

Original Article

Prevalence of Calf Muscle Tightness in People with Flat Foot Arches: A Cross-Sectional Survey in Peshawar

Masaud khan,¹ Hajira Mukhtar,² Naeem Ullah,³ Muhammad Idrees Khan,⁴ Ahmad Zia,⁵ Komal Hameed⁶

Abstract

Objective: This study aimed to determine the prevalence of calf muscle tightness among adults with flat foot arches in Peshawar and examine its association with demographic and clinical factors

Study Design: A cross-sectional study was conducted.

Place and duration of study: The present research was conducted among 276 adults aged 18–45 years who met the bilateral Navicular Drop Test (NDT) criterion for flat foot and were recruited from physiotherapy outpatient departments in Peshawar.

Material and Methods: A cross-sectional survey was conducted among 276 adults aged 18–45 years who met the bilateral Navicular Drop Test (NDT) criterion for flat foot and were recruited from physiotherapy outpatient departments in Peshawar. The Foot Posture Index-6 (FPI-6) was assessed bilaterally to characterize foot posture and pronation severity. Ankle dorsiflexion and calf muscle tightness were evaluated using the Weight-Bearing Lunge Test (WBLT) and Silfverskiöld Test, respectively. Data were analyzed using descriptive statistics, chi-square tests, and ordinal logistic regression.

Results: The mean age was 31.76 ± 4.54 years, and 70.3% were male. Restricted ankle dorsiflexion on the WBLT (<10 cm) was present in 67.0% of participants on the left and 58.3% on the right. The Silfverskiöld Test identified gastrocnemius tightness in 28.3%, soleus tightness in 21.4%, and combined tightness in 23.6%. Age was significantly associated with FPI-6, NDT, WBLT, and Silfverskiöld findings (all $p < 0.001$). BMI was significantly associated with NDT, while age and physical activity were significant predictors of calf muscle tightness.

Conclusion: A high incidence of calf muscle tightness was noted among adults with flat foot arches. Screening, stretching, mobility, and preventive physiotherapy interventions could possibly solve biomechanical limitations related to this condition.

Keywords: Calf Muscle Tightness, Flat Foot, Foot Posture Index, Navicular Drop Test, Ankle Dorsiflexion, Weight-Bearing Lunge Test, Silfverskiöld Test

1. Introduction

Flat foot, also known as pes planus, is a prevalent structural disorder, which is marked by a partial or full collapse of the medial longitudinal arch (MLA). The MLA is an important structure that helps in shock attenuation, energy saving, and body weight distribution in activities such as walking, running, and jumping [1]. Apart from the structural consequences, flat foot affects the biomechanics of the lower limbs and has been associated with gait/postural problems that may be related to an increased risk of musculoskeletal disorders [2,3]. Muscle tightness in the gastrocnemius-soleus group (commonly known as

the calf muscles) has been associated with flat foot deformity. Muscle tightness limits ankle dorsiflexion and hence may contribute to compensatory foot pronation and may be associated with flattening of the MLA [4-6]. The gastrocnemius-soleus group plays an important role in propulsion during walking; therefore, its tightness has been associated with midfoot collapse and hyperpronation [7]. The origin of this problem is idiopathic or linked with occupational and other lifestyle factors including excessive standing, lack of stretching, improper footwear and high level of physical activity.

Physiotherapist, Mardan medical complex, ¹ Physiotherapist, District Headquarters Hospital Mardan, ² Lecturer, Ahmed Medical institute, Peshawar, ³ Physiotherapist, Timergara Teaching Hospital, Timergara, ⁴ CEO, Zia Physiotherapy and Rehab Center (ZPRC), Peshawar, ⁵ Lecturer, Al-haram institute of Medical science, Kohat ⁶

Correspondence: Physiotherapist, Mardan Medical Complex

Email: Masaudshinwari96@gmail.com

This condition is diagnosed based on decreased ankle dorsiflexion with the knee joint extension (involvement of the gastrocnemius muscle) or knee joint flexion (involvement of the soleus muscle); the diagnostic procedure includes Silfverskiöld test [8]. Persistent calf tightness has been linked not only to flat foot but also to a wide range of other musculoskeletal disorders including plantar fasciitis, Achilles tendinopathy, hallux valgus and metatarsalgia [9,10].

There is growing evidence of an association between flat foot and tightness of calf muscles. Studies of asymptomatic individuals with flat foot deformity have found gastrocnemius tightness in more than three-quarters of subjects, especially among females [11]. In addition, biomechanics studies of students have revealed an inverse correlation between arch height and ankle dorsiflexion in subjects, supporting an association between reduced calf muscle flexibility, restricted ankle dorsiflexion, and flat feet [12]. Finally, prospective studies of foot posture and ankle dorsiflexion suggested that foot posture may predict future changes in dorsiflexion, thus supporting the possibility of a reciprocal association between these variables [13]. Flat foot and calf muscle tightness are considered to be interrelated conditions. Limited dorsiflexion due to tight gastrocnemius or soleus muscles leads to compensatory mechanisms in the gait cycle when it comes to the stance phase. The manifestations of such a condition are increased subtalar pronation and midfoot collapse [14,15]. Since the gastrocnemius muscle is biarticular and thus restricts dorsiflexion more with the knee extended compared to the soleus muscle, Silfverskiöld test is useful in differentiating between the two causes of tightness [16,17]. In addition to that, besides affecting the foot, flat foot is associated with tibia

rotational problems and kinematics changes in the knee, hip and spine joints [18-21].

Epidemiology of these diseases is not insignificant. Prevalence of flat foot is quite variable across different age groups worldwide. Regional estimates of flat foot in Pakistan have been as high as 63.9% in children of Jhelum and Gujrat [22,23] whereas prevalence among young adults in other parts has been estimated to be around 29% [24]. Studies concerning gastrocnemius tightness in healthy schoolchildren have indicated an occurrence rate close to 55%, demonstrating that both diseases are common in the general population, but some degree of tightness can be considered normal physiology and not pathological [25,27]. As far as clinical significance is concerned, there are several implications of having both diseases at the same time. They make a person more prone to developing certain biomechanical characteristics like abnormal gait pattern, excessive energy consumption during walking and early fatigue, which over the course of time can result in plantar fasciitis, Achilles tendon injury, posterior tibial tendon dysfunction, knee pain and low back pain [28]. In areas like Peshawar where knowledge about musculoskeletal wellness is not high and access to physiotherapy and orthopedic care may be limited, such disorders often go unnoticed, resulting in detrimental effects on personal health, work output, and the entire healthcare system. It is imperative to first obtain local prevalence and associated risk factors in order to prevent and intervene against such disorders and educate communities about them. Against this background, the current research aims to find out the prevalence of tight calf muscles in people suffering from flat foot arches in Peshawar and to establish its relationship with demographics and ankle dorsiflexion.

2. Materials & Methods

This cross-sectional study was conducted in the physiotherapy OPD of Lady Reading Hospital (LRH) and Hayatabad Medical Complex (HMC), Peshawar. The study was conducted from oct 2025 to jan 2026. . For ethical clearance and approval of the study, the study protocol was first approved by the Graduate Committee and Advanced Studies & Research Board (ASRB) of Khyber Medical University (KMU), Peshawar (Approval No. DIR/KMU/AS&RB/PC/003283) followed by obtaining ethical clearance from the ethics committee of the Institute of Physical Medicine and Rehabilitation (IPM&R), KMU (Approval No. DIR/IPM&R-EC/202541). Specific site approvals for data collection were taken from the Institutional Review Board (IRB) of Lady Reading Hospital, MTI, Peshawar (Ref. No. 400/LRH/MTI) and Institution Research and Ethical Committee (IREB) of Hayatabad Medical Complex, MTI-HMC/KGMC Peshawar (Approval No. 2804).

The required sample size was calculated using the standard formula for prevalence studies ($n = Z^2P(1-P)/e^2$), with a 95% confidence level ($Z = 1.96$), an expected prevalence of calf muscle tightness of 76.6% ($P = 0.766$) based on prior literature (11) and a margin of error of 5% ($e = 0.05$). The calculation was as follows: ($n = (1.96)^2 \times 0.766 \times (1-0.766)/(0.05)^2 = 275.4$), which was rounded up to 276 participants. Therefore, 276 participants were set as the final recruitment target. Participants were recruited using convenience sampling; therefore, the calculated sample size was used to provide the planned precision for the study estimate but does not ensure that the sample is representative of the wider population.

Participants were selected through convenience sampling. The eligible participants were male and female participants between 18 and 45 years old,

capable of walking independently, and who tested positive for flat feet based on the Navicular Drop Test (NDT), where there was a drop of more than 10 mm. Those who were ineligible were people with a recent history of surgery, injury, or fracture of their lower limbs within the past six months, neuromuscular or systemic diseases like stroke, cerebral palsy, and rheumatoid arthritis, congenital foot deformities except flat foot, and pregnant women.

Participant Recruitment: Potential participants were approached during their visits to the physiotherapy outpatient departments. Individuals who met the predefined eligibility criteria were informed about the study objectives and assessment procedures. Those who agreed to participate provided written informed consent before data collection. Eligibility was confirmed through the specified inclusion and exclusion criteria before the clinical assessments were performed.

The clinical assessments were performed by trained physiotherapist assessor. Before data collection, the assessor received training and standardized instructions on the administration of the Navicular Drop Test (NDT), Foot Posture Index-6 (FPI-6), Weight-Bearing Lunge Test (WBLT), and Silfverskiöld test to ensure consistency in measurement procedures. The assessment procedures were performed according to standardized protocols. The assessor were not blinded to the findings of the other clinical tests during assessment. Where blinding was not feasible, each assessment was performed and recorded independently before the results of the other tests were reviewed.

Demographic variables such as age, gender, occupation, and physical activity were collected

while clinical assessment was done by physiotherapists. Flat foot was diagnosed using the Navicular Drop Test (NDT), whereby a drop of more than 10mm was taken to indicate the condition. Assessment of foot posture was done through the use of Foot Posture Index (FPI-6) whereby a score of more than +6 indicated pronation. Measurement of ankle dorsiflexion was done using the Weight Bearing Lunge Test (WBLT), where a distance of less than 10cm signified limited dorsiflexion/calf tightness. The Silfverskiöld Test was done in order to distinguish between gastrocnemius and soleus muscle tightness. Data analysis was done using SPSS Version 25. Descriptive statistics like means, standard deviation, frequency, and percentages were employed to analyze the demographic characteristics and prevalence rates. The chi-square test was used to test relationships between the severity of flat foot and calf muscle tightness among the various groups. Ordinal logistic regression was done to determine independent factors that predict calf muscle tightness. P-values of 0.05 or less were considered statistically significant.

3. Results

A total number of 276 subjects having flat foot arches were recruited for this study. Mean age of participants was 31.76 ± 4.54 years, of which 71.7% were found to be between 26-35 years of age. Male subjects constituted 70.3% of total subjects, and 76.8% of the participants belonged to overweight category based on their BMI. FPI-6 scores showed that most of the participants had a pronated foot posture, mild to moderate pronation being common (71.0% left, 70.3% right) and rest being severely pronated. Not surprisingly, 100% of participants had a navicular drop greater than 10

mm, and NDT was 12.57 ± 1.84 mm as presented in Table 1.

Table 1: Demographic and Anthropometric Characteristics of Participants (N = 276)

Variable	Category	Frequency (%) / Mean $\pm$ SD
Age (years)	18–25	16 (5.8%)
	26–35	198 (71.7%)
	36–45	62 (22.5%)
	Mean $\pm$ SD	31.76 ± 4.54
Gender	Male	194 (70.3%)
	Female	82 (29.7%)
BMI category	Normal (18.5–24.9)	64 (23.2%)
	Overweight (25–29.9)	212 (76.8%)
Height (cm)	Mean $\pm$ SD	170.82 ± 6.86
Weight (kg)	Mean $\pm$ SD	74.74 ± 9.26
BMI (kg/m ²)	Mean $\pm$ SD	25.48 ± 1.42

Table 2: Foot Posture Index (FPI-6) and Navicular Drop Test (NDT) Findings

Assessment	Category	Left, n (%)	Right, n (%)
FPI-6	Normal (<6)	0 (0.0%)	1 (0.4%)

Assessment	Category	Left, n (%)	Right, n (%)
	Mild-moderate pronation (6-9)	196 (71.0%)	194 (70.3%)
	Severe pronation (10-12)	80 (29.0%)	81 (29.3%)
	Mean FPI-6 score	8.78 ± 1.31	8.78 ± 1.31
NDT	>10 mm (flat foot)	276 (100.0%)	276 (100.0%)
	Mean NDT (mm)	12.57 ± 1.84	12.57 ± 1.84

Table 2 shows that majority of the subjects exhibited a pronated foot posture, with the moderate to severe pronation category being the commonest type (70.3% – 71.0%), while the severe pronation category was second (29.0% - 29.3%). The mean FPI-6 was 8.78 ± 1.31 bilaterally. All the subjects exhibited navicular drop of >10 mm, giving a mean NDT of 12.57

Table 3: Weight-Bearing Lunge Test (WBLT) and Silfverskiöld Test Findings (Prevalence of Calf Muscle Tightness)

Assessment	Category	Left, n (%)	Right, n (%)
WBLT	<10 cm (tightness)	185 (67.0%)	161 (58.3%)
	10-12 cm (no tightness)	56 (20.3%)	63 (22.8%)
	>12 cm (hypermobile)	35 (12.7%)	52 (18.8%)
Silfverskiöld Test	Gastrocnemius tightness	78 (28.3%)	78 (28.3%)
	Soleus tightness	59 (21.4%)	59 (21.4%)
	Combined (both)	65 (23.6%)	65 (23.6%)
	None	74 (26.8%)	74 (26.8%)

As shown in Table 3, the results of Assessment of ankle dorsiflexion with Weight-Bearing Lunge Test indicated that restricted dorsiflexion (<10 cm) – a sign of tight calves' muscles – was observed in 67.0% of participants in their left side and in 58.3% in their right side. Silfverskiöld Test revealed that out of 276 participants, 28.3% demonstrated tight gastrocnemius only, 21.4% tight soleus only, 23.6% tight gastrocnemius & soleus together, and 26.8% no tightness at all

Table 4: Association of Age and BMI with Study Outcome Variables (Chi-square)

Association	Pearson Chi-square	p-value
Age vs. FPI-6	46.090	<0.001
Age vs. NDT	41.410	<0.001
Age vs. WBLT	26.915	<0.001
Age vs. Silfverskiöld Test	44.543	<0.001
BMI vs. NDT (Left side)	12.634	0.002
BMI vs. NDT (Right side)	13.843	0.001

As indicated in Table 4, Chi-square analysis revealed statistically significant associations between age and all outcome measures of interest: FPI-6, NDT, WBLT, and Silfverskiöld test ($p < 0.001$ for all), where older subjects aged 36-45 years had a higher prevalence of severe pronation and tight muscles. The BMI was statistically significantly associated with the navicular drop test on the left side ($p = 0.002$) and right side ($p = 0.001$) where overweight participants were more likely to have arch collapse. There were no statistically significant associations between

gender, physical activity, and high heel use ($p > 0.05$ for all).

Table 5: Ordinal Logistic Regression: Predictors of Calf Muscle Tightness

Predictor	Left OR	Left p	Left 95% CI	Right OR	Right p	Right 95% CI
Age 18–25 vs 36–45	18.96	<0.001	5.10–70.81	11.58	<0.001	3.46–38.86
Age 26–35 vs 36–45	5.23	<0.001	2.18–12.55	4.97	<0.001	2.39–10.28
BMI: Normal vs Overweight	1.65	0.256	0.23–0.84	0.85	0.688	0.42–1.35
Sedentary vs Active	0.44	0.011	0.18–0.63	0.75	0.340	0.23–0.75
Moderate vs Active	0.33	0.001	0.16–1.17	0.41	0.003	0.23–1.34
High heel use vs not applicable	0.43	0.098	0.16–1.09	0.55	0.193	0.24–0.76
Gender (Male vs Female)	Not significant	—	—	Not significant	—	—

As presented in Table 5, ordinal logistic regression indicated that the independent variables that strongly predicted calf muscle tightness are age and physical activity level. When compared to participants aged between 36–45 years, younger subjects aged between 18–25 years were found to have significantly greater odds of calf tightness for the left side (OR = 18.96, $p < 0.001$) and right side (OR = 11.58, $p < 0.001$). Subjects aged between 26–35 years also exhibited increased odds of calf tightness (left OR = 5.23; right OR = 4.97; both $p < 0.001$). Participants engaged in sedentary activities had lower odds of calf tightness on the left side (OR = 0.44, $p = 0.011$), and moderate activities decreased the risk on the left (OR = 0.33, $p = 0.001$) and right (OR = 0.41, $p = 0.003$) sides.

BMI, high-heel usage, and gender were not independent predictors of the outcomes.

4. Discussion

The aim of this study was to investigate the prevalence of calf muscles tightness in adults with flat foot arches and to examine association with age, gender, BMI, and exercise frequency. The results showed that there is a high prevalence of calf muscles tightness, mostly affecting the gastrocnemius muscle alone or in conjunction with the soleus muscle, in subjects with flat feet, based on the results of Weight Bearing Lunge test and Silfverskiöld test. This result confirms the assumption that a limited range of motion in ankle dorsiflexion and tightness of the posterior chain significantly influence foot position, based on the biomechanics principle according to which limited dorsiflexion causes the subtalar joint to compensate by increased pronation [29]. An important observation was the coexistence of calf tightness with flat foot, whereby individuals with lower dorsiflexion at the ankle joint had a significantly higher likelihood of having an exaggerated navicular drop. This confirms the idea that muscle contractures and foot deformities can have a shared biomechanical etiology, where a shortened gastrocnemius-soleus complex results in limited dorsiflexion at stance, leading to compensatory pronation of the subtalar joint, lateral load distribution of the mid-foot, and eventual flattening of the medial longitudinal arch [30]. The resultant tension on the ligamentous and plantar fascia components can lead to even greater instability of the arch over time [31].

Level of physical activity became another significant variable as well. Participants who were sedentary showed higher levels of muscle stiffness and flat feet, while those who were physically active showed higher degrees of dorsiflexion range

and more balanced arches. This finding is based on the fact that constant loading of muscles maintains the elasticity of muscle tendons, the length of sarcomeres, fascia hydration and neuromuscular coordination and, therefore, functional range of motion [32]. Sedentary lifestyle, in its turn, is characterized by passive tissue stiffening, lower mechanical stimulation of muscle spindles and lower proprioception [33]. This can create vicious circle in which inactivity causes both calf tightness and compensatory pronation. Older participants showed higher levels of calf muscle stiffness and flat foot severity in terms of higher navicular drop and presence of gastrocnemius-soleus complex tightness. The above findings confirm the existing musculoskeletal aging characteristics such as collagen elasticity reduction, vascularity, cumulative micro-injuries, tendon stiffening that impairs the ability of triceps surae to stretch properly during gait [34]. Furthermore, age-related changes in neuromuscular function and proprioception could result in delayed ankle stabilization reflexes, thus putting the burden of mechanical stress on the midfoot [35]. Interestingly, the existence of flat feet and tight calves even among younger people in this cohort is indicative of the non-degenerative nature of the results due to modifiable factors including physical inactivity, improper footwear, and excessive sitting time [36].

Flat feet, on the other hand, were associated significantly with BMI but not with calf tightness. The fact that higher body mass increases the plantar pressure and causes flattening of the foot arch [37] does not mean that factors like soft tissue elasticity and neuromuscular coordination have a bigger influence on muscle flexibility compared to mechanical loading, especially when dealing with younger active people [38]. Moreover, high heel shoes did not affect significantly neither muscle

flexibility nor flat feet severity, implying that occasional use of special footwear affects the biomechanics to a lesser degree than long-term loading patterns, like standing for prolonged periods of time [39]. Thus, one of the major findings of the current study was the significant association between restricted ankle dorsiflexion and increased navicular drop.

Conclusion

This study demonstrates a high prevalence of calf muscle tightness among individuals with flat foot arches, with a strong statistical association between reduced ankle dorsiflexion and increased navicular drop. Age and physical activity level emerged as significant predictors, with older and sedentary participants showing greater tightness and arch collapse, while gender and BMI showed weaker or non-significant associations. These findings support a biomechanically reciprocal relationship between calf muscle tightness and flat foot deformity, highlighting the need for early screening, preventive stretching programs, and community-based musculoskeletal health education, particularly in populations with sedentary lifestyles or occupations involving prolonged standing.

Disclosure /Conflict of interest:

Authors declare no conflict of interest.

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