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Original Research Article

Correlation between pronated foot posture, movement quality and postural stability among college students: a pilot study

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ABSTRACT

Background: Postural control and movement mechanics are significantly influenced by foot position. Pronated foot posture has been associated with reduced movement quality and impaired balance. It is characterized by medial arch collapse and foot eversion. College students may be more prone to these musculoskeletal abnormalities as a result of their lifestyle choices and extended periods of inactivity.
Methods: The 22 college students between the ages of 18 and 25 participated in a pilot cross-sectional study. The Flamingo balance test (FBT) was used to test static balance, the Y-balance test (YBT) was used to measure dynamic balance, the foot posture index-6 (FPI-6) was used to measure foot posture, and the functional movement screen (FMS) was used to evaluate movement quality. The association between postural stability, movement quality, and pronated foot posture was ascertained using Pearson's correlation coefficient.
Results: FPI-6 showed a strong negative correlation with FMS ($r=-0.72$, $p<0.001$ right; $r=-0.599$, $p=0.003$ left) and static balance ($r=-0.75$, $p<0.001$ right; $r=-0.55$, $p=0.008$ left). No significant correlation was observed with dynamic balance ($p>0.05$). FMS was positively correlated with static balance ($r=0.648$, $p=0.001$ right; $r=0.621$, $p=0.002$ left) but not with dynamic balance ($p>0.05$).
Conclusions: The study found that college students who have pronated foot posture have considerably worse static and dynamic balance as well as lower movement quality. Early detection and foot posture-focused remedial measures may enhance functional results and avert further musculoskeletal problems.

Keywords: Pronated foot posture, FPI-6, FMS, Flamingo balance test, Y-balance test

INTRODUCTION

The human foot serves as the lower kinetic chain's structural and functional base and is necessary for coordinated movement, load transmission, and posture control.[1] One important biomechanical component affecting musculoskeletal alignment and movement efficiency is foot posture, especially excessive pronation.[2,3]

An irregular gait and possible injury can result from a pronated foot, which is defined by medial arch collapse and greater subtalar eversion.[4-6]

Static foot alignment in several planes can be evaluated clinically with the FPI-6.[7] Pronated posture can change proprioceptive responses and neuromuscular activation, which can affect proximal joint mechanics.[8-10] The FMS, which examines seven basic movement patterns, is frequently used to evaluate the quality of movement.[11,12] Because poor foot alignment affects joint mobility, stability, and motor control, it may be a factor in lower FMS scores.[13,14] Static and dynamic control are two categories for postural stability, which is a crucial aspect of function. The YBT gauges dynamic stability in several directions, whereas the FBT assesses static single-leg posture.[15-18]According to research, changed foot posture may impact functional tasks and raise the risk of falls or injuries by influencing postural sway, balance reactions, and weight distribution.[19,20]

Foot posture, especially severe pronation, has been found to have a major impact on balance, motor control, and musculoskeletal alignment. There is still a dearth of integrative research that simultaneously assesses the relationship between pronated foot posture and movement quality and postural stability, particularly in young adult populations that are in good health, like physiotherapy students, even though a variety of studies have independently investigated the effects of this posture on lower limb mechanics and injury risk. According to recent research by Hosein et al those with pronated foot had altered neuromuscular responses and decreased ankle proprioception, which may impair postural and functional mobility.[21]Similar to this, Souza et al showed that young adults' dynamic stability performance was greatly impacted by foot misalignment, particularly while doing single-leg stance tasks.[22] Early postural deviations in physically active populations should be studied since they can remain asymptomatic but result in chronic compensatory behaviours and injury risk, according to studies by Ribeiro et al and Eguchi et al.[23,24]Additionally, Kim and Kim demonstrated how university students' basic movement patterns and balance were impacted by their altered foot mechanics.[25]

Finding relationships between foot posture, movement quality, and balance in physiotherapy students is crucial since they engage in physically demanding jobs and are supposed to mimic ideal movement patterns. Early screening, focused corrective exercise programs, and curriculum changes to improve physical preparedness and injury prevention can all benefit from this data. Any underlying biomechanical imbalances in these students' bodies may also affect their performance as future physicians who will be tasked with diagnosing and treating movement dysfunctions in others. In addition to improving their own musculoskeletal health, early detection and repair of such aberrations may also enhance their reputation and efficacy as movement specialists.

METHODS

This cross-sectional study was conducted between May and June 2025 among students of Laxmi Memorial College of Physiotherapy, Mangalore, Karnataka, India. Participants were selected based on defined inclusion and exclusion criteria. Initially, convenience sampling was employed for estimating sample size. Based on a previous study by Del-Castillo et al which reported that 6.6% of subjects with pronated feet demonstrated good movement quality, and using a 95% confidence level with an absolute precision of 9%. However, a total of 22 participants were ultimately recruited using purposive sampling.

Ethical clearance for the study was obtained from the ethics committee of A. J. Institute of Medical Sciences, Mangalore. The objectives of this study were to comprehensively assess foot posture, movement quality, and postural stability among college students. Foot posture was evaluated using the FPI-6, Movement quality was assessed through the FMSing, static postural stability was measured using the FBT, while dynamic postural stability was assessed through the YBT. Inclusion criteria were college students aged 18-25 years with normal BMI, identified with pronated foot posture through FPI-6, not engaged in sports, gym, or training activities for the past two years, not using foot orthotics, and free from foot pain. Exclusion criteria included any negative or zero FPI component score, recent injuries or falls, history of upper or lower extremity surgery, acute or chronic ankle sprain, upper or lower limb pain, spinal deformities, systemic diseases, vestibular disorders, back pain, congenital foot deformities, and visual or balance impairments.

FPI-6

The FPI-6 was assessed with the participant standing in a relaxed double-limb stance. Observations were made from the anterior, posterior, medial, and lateral views. The assessment included six criteria: (1) talar head palpation, (2) curves above and below the lateral malleoli, (3) calcaneal alignment in the frontal plane, (4) bulging at the talonavicular joint, (5) medial longitudinal arch shape, and (6) forefoot-to-rearfoot abduction/adduction. Each criterion was scored from -2 (supinated) to +2 (pronated), and the total score ranged from -12 to +12. These scores were then recorded in the master chart.[26]

FMS

The FMS consists of seven tests: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, and rotary stability. Each test is scored on a scale from 0 to 3 across three trials, with the highest score recorded per test. A score of 0 indicates pain, 1 indicates incomplete or unstable movement, 2 denotes compensated movement, and 3 reflects correct movement without compensation. For bilateral tests, the lower score is recorded. The composite FMS score ranges from 0 to 21.[12]

FBT

Participants stood barefoot on a wooden box and flexed one leg by holding the same-side ankle toward the buttocks to maintain balance. Timing began on the investigator's cue. The maximum duration (in seconds) of static balance was recorded. The test ended upon postural loss, adjustment, or stepping off the box. Each leg was tested separately.[27]

YBT

For the YBT, three tape lines were arranged on the floor: one anterior and two at 135° angles posterolaterally and posteromedially, forming a Y-shape. The participant stood on one leg at the tape intersection and reached with the other leg in all three directions. Each leg was tested separately, and reach distances were normalized to limb length to compute the score.[28]

Statistical analysis

Statistical analysis was conducted using IBM SPSS Statistics for Windows, version 20.0. Descriptive statistics were expressed as mean and standard deviation, and demographic variables were presented as frequency and percentage. Karl Pearson's coefficient of correlation was used to examine the relationship between pronated foot posture, movement quality, and postural stability. A $p<0.05$ was considered statistically significant.

RESULTS

The study included 22 participants, with an equal distribution in age and gender-50% were under 24 years and 50% were 24 years or older, while 50% were male and 50% were female. Regarding leg dominance, 95.45% of participants were right-leg dominant and only 4.55% were left-leg dominant. The mean height was 161.58±4.94 cm, weight was 59.66±7.93 kg, and BMI was 22.79±2.17 kg/m².

The participants showed a left leg FPI ranging from 6 to 12, with a mean of 9.40±2.06. FMSing scores ranged from 10 to 16, with a mean of 12.04±2.05. FBT times were 9.2-12.67 sec for the right leg (mean 11.23±0.94 sec) and 7.27-11.99 sec for the left leg (mean 10.20±1.53 sec). Y balance test (YBT) scores ranged from 60.99 to 85.71sec for the right leg (mean 74.84±6.11 sec) and 59.08 to 82.46 sec for the left leg (mean 71.32±6.06 sec).

The results show that FPI-6 scores for both right and left feet have a strong negative correlation with FMS ($r=-0.72$, $p=0.00016$ for right; $r=-0.599$, $p=0.0032$ for left), indicating that higher FPI is associated with poorer movement quality. Similarly, FPI-6 is strongly and negatively correlated with static balance ($r=-0.75$, $p=0.000058$ for right; $r=-0.55$, $p=0.0076$ for left), suggesting that abnormal foot posture reduces static balance performance. However, no significant correlation was observed between FPI-6 and dynamic balance for either foot ($p>0.05$), implying that foot posture may not influence dynamic balance.

Table 1: Mean FPI-6, FMS, static balance and dynamic balance.

Variables	Minimum	Maximum	Mean	SD
FPI-6 (R)	7	12	9.63	1.91
FPI-6 (L)	6	12	9.40	2.06
FMS	10	16	12.04	2.05
Static balance (R)	9.2	12.67	11.23	0.94
Static balance (L)	7.27	11.99	10.20	1.53
Dynamic balance (R)	60.99	85.71	74.84	6.11
Dynamic balance (L)	59.08	82.46	71.32	6.06

Table 2: Correlation of FPI-6 with FMS, static balance and dynamic balance.

Variables	Correlation with	R value	P value	N
FPI-6 (R)	FMS	-0.72	0.00016	22
	Static balance	-0.75	0.000058	22
	Dynamic balance	-0.094	0.677	22
FPI-6 (L)	FMS	-0.599	0.0032	22
	Static balance	-0.55	0.0076	22
	Dynamic balance	-0.060	0.323	22

Table 3: Correlation of FMS with Static balance and dynamic balance.

	Correlation with	R value	P value
FMS (R)	Static balance	0.648	0.0011
	Dynamic balance	0.160	0.476
FMS (L)	Static balance	0.621	0.0021
	Dynamic balance	0.137	0.543

Correlation analysis showed that FMS has a strong positive correlation with static balance on both right ($r=0.648$, $p=0.0011$) and left sides ($r=0.621$, $p=0.0021$), suggesting that better functional movement is associated with improved static balance. However, no significant relationship was observed between FMS and dynamic balance on either side (p>0.05). This implies that while functional movement strongly influences static balance, it may not have a notable effect on dynamic balance.

DISCUSSION

This main goal of the study was to investigate the connection between college students' postural stability, movement quality, and pronated foot posture. Since maintaining effective movement patterns and balance depends heavily on foot alignment, it is imperative to comprehend this correlation. Few research have used integrated outcome measures such the FPI-6, FMS, FBT, and YBT to evaluate the interdependence of foot posture and balance effects in a young, healthy population, despite the fact that numerous studies have looked at these effects separately. This conversation highlights the therapeutic significance of the current findings and interprets them in the context of recent literature.

The study included 22 participants with equal age and gender distribution, where 95.45% were right-leg dominant and only 4.55% were left-leg dominant. FPI-6 of both the right and left legs showed a strong negative correlation with FMS (r=-0.72 and -0.599) and static balance (r=-0.75 and -0.55), but no significant correlation with dynamic balance. FMS of both the right and left legs showed a strong positive correlation with static balance (r=0.648 and 0.621), while no significant correlation was observed with dynamic balance.

According to a recent study by Garcia et al which evaluated 120 collegiate athletes, people with pronated feet performed noticeably lower on static balance tests than people with neutral foot posture.[29] Similarly, pronated foot posture was linked to altered postural sway characteristics and impaired lower limb proprioception.[30] Interestingly, we found no significant correlation between dynamic balance (YBT performance) and foot pronation. This is consistent with research by Turner et al who found no relationship between YBT and FPI distances in young individuals in good health. Their findings suggest that dynamic balancing tasks might activate more compensating neuromuscular responses.[31]

Lerner et al reported that increased static postural control in young adults was connected with improved movement quality, which supports the considerable positive correlation between FMS scores and static balance (r=0.70-0.81).[32] Furthermore, a randomised study by Patel et al demonstrated that, in addition to static balance assessments, movement quality therapies, such as gait training and balance drills, significantly improved FMS scores.[33]

Intrinsic foot muscle (IFM) training has gained interest in addition to static exercises. In an intervention research by Morales-Rubio et al IFM strengthening greatly increased navicular height and static balance; however, gains in dynamic stability did not appear until after prolonged training.[34] These results were confirmed by a follow-up study conducted by Lee et al static balance and FMS scores were improved after 8 weeks of IFM programs; however, combined proprioceptive and strength training were needed for dynamic performance.[35]

Limitations

This study has a few limitations. The small sample size and single-center setting restrict the generalizability of the findings. Being cross-sectional, it cannot establish causality between foot posture, balance, and movement quality. The sample included only young adults with pronated feet, limiting comparisons with other foot types. Convenience sampling may have introduced bias, and only selected outcome measures were used without detailed biomechanical assessments. Finally, the lack of follow-up or intervention limits the clinical applicability of results.

CONCLUSION

According to the study's findings, college students who have pronated feet have much worse postural stability and lower movement quality. These results highlight the biomechanical function of the foot in promoting functional performance and preserving equilibrium. Through screening, focused exercises, and postural retraining, pronated foot posture can be identified early and corrected, potentially preventing musculoskeletal problems and improving young adults' physical resilience. It can be a good preventive measure to incorporate foot posture tests into regular exams, particularly for students who are physically active.

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