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Association Between Foot Posture and Self-Reported Fatigue Severity Among University Students: A Cross-Sectional Study

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ABSTRACT

Background: Variations in foot posture may influence lower-limb biomechanics and movement efficiency, but their relationship with perceived fatigue in young adults remains insufficiently understood. **Objective:** To determine the association between foot posture and self-reported fatigue severity among university students. **Methods:** This cross-sectional study included 126 university students aged 18–25 years. Foot posture was assessed using the Foot Posture Index-6 (FPI-6) and classified as neutral, pronated, or highly pronated. Perceived fatigue was assessed using the nine-item Fatigue Severity Scale (FSS) and categorized into study-defined lower, intermediate, and higher fatigue-score bands. Pearson's chi-square test was used to examine the association between foot-posture category and fatigue-score band. **Results:** Of the 126 participants, 36 (28.6%) had neutral foot posture, 48 (38.1%) had pronated foot posture, and 42 (33.3%) had highly pronated foot posture. Lower, intermediate, and higher fatigue-score bands included 37 (29.4%), 56 (44.4%), and 33 (26.2%) participants, respectively. Foot-posture category was significantly associated with fatigue-score band, $\chi^2(4) = 74.034$, $p < 0.001$, with Cramér's $V = 0.542$. Higher fatigue-score categories occurred more frequently among participants with increasingly pronated foot posture. **Conclusion:** Increasingly pronated foot posture was associated with higher self-reported fatigue scores among university students. Because of the cross-sectional design, temporal and causal relationships cannot be inferred. **Keywords:** Foot Posture; Foot Posture Index; Fatigue Severity Scale; Pronation; University Students; Cross-Sectional Study

INTRODUCTION

The medial longitudinal arch is a fundamental structural feature of the human foot that contributes to load distribution, shock attenuation, elastic energy storage, and adaptation of the foot during weight-bearing activities. Variations in arch morphology occur across a continuum, and a lowered medial longitudinal arch may be described clinically as flatfoot or pes planus when appropriate diagnostic criteria are satisfied. However, definitions of flatfoot are not entirely uniform across clinical and research settings, and a low or pronated foot posture should not automatically be considered synonymous with a pathological flatfoot deformity (1). This distinction is particularly important when clinical posture-rating instruments are used to classify participants rather than imaging or other diagnostic procedures.

Foot posture can influence the mechanical behavior of the lower extremity during weight-bearing and locomotion. A systematic review examining foot posture and lower-limb kinematics found evidence that increasing planus foot posture is associated with greater rearfoot motion during gait, although the magnitude and consistency of these relationships varied across studies (2). More recent evidence from university students has similarly demonstrated associations between medial longitudinal arch morphology and several biomechanical characteristics, including hindfoot alignment, plantar-pressure behavior, arch function, bilateral asymmetry, and postural-control measures (3). Variations in medial longitudinal arch flexibility have also been associated with differences in interjoint coordination and ground-reaction impulses during walking and running, indicating that structural characteristics of the foot may influence movement strategies throughout the lower-limb kinetic chain (4).

Changes in foot posture may also be relevant to balance and sensorimotor function. Among young adults, differences in foot posture have been associated with static balance and ankle and knee joint-position sense, suggesting that altered foot structure may be accompanied by changes in the biomechanical and proprioceptive demands of maintaining posture and performing functional activities (5). These findings support the concept that the consequences of foot-posture variation are not necessarily restricted to the foot itself but may involve more proximal segments of the lower extremity. Nevertheless, the magnitude and clinical importance of these associations may differ according to the population, measurement method, activity, and severity of postural deviation.

During walking, the medial longitudinal arch contributes to the mechanical behavior of the foot and the transfer of energy through the lower extremity. Experimental work in young adults has shown that individuals with pronated feet may demonstrate altered energetic behavior during walking, including greater negative work in structures distal to the forefoot and reduced positive work at the ankle and whole-body center of mass compared with individuals with neutral foot posture (6). Such findings provide biomechanical plausibility for a relationship between foot-posture characteristics and the effort associated with repeated weight-bearing activity. They do not, however, establish that pronated foot posture directly causes subjective fatigue, and this distinction is important when interpreting observational associations.

Fatigue is a multidimensional symptom reflecting interactions between perceived fatigue and performance fatigability rather than a single localized physiological process (7). Experimental studies have demonstrated that physical fatigue can alter lower-limb kinematics, joint power, muscle activation, and postural control during functional tasks (8,9). Conversely, biomechanical inefficiency or altered movement strategies could plausibly increase the physical demands associated with repeated activity. The relationship between foot posture and self-reported fatigue therefore warrants investigation, but perceived fatigue should be distinguished from objectively measured muscle fatigability and from fatigue attributed specifically to an anatomical region unless a region-specific measurement instrument has been used.

Foot-posture variation is relevant in young adults because both neutral and pronated postures occur within this population. Reference data obtained using the Foot Posture Index in healthy adults aged 18–25 years have shown neutral posture to be the most frequent classification while also identifying a meaningful proportion of pronated feet and significant side-to-side variation (10). University students

are an especially relevant population for studying the functional correlates of foot posture because routine academic activities may involve repeated walking, prolonged standing, stair negotiation, and other weight-bearing tasks. Recent university-based biomechanical research has demonstrated measurable associations between arch morphology and lower-limb alignment and postural-control characteristics in this age group (3).

Despite increasing evidence linking foot-posture characteristics with gait mechanics, balance, proprioception, plantar loading, and movement efficiency, evidence directly examining the relationship between clinically assessed foot posture and perceived fatigue severity among university students remains limited (3–6). Clarifying this association may contribute to a better understanding of whether variations in foot posture are accompanied by differences in fatigue-related functional experience in young adults while avoiding assumptions of causality that cannot be established by a cross-sectional design. Therefore, the present study aimed to determine the association between foot posture and self-reported fatigue severity among university students.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional observational study was conducted at The University of Lahore, Lahore, Pakistan. The study was completed over a six-month period following approval of the research synopsis. The investigation was designed to examine the association between foot posture and self-reported fatigue severity among university students.

Participants and Sampling

A total of 126 university students aged 18–25 years were included using a non-probability convenience sampling technique. The sample size of 126 was based on a prevalence estimate derived from a parent study. Male and female university students were eligible to participate if they were willing to provide informed consent, were independent in performing activities of daily living, and had no acute illness or injury affecting mobility at the time of assessment.

Participants were excluded if they had a history of surgery or trauma involving the lower limb, were using foot orthoses or assistive devices, had unsteadiness, balance impairment, or vestibular dysfunction, or had a systemic condition known to contribute substantially to fatigue, including anemia or chronic systemic disease. These criteria were applied to reduce the influence of conditions that could independently affect mobility, foot-posture assessment, balance, or perceived fatigue.

Study Variables

The principal explanatory variable was foot posture assessed using the Foot Posture Index-6 (FPI-6). The primary outcome was self-reported fatigue severity assessed using the Fatigue Severity Scale (FSS). Age, sex, and body mass index (BMI) were recorded as participant characteristics.

Foot Posture Assessment

Foot posture was assessed in standing using the Foot Posture Index-6 (FPI-6), a clinical observational instrument developed to provide a multidimensional assessment of static foot posture. The FPI-6 evaluates six clinical features of the foot, with each criterion scored on an ordinal scale from −2 to +2. The individual item scores are summed to obtain an overall score ranging from −12 to +12, with progressively positive scores representing increasingly pronated foot posture (11).

For the categorical analysis, the FPI-6 scores relevant to the study population were classified as neutral foot posture (0 to +5), pronated foot posture (+6 to +9), and highly pronated foot posture (+10 to +12), consistent with established FPI reference classifications used in young adults (10,11). This terminology was used instead of describing scores of 0 to +5 as mild flatfoot because this interval represents neutral rather than pathological foot posture within the established FPI classification.

Fatigue Assessment

Self-reported fatigue was assessed using the Fatigue Severity Scale (FSS). The FSS is a nine-item self-administered questionnaire developed to quantify perceived fatigue and the extent to which fatigue interferes with functioning. Each item is rated on a 7-point Likert scale ranging from 1 to 7, with higher scores representing greater perceived fatigue (12). Subsequent psychometric evaluation has supported the reliability of the nine-item FSS for quantifying fatigue, including its use in healthy participants and different clinical populations (13).

In the present analysis, responses to the nine items were summed, yielding a possible total score of 9–63. For the categorical association analysis, total FSS scores were divided into three study-defined fatigue-score bands: 9–27, 28–45, and 46–63. These categories were treated as lower, intermediate, and higher fatigue-score bands, respectively. This operational categorization was used for the cross-tabulation with foot-posture categories; higher FSS scores consistently represented greater perceived fatigue. The FSS was interpreted as a measure of perceived fatigue severity rather than as a direct measure of localized lower-limb muscle fatigability (7,12,13).

Data Collection Procedure

Eligible students were informed about the study and written informed consent was obtained before data collection. Assessments were performed under standardized conditions. Participant characteristics were recorded, followed by assessment of standing foot posture using the FPI-6 and assessment of perceived fatigue using the FSS. The collected data were systematically recorded for subsequent statistical analysis.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 27. Continuous participant characteristics were summarized using means and standard deviations, together with observed ranges where appropriate. Categorical variables were summarized using frequencies and percentages.

For the primary categorical analysis, participants were classified according to their FPI-6 foot-posture category and FSS fatigue-score band. Pearson's chi-square test of independence was used to examine the association between foot-posture category and fatigue-score category. Statistical significance was defined as a two-sided p value ≤0.05.

Ethical Considerations

Ethical approval was obtained from the Institutional Research Ethics Board of The University of Lahore, Lahore, Pakistan. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Written informed consent was obtained from all

participants before enrollment. Participation was voluntary, and participants were free to withdraw from the study without penalty. Confidentiality and anonymity were maintained throughout data collection, analysis, and reporting.

RESULTS

Participant Characteristics

A total of 126 university students were included in the analysis. The mean age was 21.54 ± 2.37 years, with an observed range of 18–25 years. The mean body mass index (BMI) was 22.84 ± 3.54 kg/m², ranging from 17.0 to 34.0 kg/m². Of the 126 participants, 66 (52.4%) were male and 60 (47.6%) were female (Table 1\).

Table 1. Participant Characteristics (n = 126)

Characteristic	Value
Age, years, mean ± SD	21.54 ± 2.37
Age, years, range	18–25
BMI, kg/m², mean ± SD	22.84 ± 3.54
BMI, kg/m², range	17.0–34.0
Male, n (%)	66 (52.4)
Female, n (%)	60 (47.6)

BMI, body mass index; SD, standard deviation.

Distribution of Foot-Posture and Fatigue-Score Categories

According to the corrected FPI-6 classification, 36 participants (28.6%) had neutral foot posture, 48 (38.1%) had pronated foot posture, and 42 (33.3%) had highly pronated foot posture. Based on the study-defined FSS score bands used for the categorical analysis, 37 participants (29.4%) were in the lower fatigue-score band, 56 (44.4%) were in the intermediate fatigue-score band, and 33 (26.2%) were in the higher fatigue-score band. The distribution of fatigue-score categories differed across foot-posture categories (Table 2). Among participants with neutral foot posture, 26 of 36 (72.2%) were in the lower fatigue-score band, 10 (27.8%) were in the intermediate band, and none were in the higher band. Among participants with pronated foot posture, 11 of 48 (22.9%) were in the lower band, 30 (62.5%) were in the intermediate band, and 7 (14.6%) were in the higher band. Among those with highly pronated foot posture, none of the 42 participants were in the lower fatigue-score band, 16 (38.1%) were in the intermediate band, and 26 (61.9%) were in the higher band.

Table 2. Association Between Foot-Posture Category and Fatigue-Score Band (n = 126)

Foot-Posture Category	Lower Fatigue Score, n (%)	Intermediate Fatigue Score, n (%)	Higher Fatigue Score, n (%)	Total, n
Neutral	26 (72.2)	10 (27.8)	0 (0.0)	36
Pronated	11 (22.9)	30 (62.5)	7 (14.6)	48
Highly pronated	0 (0.0)	16 (38.1)	26 (61.9)	42
Total	37 (29.4)	56 (44.4)	33 (26.2)	126

Percentages in the three foot-posture rows are calculated within each foot-posture category. Percentages in the total row are calculated using the overall sample as the denominator. FPI-6 categories were neutral (0 to +5), pronated (+6 to +9), and highly pronated (+10 to +12). Study-defined FSS score bands were lower (9–27), intermediate (28–45), and higher (46–63).

Association Between Foot Posture and Fatigue Score

Pearson's chi-square test demonstrated a statistically significant association between foot-posture category and fatigue-score band, $\chi^2(4) = 74.034$, $p < 0.001$. The assumptions of the chi-square analysis were satisfied: no expected cell count was below 5, and the minimum expected count was 9.43. The corresponding Cramér's V was 0.542, indicating the magnitude of the observed categorical association. The likelihood-ratio chi-square test yielded a consistent result, $\chi^2(4) = 83.998$, $p < 0.001$ (Table 3). The observed distribution showed a progressive shift toward higher fatigue-score bands across increasingly pronated foot-posture categories; however, the cross-sectional analysis establishes an association and does not determine temporal or causal direction.

Table 3. Statistical Association Between Foot-Posture Category and Fatigue-Score Band

Statistic	Value	df	p Value
Pearson chi-square	74.034	4	<0.001
Likelihood-ratio chi-square	83.998	4	<0.001
Cramér's V	0.542	—	—
Valid cases	126	—	—

No expected cell count was <5; minimum expected count = 9.43. Cramér's V was derived from the reported Pearson chi-square statistic and total sample size.

DISCUSSION

Principal Findings

The present study identified a statistically significant association between foot-posture category and self-reported fatigue-score band among university students. The distribution of fatigue scores shifted progressively across the FPI-6 categories: most participants with neutral foot posture were in the lower fatigue-score band, whereas most participants with highly pronated foot posture were in the higher

fatigue-score band. The association was statistically significant, $\chi^2(4) = 74.034$, $p < 0.001$, with a Cramér's V of 0.542. These findings indicate a clear relationship between increasingly pronated foot posture and higher self-reported fatigue scores within this sample. Because the study was cross-sectional, however, the observed relationship cannot establish temporal sequence or causality.

The corrected FPI-6 classification also changes the interpretation of the sample distribution compared with describing all participants as having varying severities of flatfoot. Of the 126 participants, 36 (28.6%) had neutral foot posture, 48 (38.1%) had pronated foot posture, and 42 (33.3%) had highly pronated foot posture. Thus, the findings concern variation across neutral and increasingly pronated foot-posture categories rather than severity levels of a universally present flatfoot disorder. These proportions describe the present convenience sample and should not be interpreted as population prevalence estimates.

Foot Posture and Lower-Limb Biomechanics

The association identified in this study is biomechanically plausible in the context of previous research examining foot posture and lower-extremity function. A systematic review by Buldt et al. found evidence that planus foot posture is associated with increased lower-limb motion during walking, particularly greater frontal-plane rearfoot motion, although the findings across studies were heterogeneous and effect sizes were generally modest (2). More recent work in university students has demonstrated associations between medial longitudinal arch morphology and hindfoot alignment, plantar-pressure characteristics, arch function, bilateral asymmetry, and postural-control measures (3). Similarly, differences in medial longitudinal arch flexibility have been associated with alterations in lower-limb interjoint coordination and ground-reaction impulses during gait (4).

These relationships are also consistent with evidence concerning balance and proprioceptive function. Ghorbani et al. identified differences in static balance and ankle and knee joint-position sense between young women with flexible flatfoot and those with normal foot posture (5). In addition, plantar-loading studies have demonstrated that low-arched feet may exhibit greater midfoot contact and pressure during standing compared with normal- and high-arched feet (14). Collectively, these observations indicate that foot-posture variation may be accompanied by measurable differences in loading, alignment, sensory-motor control, and lower-limb movement behavior. They do not, however, imply that foot posture alone determines functional impairment.

Fatigue and Interpretation of the Association

Fatigue is a multidimensional construct involving perceived fatigue and performance fatigability, which should not be assumed to originate from a single anatomical structure or physiological mechanism (7). In the present study, fatigue was assessed using the FSS; therefore, the findings represent self-reported fatigue severity and its perceived functional impact, rather than objectively measured muscle fatigability or fatigue localized specifically to the lower limbs.

Experimental evidence nevertheless demonstrates that physical fatigue can interact with lower-limb function. Zhang et al. reported alterations in lower-limb kinematics, joint power, and muscle activity following experimentally induced fatigue during gait (8), while Gebel et al. demonstrated changes in postural sway after physical fatigue in healthy young adults (9). These studies examine the effects of experimentally induced fatigue on biomechanics and therefore address a different direction of association from the present cross-sectional study. They nevertheless support a broader interaction between fatigue and movement performance.

An important interpretive distinction is that the three FSS groups used in the present study—scores of 9–27, 28–45, and 46–63—were study-defined analytical bands rather than externally validated clinical categories of mild, moderate, and severe fatigue. Accordingly, the progressive distribution across foot-posture categories demonstrates an association with relatively lower or higher FSS scores within this sample but should not be interpreted as evidence that particular FPI-6 categories produce clinically defined stages of fatigue.

Plausible Biomechanical Mechanisms

Several mechanisms may plausibly contribute to the observed association, although they were not directly tested in the present study. The medial longitudinal arch contributes to the mechanical behavior of the foot during stance and locomotion, and changes in arch configuration can influence how forces and movement are transmitted through the lower extremity. Kawakami et al. demonstrated that young adults with pronated feet exhibited altered energetic behavior during walking, including greater negative work in structures distal to the forefoot and reduced positive work at the ankle and whole-body center of mass compared with participants with neutral foot posture (6). Variations in arch flexibility have also been associated with altered interjoint coordination and gait impulses (4).

Neuromuscular adaptation may represent another potential pathway. Pan et al. examined individuals with unilateral flatfoot using surface electromyography and identified asymmetry in muscle-synergy organization and compensatory medial gastrocnemius activity between affected and unaffected limbs during stance (15). Such findings suggest that altered foot structure may be accompanied by changes in neuromuscular coordination during gait. However, the present study did not measure electromyographic activity, gait energetics, plantar pressure, or muscle fatigability; these mechanisms therefore provide biological plausibility rather than direct explanations of the observed FSS association.

Functional and Clinical Implications

The findings suggest that foot posture may be a relevant component of a broader musculoskeletal assessment in young adults who report fatigue during routine activities, particularly when pronounced foot pronation coexists with functional complaints. Foot posture should not, however, be considered an isolated explanation for fatigue because fatigue is influenced by multiple physical, behavioral, psychological, and health-related factors.

Interventions directed at foot mechanics have demonstrated measurable biomechanical effects in other populations. A systematic review of short-foot exercises found evidence that programs of at least several weeks may improve measures of the medial longitudinal arch, although intervention protocols and results were heterogeneous (16). Foot orthoses have also been shown to modify selected lower-limb joint angles and moments during running in individuals with pes planus (17). These findings support the modifiability of some biomechanical characteristics associated with foot posture, but they do not demonstrate that correcting pronation reduces self-reported fatigue. The present cross-sectional findings therefore do not justify prescribing a particular intervention or inferring treatment effectiveness.

Participant Characteristics and Potential Confounding

The participants were young adults aged 18–25 years, with a mean age of 21.54 years. The mean BMI was 22.84 kg/m², although individual values ranged from 17.0 to 34.0 kg/m². The original observation that a normal mean BMI made an effect of body weight unlikely is not supported by the study design because a group mean does not exclude individual variation or confounding. Similarly, the relatively

balanced representation of males and females—52.4% male and 47.6% female—does not by itself eliminate sex-related confounding or selection bias.

The primary analysis was unadjusted and categorical. Consequently, the independent contributions of BMI, sex, age, physical activity, daily weight-bearing exposure, and other potential determinants of fatigue could not be separated from the observed association between foot posture and FSS category. The narrow age range reduces age heterogeneity within the sample but does not remove the possibility of residual confounding from other participant characteristics.

Strengths and Limitations

A strength of the study was the use of established clinical instruments to characterize foot posture and perceived fatigue in a clearly defined young-adult university population. The study also included both male and female participants and reported complete categorical data for all 126 participants included in the analysis. The observed chi-square association was accompanied by adequate expected cell frequencies, reducing concern regarding violation of this assumption of the test.

Several limitations must nevertheless be considered. First, the cross-sectional design prevents determination of whether more pronated foot posture precedes higher fatigue, whether fatigue-related behavior influences foot mechanics, or whether both are associated with other underlying factors. Second, convenience sampling from a single university limits representativeness and restricts generalization to broader student or young-adult populations.

Third, fatigue was measured using the self-reported FSS. Although the FSS is an established measure of perceived fatigue (12,13), it does not provide an objective measure of lower-extremity muscle fatigability or identify the anatomical origin of fatigue. The study-defined FSS bands also lack the status of validated clinical severity categories and therefore should be interpreted as analytical strata rather than diagnostic thresholds.

Fourth, the FPI-6 provides a static clinical assessment of foot posture rather than a direct measurement of dynamic gait mechanics, plantar loading, energetic expenditure, or neuromuscular activity (11). Although previous biomechanical studies provide plausible mechanisms linking foot posture with movement behavior, those mechanisms were not measured directly in this study. Finally, the analysis did not adjust for potential confounding variables. Therefore, the magnitude of the independent association between foot posture and fatigue cannot be established from the available categorical analysis.

Future Research

Future studies should examine this relationship using larger and more diverse samples recruited across multiple institutions and, where feasible, probability-based or otherwise more representative sampling approaches. Prospective designs would help establish temporal relationships between foot posture and fatigue. Analysis of continuous FPI-6 and FSS scores, together with multivariable adjustment for relevant participant characteristics, would preserve more information than broad categorization and permit more precise estimation of the association.

Further research should also integrate subjective fatigue measures with objective assessments such as gait analysis, plantar-pressure measurement, physical-activity monitoring, electromyography, and standardized measures of lower-limb fatigability. Such multimodal approaches could determine whether the observed association with perceived fatigue corresponds to measurable alterations in mechanical efficiency, neuromuscular demand, or functional performance. Interventional studies would then be required to determine whether modifying foot mechanics produces meaningful changes in fatigue or other patient-relevant outcomes.

CONCLUSION

Among university students, foot-posture category was significantly associated with self-reported fatigue-score band, with progressively higher fatigue scores observed across neutral, pronated, and highly pronated foot-posture categories. These findings suggest that increasingly pronated foot posture is related to greater perceived fatigue within this sample; however, the cross-sectional design does not establish temporal or causal relationships. Prospective studies incorporating continuous measures, relevant confounders, and objective assessments of gait, physical function, and fatigability are needed to further clarify this relationship.

DECLARATIONS

Author Contributions:	Concept: WR; Design: WR and IN; Data Collection: SF, AT, HY and HA; Analysis: WR and IN; Drafting: WR, IN and SF; Critical Review: AT, HY and HA; Final Approval: WR, IN, SF, AT, HY and HA.
Ethical Approval:	Institutional Research Ethics Board (IREB), The University of Lahore, Lahore, Pakistan.
Informed Consent:	Written informed consent was obtained from all participants.
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AI Declaration:	Generative AI tools were used solely for language and readability improvement. The authors reviewed and verified the final manuscript and take full responsibility for its content and integrity.

REFERENCES

1. Sorrentino R, Carlson KJ, Orr CM, Pietrobelli A, Figus C, Li S, et al. Morphological and evolutionary insights into the keystone element of the human foot's medial longitudinal arch. Commun Biol. 2023;6(1):1061. doi:10.1038/s42003-023-05431-8.
2. Buldt AK, Murley GS, Butterworth P, Levinger P, Menz HB, Landorf KB. The relationship between foot posture and lower limb kinematics during walking: a systematic review. Gait Posture. 2013;38(3):363–372. doi:10.1016/j.gaitpost.2013.01.010.
3. Xu Z, Lin Y, Chen Y, Lu J, Jiang Y, He J, et al. Foot arch morphology and lower-limb biomechanical characteristics in university students: a cross-sectional multifactorial analysis of 1,078 participants. Sci Rep. 2026;16(1):7329. doi:10.1038/s41598-026-38118-1.
4. Cen X, Yu P, Song Y, Sun D, Liang M, Bíró I, et al. Influence of medial longitudinal arch flexibility on lower limb joint coupling coordination and gait impulse. Gait Posture. 2024;114:208–214. doi:10.1016/j.gaitpost.2024.10.002.
5. Ghorbani M, Yaali R, Sadeghi H, Luczak T. The effect of foot posture on static balance, ankle and knee proprioception in 18-to-25-year-old female student: a cross-sectional study. BMC Musculoskelet Disord. 2023;24(1):547. doi:10.1186/s12891-023-06678-2.

6. Kawakami W, Iwamoto Y, Sekiya J, Ota M, Ishii Y, Takahashi M. Impact of pronated foot on energetic behavior and efficiency during walking. Gait Posture. 2024;107:23–27. doi:10.1016/j.gaitpost.2023.09.003.
7. Enoka RM, Duchateau J. Translating fatigue to human performance. Med Sci Sports Exerc. 2016;48(11):2228–2238. doi:10.1249/MSS.0000000000000929.
8. Zhang L, Yan Y, Liu G, Han B, Fei J, Zhang Y. Effect of fatigue on kinematics, kinetics and muscle activities of lower limbs during gait. Proc Inst Mech Eng H. 2022;236(9):1365–1374. doi:10.1177/09544119221112516.
9. Gebel A, Busch A, Stelzel C, Hortobágyi T, Granacher U. Effects of physical and mental fatigue on postural sway and cortical activity in healthy young adults. Front Hum Neurosci. 2022;16:871930. doi:10.3389/fnhum.2022.871930.
10. Alahmari KA, Kakaraparthi VN, Reddy RS, Samuel PS, Tedla JS, Rengaramanujam K, et al. Foot Posture Index reference values among young adults in Saudi Arabia and their association with anthropometric determinants, balance, functional mobility, and hypermobility. Biomed Res Int. 2021;2021:8844356. doi:10.1155/2021/8844356.
11. Redmond AC, Crosbie J, Ouvrier RA. Development and validation of a novel rating system for scoring standing foot posture: the Foot Posture Index. Clin Biomech (Bristol, Avon). 2006;21(1):89–98. doi:10.1016/j.clinbiomech.2005.08.002.
12. Krupp LB, LaRocca NG, Muir-Nash J, Steinberg AD. The Fatigue Severity Scale: application to patients with multiple sclerosis and systemic lupus erythematosus. Arch Neurol. 1989;46(10):1121–1123. doi:10.1001/archneur.1989.00520460115022.
13. Valko PO, Bassetti CL, Bloch KE, Held U, Baumann CR. Validation of the Fatigue Severity Scale in a Swiss cohort. Sleep. 2008;31(11):1601–1607. doi:10.1093/sleep/31.11.1601.
14. Periyasamy R, Anand S. The effect of foot arch on plantar pressure distribution during standing. J Med Eng Technol. 2013;37(5):342–347. doi:10.3109/03091902.2013.810788.
15. Pan J, Gao Z, Zhou Z, Wang D, Li F, Chen D, et al. Muscle synergy asymmetry between the affected and unaffected limbs during the stance phase in unilateral flatfoot. J Neuroeng Rehabil. 2026;23(1):198. doi:10.1186/s12984-026-01995-8.
16. Hara S, Kitano M, Kudo S. The effects of short foot exercises to treat flat foot deformity: a systematic review. J Back Musculoskelet Rehabil. 2023;36(1):21–33. doi:10.3233/BMR-210374.
17. Ataabadi PA, Abbassi A, Letafatkar A, Vanwanseele B. The effects of foot orthosis and low-dye tape on lower limb joint angles and moments during running in individuals with pes planus. Gait Posture. 2022;96:154–159. doi:10.1016/j.gaitpost.2022.05.024.