clinical populations. Static and dynamic balance are critical components of daily functioning, particularly for individuals who rely on stable postural control for occupational or physical activities. Assessing the relationship between foot arch type and balance performance could provide valuable insights for clinicians and therapists in devising effective intervention strategies. The objective of this study is to evaluate and compare static and dynamic balance in individuals with flat feet and those with neutral arches attending tertiary care teaching hospitals in Dera Ismail Khan, aiming to develop targeted rehabilitation protocols and enhance overall functional outcomes.

METHODS

The study employed a comparative cross-sectional survey design to investigate static and dynamic balance in individuals with flat feet and neutral arched feet. The research was conducted in public tertiary care hospitals in Dera Ismail Khan, specifically at the District Headquarter Teaching Hospital and Mufti Mehmood Memorial Teaching Hospital. The study population comprised patients who presented at the physiotherapy outpatient department (OPD) with either flat feet or neutral foot arches. The duration of the study spanned six months, from March to August. The sample size was determined using the OpenEpi sample size calculator (www.openepi.com), resulting in a total of 92 participants. These participants were divided into two groups based on foot structure: 46 individuals with flat feet and 46 individuals with neutral arches. A non-probability convenience sampling technique was utilized for participant selection, allowing for the inclusion of patients who met the eligibility criteria and were readily available during the data collection period. This sampling approach, while practical in clinical settings, may introduce selection bias, which should be considered when interpreting the study's generalizability.

Data analysis was performed using SPSS version 22. Descriptive statistics, including frequencies and percentages, were applied to summarize demographic variables such as age, height, weight, body mass index (BMI), and levels of physical activity. The Shapiro–Wilk test was employed to assess the normality of the data for both static and dynamic balance measurements, revealing that the data

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were not normally distributed. Consequently, non-parametric tests were used for statistical analysis. The Wilcoxon signed-rank test was applied for within-group comparisons, while the Mann-Whitney U test was used for between-group comparisons, providing an appropriate approach for analyzing non-parametric data.

Participants were assessed for eligibility based on clearly defined inclusion and exclusion criteria. The inclusion criteria encompassed individuals aged 18 to 39 years with either flat feet or neutral arched feet, attending the physiotherapy OPD. Both male and female participants were considered eligible for inclusion. The exclusion criteria aimed to eliminate potential confounding factors that could influence balance assessment outcomes. Patients with diagnosed neurological disorders, vestibular dysfunctions, or lower extremity arthritis were excluded from the study. Additionally, individuals with a history of lower limb injuries or surgeries within the past six months were not included, as these factors could compromise balance performance. Females in the third trimester of pregnancy were also excluded due to physiological changes that could affect postural control. Furthermore, individuals with leg length discrepancy (LLD) were excluded, as variations in limb length could independently influence balance and gait mechanics.

RESULTS

Sample size of 92 had 95% level of confidence and power 80%. Each group had 46 subjects. Mann Whitney U test and Wilcoxon test was applied to make comparison of static balance with eye open and eye closed, dynamic balance right leg and left leg composite score percentage between groups. The mean age of the sample was 25.32±6.51years. The mean heightandweightofalltheparticipantswere167.41±10.66cmand61.69±13.57kg respectively and a mean value of 22.01±4.14kg/cm2 were calculated for BMI of thesamples.The mean scores for the static balance with eye open and eye closed were 43.84±10.86 and 13.93±25.41 respectively. For dynamic balance, mean for right leg composite score is 75.45±15.81 and 75.28±17.31 for left leg as shown in table 1.

Table 1 Group wise measurement of variables (means ±SD)

Variables	Total (Mean±SD)	Flat (Mean ±SD)	Neutral (Mean±SD)
Age(years)	25.32±6.51	25.26±6.44	25.39±6.65
Weight(kg)	61.69±13.57	63.20±12.91	60.18±14.17
Height(cm)	167.41±10.6	165.62±11.2	169.20±9.64
BMI(kg/cm2)	22.015±4.14	23.22±4.25	20.80±3.69
Right limb length	88.85±8.65	88.84±7.07	88.86±10.06
Left limb length	88.97±8.64	88.99±7.07	88.95±10.06
Static eye open	43.84±10.86	40.97±12.40	46.70±8.30
Static eye close	13.93±25.41	13.75±35.52	14.12±6.62
Dynamic Rt leg composite score	75.45±15.81	73.08±16.56	77.81±14.82
Dynamic Lf leg composite score	75.28±17.31	72.87±17.46	77.69±17.0

Table 2 Gender-wise measurement in each group (means ±SD)

GENDER	TOTAL	NEUTRAL FEET	FLAT FEET
MALE	50 (54.3%)	25(27.2%)	25(27.2%)
FEMALE	42(45.7%)	21(22.8%)	21(22.8%)

The table presents the gender distribution of the study participants. Out of 92 individuals, 50 (54.3%) were male and 42 (45.7%) were female. Each gender group was equally divided between those with neutral feet and flat feet, with 25 males (27.2%) and 21 females (22.8%) in each foot type category.

Frequency of demographic information for level of BMI for neutral feet group was collected as shown in figure 4.

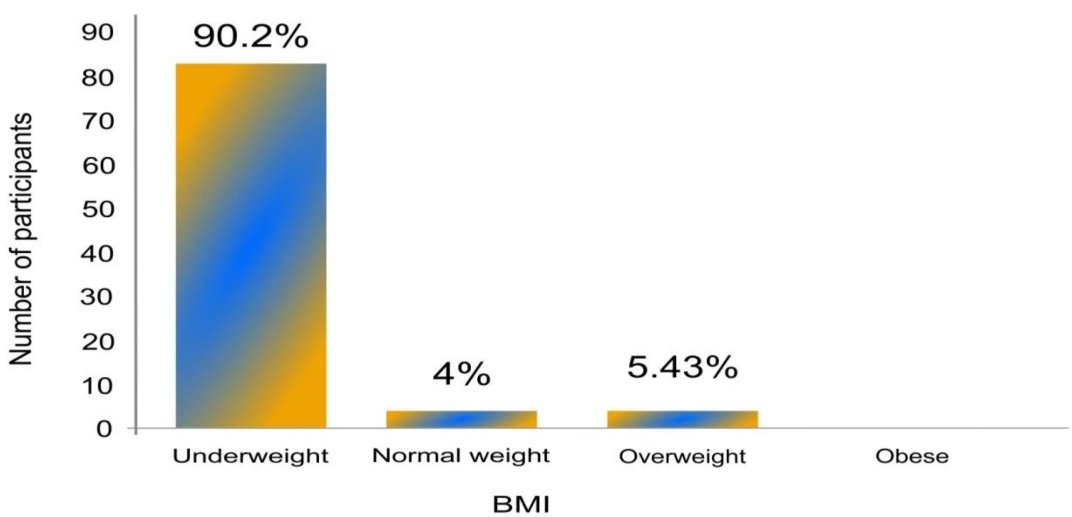

Figure 1 Frequency of demographic information for level of BMI for neutral feet group

Table 2: Level of BMI measurement in flat feet group (mean ±SD)

BMI	FLAT
UNDERWEIGHT	42 (91.30%)
NORMAL WEIGHT	2(4.34%)
OVER WEIGHT	2 (4.34%)
OBESE	0(0%)

Underweight Class was most common with n=42 (91.30%) of the total 46 participants in flat feet group, followed by n=2(4.34%) in normal weight class and n=2 (4.34%) in overweight class.

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Table 3: P value for each measuring variable between flat and neutral feet group

MEASURING TOOLS	BETWEEN FLAT FEET NETRAL FEET(P-value)
Static balance with eye open	0.001
Static balance with eye closed	0.001
Y balance right leg composite scores	0.093
Y balance left leg composite scores	0.144

The table shows the p-values comparing balance measures between flat feet and neutral feet groups. Significant differences were observed in static balance with eyes open and closed ($p = 0.001$ for both). However, no significant differences were found in Y-balance composite scores for the right leg ($p = 0.093$) and left leg ($p = 0.144$).

DISCUSSION

The present study assessed the relationship between foot structure, specifically flat feet (pes planus) and neutral arched feet (pes rectus), in terms of physical activity levels, body mass index (BMI), and balance performance. The comparison was conducted using established clinical tools to evaluate static and dynamic balance. The unipedal stance test, performed with eyes open and closed, served as a reliable measure of static balance, while the Y-Balance Test was employed to assess dynamic balance between the two groups. These tools are widely recognized for their validity in predicting the risk of falls in populations with varying foot arch types. The findings revealed a statistically significant difference in static balance between individuals with flat feet and those with neutral arches. Both static balance with eyes open ($p = 0.001$) and eyes closed ($p = 0.001$) demonstrated notable impairments in the flat feet group. These results highlight the compromised postural stability associated with a collapsed medial longitudinal arch, which likely alters the normal distribution of body weight and affects neuromuscular control. In contrast, dynamic balance, as measured by the Y-Balance Test, did not exhibit a statistically significant difference between the two groups for both the right ($p = 0.093$) and left leg composite scores ($p = 0.144$). This suggests that dynamic balance, which requires more extensive muscle coordination and proprioceptive input, may not be as strongly influenced by foot structure alone.

These findings are consistent with a study conducted in the United States by Cob et al., which also observed significant impairments in static balance with eyes closed across both groups, indicated by greater anterior-posterior (AP) and medial-lateral (ML) postural instability ($p < 0.05$). However, contrary to the present study's findings, no significant differences were observed during the eyes-open condition ($p > 0.05$) in their research. Notably, methodological differences such as sample size and participant selection may account for this discrepancy. The current study's larger sample of 92 participants, as opposed to 32 volunteers in the Cob et al. study, provided greater statistical power and a more representative demographic distribution. Another critical distinction lies in the inclusion criteria, as Cob et al. selected participants based on forefoot varus angle, whereas this study categorized individuals solely on the presence of flat or neutral foot arches (35).

Contrasting findings were also reported in a study conducted in India, where the Star Excursion Balance Test (SEBT) was used to assess dynamic balance (36). That study revealed significantly reduced reach distances across all directions in individuals with flat feet compared to those with neutral arches, with the lateral direction being the most affected. The SEBT, a more comprehensive version of the Y-Balance Test, evaluated a broader range of movement directions, potentially explaining the significant differences observed in that study (37). In contrast, the present study, utilizing the shorter Y-Balance Test, did not find significant differences in dynamic balance outcomes. Despite similarities in sample size, study design, and inclusion criteria, differences in assessment tools likely contributed to the variations in findings (38).

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One of the strengths of this study lies in its robust methodology and use of validated clinical tests for balance assessment. The use of objective measures provided reliable data on the functional implications of foot arch structure on postural stability (39). However, certain limitations must be acknowledged. The use of a comparative cross-sectional design, driven by resource constraints, limits the ability to infer causality. The relatively small sample size, coupled with a greater number of male participants, may have introduced gender-based bias in the results, potentially affecting the generalizability of the findings. Additionally, the study was confined to patients from public tertiary care teaching hospitals in Dera Ismail Khan, which may limit the applicability of the findings to broader populations (40).

The study highlights the need for further research using randomized controlled trials (RCTs) with larger sample sizes to validate these findings (41, 42). Future studies should incorporate detailed biomechanical assessments and include equal representation of both genders to minimize potential biases. Additionally, expanding the assessment tools to include more comprehensive balance tests, such as the SEBT, could offer a deeper understanding of the dynamic balance differences associated with foot structure. Despite its limitations, this study contributes valuable insights into the functional consequences of flat feet on postural control and underscores the importance of early identification and intervention for individuals at risk of balance impairments (43).

A recent study aimed to investigate the relationship between flexible flatfeet and functional movement, balance, agility, and core muscle strength in young females. The researchers assessed 60 participants, dividing them into two groups: those with flexible flatfeet and those with normal arches. They utilized the Functional Movement Screen (FMS) to evaluate movement patterns, the Y-Balance Test for dynamic balance assessment, agility T-tests, and core muscle strength measurements. The findings revealed that individuals with flexible flatfeet exhibited significantly lower scores in the FMS and Y-Balance Test, indicating compromised functional movement and balance. Additionally, the flatfooted group demonstrated reduced agility and core muscle strength compared to their normal-arched counterparts. These results suggest that flexible flatfeet may adversely affect overall functional performance, emphasizing the need for targeted interventions to address these deficits in affected individuals (44).

Author Contribution

Author	Contribution
Mariam Ali	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Javeria Shabir	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Majeeda Ghani	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Naveed Akhtar	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Rab Nawaz	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Inayat Ullah*	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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