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Static and Dynamic Balance in Recreational Bharatanatyam Dancers with Flat and Normal Arched Feet: A Cross-Sectional Study

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ABSTRACT

Bharatanatyam is one of the most widely practiced Indian classical dance forms. It involves repetitive foot stamping, sustained postures, single-leg stance and dynamic movements, placing high demands on balance and foot mechanics. This study aimed to compare static and dynamic balance in recreational Bharatanatyam dancers with flat feet and normal arched feet. A cross-sectional study was conducted among 50 recreational Bharatanatyam dancers aged 18–30 years. Participants were categorized into flat-foot and normal-arched-foot groups based on the Foot Posture Index. Static balance was assessed using the Unipedal Stance Test under eyes-open and eyes-closed conditions. Dynamic balance was evaluated using the Y Balance Test in the anterior, posteromedial and posterolateral directions. Data were analysed using an unpaired Student's t-test, with statistical significance set at $p < 0.05$. Dancers with flat feet demonstrated significantly lower static balance performance under eyes-open and eyes-closed conditions and reduced Y Balance Test reach distances in all directions compared with dancers with normal arches ($p < 0.05$). Foot structure plays an important role in Bharatanatyam dancers. Flat feet are associated with impaired static and dynamic balance, which may further increase the risk of injuries and negatively affect performance.

Keywords: Bharatanatyam, flat foot, static balance, dynamic balance, foot posture

INTRODUCTION

Bharatanatyam is a classical Indian dance form that traces its roots to the 2nd century and remains one of the most popular and widely practised dance forms in India (1). Recreational Bharatanatyam dancers are individuals who practise the dance form regularly for leisure rather than professional performance. These dancers often practise for several years, with sessions lasting multiple hours per week, exposing them to repetitive loading patterns similar to those experienced by trained dancers.

The basic posture of Bharatanatyam is called Aramandi, in which the dancer maintains an erect spine while assuming a half-squat position, with the hips externally rotated and knees flexed. The feet are placed heel-to-heel, with a distance of approximately 2–3 inches between them (2). This dance style requires subtle, continual adjustments to enable quick, smooth and

complete movements. It incorporates single-leg positional holds, spins (on one or both legs), rapid movement transitions, and changes in positions and stances; therefore, balance is particularly important (1).

The foot is the main weight-bearing component during dance. Repetitive barefoot stamping and prolonged practice may lead to alterations in foot structure, including flattening of the medial longitudinal arch. Such changes can affect postural stability and may increase the risk of injury. Previous studies have reported a high prevalence of flat foot among Bharatanatyam dancers, suggesting that repetitive dance-specific loading may influence foot posture (3). However, limited literature specifically compares balance performance between recreational Bharatanatyam dancers with flat feet and those with normal arched feet.

Therefore, the objective of this study was to evaluate and compare static and dynamic balance in recreational Bharatanatyam dancers according to foot posture.

MATERIALS & METHODS

A cross-sectional study design was used, with purposive sampling. Bharatanatyam dance academies in Pune were contacted for participation.

Participants

A total of 50 recreational Bharatanatyam dancers aged between 18 and 30 years participated in the study. Based on the Foot Posture Index (FPI), participants were classified into two groups: flat foot (21 participants) and normal arched foot (29 participants). Participants were required to have a minimum of five years of dance experience and practise at least twice a week.

Dancers with known neurological disorders, cardiopulmonary conditions, musculoskeletal impairments, recent injuries, pregnancy or childbirth within the previous year, and those using corrective orthotics for flat foot were excluded from the study.

Outcome Measures

Static Balance

Static balance was assessed using the Unipedal Stance Test on both the right and left limbs under eyes-open and eyes-closed conditions. Each participant performed three trials per condition, and the average value was recorded (4).

Dynamic Balance

Dynamic balance was assessed using the Y Balance Test (YBT) in the anterior, posteromedial and posterolateral directions. Participants used the foot of the non-stance leg to slide the reach indicator along the designated tube as far as possible and then returned the foot to the starting position while maintaining balance. Limb length was measured from the anterior superior iliac spine to the medial malleolus and was used to normalize reach distance using the following formula (5):

(Reach Distance / Limb Length) × 100

Statistical Analysis

Statistical analysis was performed using Microsoft Excel. Descriptive statistics were calculated, and data were presented as mean ± standard deviation. The normality of the data distribution was assumed prior to analysis. An unpaired Student's t-test was used to compare balance parameters between Bharatanatyam dancers with flat feet and those with normal arched feet. A p-value of less than 0.05 was considered statistically significant.

RESULT

Static Balance

A statistically significant difference was observed between the flat-foot and normal-arched-foot groups under all testing conditions. The normal-arched-foot group demonstrated significantly higher balance times in both eyes-open and eyes-closed conditions for both limbs ($p < 0.05$).

Table 1. Comparison of Static Balance Between Normal-Arched-Foot and Flat-Foot Groups (Unipedal Stance Test)

Condition	Limb	Normal Arched Foot (Mean ± SD)	Flat Foot (Mean ± SD)	t-value	p-value
Eyes open	Right	40.0 ± 6.1	35.6 ± 7.6	2.3	0.01
Eyes closed	Right	21.0 ± 8.0	7.1 ± 2.3	9.0	0.001
Eyes open	Left	39.0 ± 6.6	35.0 ± 6.8	2.0	0.01
Eyes closed	Left	28.0 ± 8.8	8.2 ± 2.1	12.0	0.001

Values are presented as mean ± standard deviation. A p-value < 0.05 was considered statistically significant.

Dynamic Balance

Dynamic balance performance was significantly better in the normal-arched-foot group across all directions of the Y Balance Test for both limbs ($p < 0.05$).

Table 2. Comparison of Dynamic Balance Between Normal-Arched-Foot and Flat-Foot Groups (Y Balance Test)

Limb	Direction	Normal Arched Foot (Mean ± SD)	Flat Foot (Mean ± SD)	t-value	p-value
Right	Anterior	74.1 ± 10.3	62.8 ± 11.8	3.4	0.001
Right	Posterolateral	78.5 ± 11.9	63.5 ± 12.2	4.2	0.0001
Right	Posteromedial	79.5 ± 10.8	66.3 ± 12.7	3.9	0.0003
Left	Anterior	76.6 ± 8.1	64.5 ± 7.8	5.2	0.0004
Left	Posterolateral	78.3 ± 11.8	68.7 ± 10.6	2.9	0.004
Left	Posteromedial	80.8 ± 6.3	65.5 ± 12.3	5.1	0.0001

Values are presented as mean ± standard deviation. A p-value < 0.05 was considered statistically significant.

DISCUSSION

The findings of this study indicate that the integrity of the foot arch plays an important role in maintaining static and dynamic balance in recreational Bharatanatyam dancers. Dancers with flat feet demonstrated reduced performance in both balance assessments compared with dancers with normal arches.

When static balance was compared within each group, performance was significantly poorer with the eyes closed than with the eyes open, suggesting an increased reliance on visual input to maintain postural stability. Dynamic balance was also significantly compromised in dancers with flat feet, indicating greater difficulty adapting to changes in the centre of gravity during movement.

These findings are consistent with previous studies reporting impaired balance in individuals with flat feet, potentially due to altered biomechanics and reduced proprioceptive efficiency (6). Foot stability is maintained by osseous and soft-tissue supports. Osseous support is provided by the contact between the talus and calcaneus, whereas soft-tissue support is provided by the deep posterior muscles of the shank and the medial ankle and foot ligaments.

Dancers with pronated feet may exhibit increased rearfoot valgus, which can contribute to balance impairment. Heel valgus may limit the contact of the heel with the ground surface; consequently, fewer sensory receptors may contribute to the sensory information required to maintain balance. This may result in poorer static balance performance among dancers with flat feet. When the test is performed with the eyes closed, the removal of visual feedback further increases the challenge and may explain the poorer performance observed (6).

Pronated foot posture may also make it more difficult to react and adjust quickly to changes in the centre of gravity as the body moves through different positions. In comparison, a normal-arched foot may allow more prompt and smooth adjustments to changes in the centre of gravity during dynamic standing movements, which may explain the better dynamic balance performance observed in this group (7). Overall, this study highlights the importance of assessing foot posture in dancers, as it may influence balance performance and injury risk.

Limitations

The study included a relatively small sample size and did not account for anthropometric variables such as body mass index or limb dominance. Additionally, female dancers were predominantly represented, limiting the generalizability of the findings. Future research should explore longitudinal designs and intervention-based approaches to determine the effectiveness of corrective exercise programmes on balance outcomes in dancers with flat feet.

CONCLUSION

Recreational Bharatanatyam dancers with flat feet exhibit significantly reduced static and dynamic balance compared with dancers with normal arched feet. Altered foot posture has a negative influence on balance during both single-limb stance and dynamic movement tasks. Foot posture assessment should be considered an important component of screening and rehabilitation to enhance performance and reduce injury risk.

Declaration By Authors

Ethical Approval: Ethical approval was obtained from the P.E.S. Modern College of Physiotherapy Ethics Committee. Written informed consent was obtained from all participants prior to data collection.

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