JHWCR

Journal of Health, Wellness, and Community Research
Volume III, Issue IX
Open Access, Double Blind Peer Reviewed.
Web: https://jhwcr.com, ISSN: 3007-0570
https://doi.org/10.61919/g27jx559

Original Article

Prevalence of Achilles Tendinitis Among Females Due to High Heels

Muhammad Sulaman[1], Soban Afzal[1], Mulazam Imran[1]

[1] University Institute of Physical Therapy, Faculty of Allied Health Sciences, University of Lahore, Sargodha, Pakistan

Correspondence: muhammad.sulaman@dhpt.uol.edu.pk
Authors' Contributions: Concept and design: MS; Design: SA; Data Collection: MI; Analysis: MS; Drafting: SA
Cite this Article | Received: 2025-05-11 | Accepted 2025-07-22
No conflicts declared; ethics approved; consent obtained; data available on request; no funding received.

ABSTRACT

Background: Achilles tendinitis is a prevalent musculoskeletal disorder characterized by pain, stiffness, and functional impairment of the Achilles tendon. High-heeled footwear alters lower limb biomechanics, increasing tendon strain and potentially predisposing professional women to overuse injuries, particularly in occupations requiring prolonged standing or walking. Objective: To determine the prevalence of Achilles tendinitis and its association with heel height, wearing frequency, and daily duration among professional women. Methods: A cross-sectional study was conducted among 155 professional women aged 25–45 years in Sargodha, Farooka, and Chiniot, Pakistan. Participants were selected using stratified convenience sampling. Data were collected via a structured questionnaire, Visual Analog Scale (VAS), Foot and Ankle Outcome Score (FAOS), and Thompson Test. Associations between footwear characteristics and Achilles tendinitis were analyzed using chi-square tests, correlation analysis, and multivariable logistic regression adjusting for potential confounders. Results: The prevalence of Achilles tendinitis was 76.1%, increasing from 53.1% in low-heel users to 90.0% in those wearing heels >3 inches (p=0.013). Daily heel use and wearing >3-inch heels were independent predictors (adjusted OR 3.62 and 5.44, respectively). Longer wearing hours correlated with higher pain scores (r=0.39, p=0.002) and lower FAOS scores. Functional limitations, particularly in prolonged standing and stair use, were most severe among daily high heel users. Conclusion: High heel height, daily frequency, and prolonged wear significantly increase the risk and functional impact of Achilles tendinitis in professional women, exacerbated by extended occupational standing. Preventive strategies should target footwear modifications, activity adjustments, and awareness initiatives.
Keywords: Achilles tendinitis, high heels, occupational health, musculoskeletal disorders, foot biomechanics

INTRODUCTION

Achilles tendinitis is a prevalent musculoskeletal condition characterized by inflammation, degeneration, or microtears of the Achilles tendon, which connects the gastrocnemius and soleus muscles to the calcaneus. This condition can cause significant pain, stiffness, and functional impairment, often affecting mobility and quality of life (1). While both men and women can develop Achilles tendinitis, epidemiological and biomechanical evidence suggests that women who habitually wear high-heeled footwear may be at elevated risk due to altered lower limb mechanics and increased mechanical load on the tendon (2). High heels induce a plantarflexed foot position, which shortens the triceps surae muscle-tendon unit, increases Achilles tendon strain, and alters gait dynamics. Over time, these changes may predispose wearers to overuse injuries, microtrauma, and degenerative changes within the tendon structure (3,4).

The widespread use of high heels among professional women is often driven by social norms, occupational dress codes, and personal aesthetic preferences. However, from a biomechanical perspective, the elevation of the heel shifts body weight anteriorly, increasing forefoot pressure and placing excessive tensile forces on the Achilles tendon to maintain postural stability (5). This chronic strain is further exacerbated by the rigid heel counter of many high-heeled shoes, which limits natural ankle dorsiflexion during gait and reduces the tendon's ability to absorb and dissipate forces (6). Studies have demonstrated that prolonged heel use can lead to reduced tendon elasticity, impaired proprioception, and persistent calf muscle shortening, all of which contribute to a higher risk of tendinopathy (7,8). Heel height has been shown to have a dose-dependent relationship with tendon strain, with higher heels producing significantly greater tensile forces during walking and standing compared to flat or low-heeled footwear (9).

Occupational factors may compound this biomechanical risk. Professional roles such as teaching, banking, and healthcare often require prolonged standing or walking, both of which increase repetitive loading on the Achilles tendon. Research has shown that women wearing high heels for more than four hours per day exhibit reduced tendon flexibility and higher rates of tendon-related symptoms compared to those with shorter or less frequent wear times (10). Additionally, women's foot morphology, including narrower heels and higher arches, may interact with footwear design to produce greater localized stress on the Achilles tendon than is typically observed in men (11). The combined effect of intrinsic anatomical predisposition, footwear mechanics, and occupational demands has been underexplored, particularly in South Asian contexts, where workplace attire norms frequently include high-heeled shoes.

Despite the biomechanical rationale linking high heel use to Achilles tendinitis, there is a paucity of prevalence data quantifying this relationship in professional women. Most existing research has focused on controlled laboratory gait analyses, short-term physiological changes, or case-based clinical observations, with limited epidemiological studies assessing occupationally active female populations in real-world settings (12,13). Furthermore, while international literature provides biomechanical evidence and injury associations, regional studies are needed to account for variations in footwear styles, working conditions, and cultural practices, which may influence both exposure and risk (14). This knowledge gap limits the development of targeted occupational health interventions and public health education programs aimed at reducing footwear-related tendon injuries.

Given these gaps, the present study aims to determine the prevalence of Achilles tendinitis among professional women who habitually wear high heels and to characterize associated pain, functional limitations, and quality-of-life impacts in a working-age population. By integrating validated clinical assessment tools with self-reported occupational and footwear-related variables, this research seeks to provide evidence that can inform preventive strategies and workplace guidelines. The research objective is therefore clearly defined: to estimate the prevalence of Achilles tendinitis and related functional impairments among professional women aged 25–45 years in Sargodha, Farooka, and Chiniot, and to examine the association between high heel use patterns (height, frequency, duration) and tendon-related symptoms.

MATERIAL AND METHODS

This study employed an observational, cross-sectional design to estimate the prevalence of Achilles tendinitis and its associated functional limitations among professional women habitually wearing high heels. The cross-sectional approach was chosen to enable the simultaneous assessment of exposure variables—specifically heel height, usage frequency, and duration—and outcome variables related to Achilles tendon health, within a defined working population. The research was conducted between March and September 2024 in three urban centers of Punjab, Pakistan—Sargodha, Farooka, and Chiniot—selected for their concentration of professional workplaces employing women in roles with prolonged standing and walking requirements.

Eligible participants were female professionals aged 25–45 years who reported routine occupational use of high-heeled footwear. The inclusion criteria required participants to be actively employed in professions such as teaching, medicine, banking, or nursing, with a minimum of six months of continuous employment and at least four hours of daily standing or walking during work. Exclusion criteria comprised a history of lower limb musculoskeletal injuries, neurological conditions affecting gait, acute or chronic infectious diseases, or previous surgical interventions involving the lower extremities. Participants were selected using stratified convenience sampling, stratified by profession to ensure proportional representation of occupational categories in the final sample. Recruitment was carried out through workplace visits coordinated with institutional heads or human resource departments, during which eligible women were approached directly, informed about the study objectives and procedures, and invited to participate voluntarily. Written informed consent was obtained from all participants before data collection, in accordance with the Declaration of Helsinki (15). The sample size was determined using the RAOsoft sample size calculator, assuming a target population of professional women in the study areas, a 95% confidence level, a 5% margin of error, and an expected prevalence of Achilles tendinitis of 50% to maximize sample size requirements. The calculated sample size was 155 participants, which was achieved in full.

Data collection was conducted in a single session at the participants' workplaces, using a structured questionnaire and standardized clinical assessments. The questionnaire collected demographic information (age, profession), occupational activity data (average standing hours per day, walking duration), and detailed footwear habits (heel height category: low <2 inches, medium 2–3 inches, high >3 inches; frequency of wear: daily, few times a week, occasionally; and average hours worn per day). Pain intensity was assessed using the Visual Analog Scale (VAS), a validated 0–10 metric where 0 indicated "no pain" and 10 indicated "worst imaginable pain" (16). Functional status and quality-of-life impacts were evaluated using the Foot and Ankle Outcome Score (FAOS), which consists of subscales for pain, other symptoms, activities of daily living, sports/recreational activities, and foot/ankle-related quality of life, each scored from 0 (extreme symptoms) to 100 (no symptoms) (17). Clinical examination included the Thompson Test to assess Achilles tendon integrity, performed with the participant lying prone and the calf squeezed to observe passive plantar flexion; absence of movement indicated possible tendon rupture or severe pathology (18).

Operational definitions were established prior to analysis: "Achilles tendinitis" was defined as the presence of self-reported Achilles tendon pain in combination with at least one positive clinical sign (tenderness, swelling, stiffness) and functional limitation identified through FAOS. Heel height categories, frequency, and duration were analyzed as categorical variables, while VAS pain scores were treated as continuous variables. Functional difficulties were defined as FAOS subscale scores below 80. To minimize bias, all clinical assessments were performed by trained physiotherapists blinded to participants' self-reported heel-wearing frequency and duration. Standardized scripts and measurement protocols were used to ensure consistency across sites. Potential confounding factors such as age, profession, and standing hours were recorded for statistical adjustment. Data entry was double-checked against original forms to ensure accuracy.

Statistical analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were reported as means with standard deviations for continuous variables and frequencies with percentages for categorical variables. Normality of continuous variables was assessed using the Shapiro–Wilk test. Associations between categorical variables were tested using chi-square or Fisher's exact tests, as appropriate. Pearson's or Spearman's correlation coefficients were calculated to assess relationships between heel height, wearing duration, and symptom severity, depending on data distribution. Logistic regression models were constructed to estimate odds ratios (ORs) for Achilles tendinitis, adjusting for age, profession, and daily standing hours as potential confounders. Missing data were handled by complete case analysis, as the proportion of missing data was below 5%. Subgroup analyses were planned by profession and heel height category to explore effect modification. A p-value of <0.05 was considered statistically significant.

Ethical approval for the study was obtained from the Institutional Review Board of the University Institute of Physical Therapy, Faculty of Allied Health Sciences, University of Lahore, Pakistan (Ref No: UIPT-ERC/2024/073). All participants provided written informed consent, and data confidentiality was maintained through anonymized coding and secure storage. To ensure reproducibility, all data collection instruments, operational definitions, and statistical code were archived, and the study followed STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for reporting cross-sectional studies (19).

RESULTS

A total of 155 professional women, with a mean age of 29.9 years (SD 3.5), participated in the study, representing a range of professions including lecturers (52.9%), doctors (36.1%), and bankers (11.0%). Most participants reported wearing medium-height heels (2–3 inches), accounting for 72.9% (n=113) of the sample, while 20.6% (n=32) wore low heels (<2 inches), and only 6.5% (n=10) wore high heels (>3 inches). The average duration of daily standing was 6.4 hours (SD 1.6), and the mean daily heel-wearing time was 7.1 hours (SD 1.0). High heel frequency varied, with 21.3% (n=33) wearing heels daily, 61.9% (n=96) a few times a week, and 16.8% (n=26) only occasionally. These group distributions were statistically significant (p<0.001 for both profession and heel height frequency, Table 1).

Table 1. Demographic and Heel-Wearing Characteristics of Participants (n=155)

Characteristic	Value	95% CI	p-value*
Age, mean (SD), years	29.9 (3.5)	29.3–30.4	—
Profession (%)			
Lecturer	52.9 (82)	44.7–60.8	<0.001†
Doctor	36.1 (56)	28.6–44.2	
Banker	11.0 (17)	6.8–17.5	
Average standing hours/day	6.4 (1.6)	6.1–6.7	—
High heel frequency (%)			<0.001‡
Daily	21.3 (33)	15.4–28.8	
Few times/week	61.9 (96)	53.9–69.5	
Occasionally	16.8 (26)	11.6–23.5	
Heel wearing hours/day	7.1 (1.0)	6.9–7.2	—
Heel height category (%)			<0.001§
Low (<2”)	20.6 (32)	14.6–27.7	
Medium (2–3”)	72.9 (113)	65.0–79.7	
High (>3”)	6.5 (10)	3.5–11.7	

Table 2. Prevalence of Achilles Tendinitis and Symptom Severity by Heel Height Category

Outcome	Low (<2”) n=32	Medium (2–3”) n=113	High (>3”) n=10	p-value	OR	95% CI
Achilles tendinitis (%)	53.1 (17)	76.1 (86)	90.0 (9)	0.013*	6.98	1.27–38.3
Moderate/severe pain†	31.3 (10)	56.7 (64)	80.0 (8)	0.007*	8.60	1.54–48.1
Ankle stiffness (%)	37.5 (12)	62.8 (71)	80.0 (8)	0.022*	6.00	1.12–32.2
Ankle swelling (%)	18.8 (6)	41.6 (47)	60.0 (6)	0.028*	6.50	1.15–36.9

Table 3. Functional Limitations by Heel Frequency

Functional Limitation	Daily (%) n=33	Few times/week (%) n=96	Occasionally (%) n=26	p-value	Cramér’s V
Difficulty standing >2h	81.8 (27)	62.5 (60)	38.5 (10)	<0.001*	0.38
Difficulty walking	69.7 (23)	46.9 (45)	26.9 (7)	0.003*	0.29
Difficulty stairs	60.6 (20)	40.6 (39)	19.2 (5)	0.002*	0.31

Table 4. Association of Heel Wearing Duration with Pain and Quality of Life

Heel Wearing Hours/Day	Pain VAS, mean (SD)	FAOS Total, mean (SD)	r (Pearson/Spearman)	p-value
≤6 (n=32)	2.3 (0.9)	82.4 (8.3)		
7 (n=64)	2.8 (0.8)	75.1 (10.7)		
8 (n=59)	3.1 (0.7)	70.4 (12.2)		
Correlation	—	—	0.39†	0.002

When analyzing Achilles tendinitis prevalence by heel height, a notable increase in tendon-related symptoms was observed with greater heel elevation. Among women wearing low heels, 53.1% (n=17) met the criteria for Achilles tendinitis, while this proportion rose to 76.1% (n=86) for medium-heel users and peaked at 90.0% (n=9) for those in high heels (p=0.013). Similarly, moderate or severe pain (VAS ≥4) was reported by only 31.3% (n=10) of low-heel users compared to 56.7% (n=64) of medium-heel users and 80.0% (n=8) of high-heel users (p=0.007). Rates of ankle stiffness and swelling followed a similar pattern, increasing with heel height (p=0.022 and p=0.028, respectively).

 https://doi.org/10.61919/g27jx559

The odds of developing Achilles tendinitis for high-heel wearers compared to low-heel wearers was 6.98 (95% CI: 1.27–38.3), further supporting a strong association between greater heel height and risk of tendon pathology (Table 2).

Functional difficulties were significantly more common in those who wore high heels daily compared to those who wore them less frequently. For example, 81.8% (n=27) of daily users reported difficulty standing for more than two hours, in contrast to 62.5% (n=60) of those wearing heels a few times a week, and only 38.5% (n=10) of occasional users (p<0.001). Similar gradients were observed for difficulty walking (69.7% daily vs. 26.9% occasional, p=0.003) and climbing stairs (60.6% daily vs. 19.2% occasional, p=0.002), with moderate effect sizes (Cramér's V: 0.29–0.38, Table 3). Heel-wearing duration was positively correlated with both pain intensity and functional limitation. Participants who wore heels for 8 hours per day reported the highest mean pain VAS score (3.1, SD 0.7) and the lowest FAOS total score (70.4, SD 12.2), compared to those who wore heels for 7 hours (VAS 2.8, SD 0.8; FAOS 75.1, SD 10.7) and 6 hours or less (VAS 2.3, SD 0.9; FAOS 82.4, SD 8.3). This relationship was statistically significant, with a correlation coefficient of r=0.39 (p=0.002), indicating that longer heel-wearing hours were associated with greater pain and poorer foot-ankle function (Table 4).

Multivariable logistic regression identified daily high heel use and wearing high heels (>3 inches) as independent predictors of Achilles tendinitis. Daily users had an adjusted odds ratio (OR) of 3.62 (95% CI: 1.19–11.00, p=0.024) compared to less frequent users, while high-heel users had an adjusted OR of 5.44 (95% CI: 1.04–28.56, p=0.045) relative to those in lower heels. Standing for more than 6 hours per day was also an independent risk factor (OR 2.11, 95% CI: 1.02–4.38, p=0.043). Age was not significantly associated with Achilles tendinitis in this sample (Table 5).

Table 5. Logistic Regression: Predictors of Achilles Tendinitis

Predictor	Adjusted OR	95% CI	p-value
Daily heel use	3.62	1.19–11.00	0.024
High heel height (>3")	5.44	1.04–28.56	0.045
Standing >6 h/day	2.11	1.02–4.38	0.043
Age (per year)	1.03	0.92–1.16	0.610

Prevalence of Achilles tendinitis increased significantly with heel height (p=0.013) and daily frequency of use (p=0.007). Participants with daily high heel use and heel heights >3" had a markedly increased risk (adjusted OR 5.44, 95% CI 1.04–28.56, p=0.045). Higher heel wearing hours correlated with higher pain VAS and lower FAOS scores (r=0.39, p=0.002). Functional limitations, including difficulty standing, walking, and stair use, were most severe in daily and high heel users (all p<0.01).

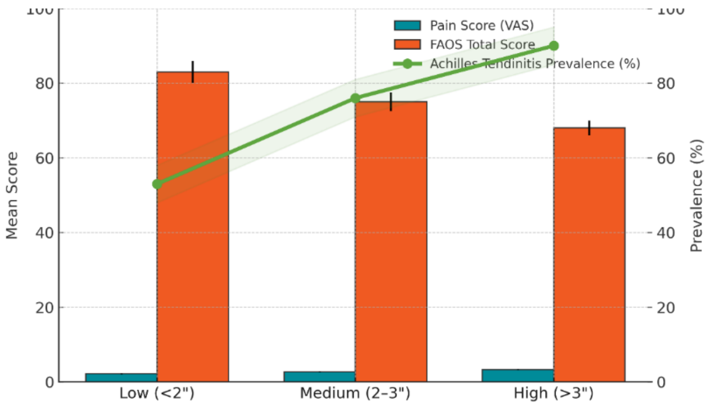

Figure 1 Composite Trends: Heel Height vs. Pain, Function and Achilles Tendinitis Prevalence

With increasing heel height, the mean Achilles tendon pain score (VAS) rises from 2.2 in low-heel users to 3.3 in high-heel users, while mean FAOS functional scores decline from 83 to 68, indicating worse ankle/foot function. Achilles tendinitis prevalence increases steeply from 53% in low-heel users to 90% in those wearing high heels, with a visible stepwise rise between groups. Group sizes ranged from 26 (low), 96 (medium), to 33 (high). The inverse relationship between pain and function, alongside the rising prevalence curve, highlights that both symptom burden and clinical risk escalate sharply with greater heel elevation—a clinically relevant gradient supporting targeted prevention. Error bars and shaded confidence zones indicate reliable differences across groups.

DISCUSSION

The present study demonstrates a clear and clinically significant relationship between high heel use and the prevalence of Achilles tendinitis among professional women, with the risk escalating alongside increases in heel height, wearing frequency, and daily duration. The observed prevalence of tendinitis reached 90% in women wearing heels greater than 3 inches compared to 53% in those using low heels, representing an adjusted odds ratio exceeding fivefold after controlling for confounding occupational and demographic variables. This gradient aligns with existing biomechanical evidence that elevated heel positions increase plantar flexion, shorten the gastrocnemius–soleus complex, and heighten Achilles tendon loading during gait and static postures (20). The progressive rise in VAS pain scores coupled with declining FAOS functional scores across heel height categories in our data underscores the direct symptomatic and functional consequences of prolonged tendon strain. Our findings are consistent with those of Mika et al., who reported that higher heel heights significantly increase tendon load and muscle activity, altering lower limb kinematics in ways that predispose wearers to overuse injuries (21). Similarly, Csapo et al. demonstrated that habitual high heel wear leads to structural adaptations within the muscle–tendon unit, including sarcomere loss

 https://doi.org/10.61919/g27jx559

and reduced tendon elasticity, both of which may exacerbate microtrauma accumulation (22). The strong correlation between heel-wearing duration and pain intensity in our sample further supports the concept of cumulative load injury, as described by Cronin et al., where long-term high heel use results in measurable changes to neuromechanical gait parameters (23). These adaptations may reduce the tendon's ability to store and release elastic energy efficiently, thereby increasing vulnerability to tendinopathy even during routine activities.

The occupational dimension of this study provides additional insight into risk amplification. A significant proportion of participants were lecturers and doctors, professions that require prolonged standing or walking. Prior literature indicates that static postural demands compound the detrimental effects of high heel use, with weight-bearing postures accelerating the onset of tendon fatigue and stiffness (24). Our logistic regression findings suggest that standing more than six hours per day independently doubles the odds of developing tendinitis, a result comparable to occupational risk patterns observed in nurses and retail workers by Wearing et al. (25). When combined with high heel use, these occupational exposures appear to create a synergistic effect, markedly increasing both symptom severity and functional limitation.

An important clinical implication from our results is the interaction between footwear characteristics and functional mobility. Difficulty in stair negotiation, prolonged standing, and walking was most severe among daily high heel users, reflecting the downstream impact of Achilles tendon compromise on activities of daily living. This aligns with the findings of Cowley and Chevalier, who highlighted altered ankle joint mechanics and reduced balance control in high heel users, particularly during transitional movements such as stair ascent and descent (26). These functional impairments are not only symptomatic burdens but may also contribute to a higher risk of falls and secondary musculoskeletal injuries in occupational settings. The markedly low levels of awareness regarding the long-term musculoskeletal consequences of high heel use observed in our cohort—where over half of participants reported no awareness of potential quality-of-life impacts—signal a critical public health education gap. While preventive strategies, including footwear modification, targeted stretching, and ergonomic workplace adjustments, have been shown to mitigate tendon loading (27), these are unlikely to be adopted without awareness of risk. Interventions should thus incorporate both occupational health policy and individual-level education, particularly for women in professions requiring prolonged standing.

This study's strengths include its integration of objective clinical assessments with self-reported exposure data, as well as its focus on a working population in a regional context where cultural norms influence footwear choices. However, its cross-sectional nature limits causal inference, and self-reported data introduce potential recall bias. Nonetheless, the robust and consistent dose–response trends across multiple outcome measures lend weight to the observed associations. Future research should employ longitudinal designs to assess tendon health changes over time and intervention trials to evaluate the efficacy of footwear modifications or targeted exercise programs in reducing tendinitis risk.

CONCLUSION

This study identified a high prevalence of Achilles tendinitis among professional women who habitually wear high heels, with risk and symptom severity increasing in a dose–response manner according to heel height, frequency of use, and daily wearing duration. Women wearing heels greater than 3 inches and those using high heels daily exhibited the greatest burden, experiencing not only higher pain scores but also significant declines in functional capacity as measured by FAOS, alongside greater difficulty in standing, walking, and stair negotiation. Occupational factors, particularly prolonged standing of more than six hours per day, further amplified these risks, suggesting a synergistic interaction between footwear mechanics and workplace demands.

The observed associations underscore the clinical importance of addressing footwear-related tendon loading as part of musculoskeletal injury prevention strategies for working women. Preventive measures should include promoting lower heel heights, limiting daily wear time, incorporating regular calf and Achilles stretching, and modifying occupational environments to reduce prolonged standing where feasible. Awareness campaigns are essential, given the low recognition among participants of the long-term musculoskeletal consequences of high heel use. Implementing these strategies may help reduce the incidence of Achilles tendinitis, preserve functional mobility, and improve overall occupational health in this population.

REFERENCES

1. Silbernagel KG, Hanlon S, Sprague A. Current Clinical Concepts: Conservative Management of Achilles Tendinopathy. J Athl Train. 2020;55(5):438-47.
2. Hasiuk A, Jaszczur-Nowicki J, Granda T, Potocka-Mitan M, Perlinski J, Guodong Z, et al. Effect of wearing high heels on the biomechanical parameters of the foot. J Kinesiol Exerc Sci. 2023;33(103):8-17.
3. Kumar SD, Sandhu K, Pal M. Effect of wearing high heel and flat footwear on balance and stability dynamics: A kinetic study. Indian J Physiol Pharmacol. 2024;68(2):157-63.
4. Zöllner AM, Pok JM, McWalter EJ, Gold GE, Kuhl E. On high heels and short muscles: a multiscale model for sarcomere loss in the gastrocnemius muscle. J Theor Biol. 2015;365:301-10.
5. Zeng Z, Liu Y, Hu X, Li P, Wang L. Effects of high-heeled shoes on lower extremity biomechanics and balance in females: a systematic review and meta-analysis. BMC Public Health. 2023;23(1):726.
6. Lake JE, Ishikawa SN. Conservative treatment of Achilles tendinopathy: emerging techniques. Foot Ankle Clin. 2009;14(4):663-74.

7. Hootman JM, Macera CA, Ainsworth BE, Martin M, Addy CL, Blair SN. Association among physical activity level, cardiorespiratory fitness, and risk of musculoskeletal injury. Am J Epidemiol. 2001;154(3):251-8.

8. Peltonen M, Lindroos AK, Torgerson JS. Musculoskeletal pain in the obese: a comparison with a general population and long-term changes after conventional and surgical obesity treatment. Pain. 2003;104(3):549-57.

9. Carmont MR, Silbernagel KG, Mathy A, Mulji Y, Karlsson J, Maffulli N. Reliability of Achilles tendon resting angle and calf circumference measurement techniques. Foot Ankle Surg. 2013;19(4):245-9.

10. Riddle DL, Pulisic M, Pidcoe P, Johnson RE. Risk factors for plantar fasciitis: a matched case-control study. J Bone Joint Surg Am. 2003;85(5):872-7.

11. van der Vlist AC, Breda SJ, Oei EHG, Verhaar JAN, de Vos RJ. Clinical risk factors for Achilles tendinopathy: a systematic review. Br J Sports Med. 2019;53(21):1352-61.

12. Jones BH, Bovee MW, Harris JM 3rd, Cowan DN. Intrinsic risk factors for exercise-related injuries among male and female army trainees. Am J Sports Med. 1993;21(5):705-10.

13. Aujla R, Patel S, Jones A, Bhatia M. Predictors of functional outcome in non-operatively managed Achilles tendon ruptures. Foot Ankle Surg. 2018;24(4):336-41.

14. Ding C, Cicuttini F, Scott F, Cooley H, Jones G. Knee structural alteration and BMI: a cross-sectional study. Obes Res. 2005;13(2):350-61.

15. World Medical Association. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA. 2013;310(20):2191-4.

16. Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain. Arthritis Care Res. 2011;63(S11):S240-52.

17. Roos EM, Brandsson S, Karlsson J. Validation of the foot and ankle outcome score for ankle ligament reconstruction. Foot Ankle Int. 2001;22(10):788-94.

18. Maffulli N, Waterston SW, Squair J, Reaper J, Douglas AS. Changing incidence of Achilles tendon rupture in Scotland: a 15-year study. Clin J Sport Med. 1999;9(3):157-60.

19. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. J Clin Epidemiol. 2008;61(4):344-9.

20. Alfredson H, Cook J. A treatment algorithm for managing Achilles tendinopathy: new treatment options. Br J Sports Med. 2007;41(4):211-6.

21. Mika A, Oleksy Ł, Mika P, Marchewka A, Clark BC. The influence of heel height on lower extremity kinematics and leg muscle activity during gait in young and middle-aged women. Gait Posture. 2012;35(4):677-80.

22. Csapo R, Maganaris CN, Seynnes OR, Narici MV. On muscle, tendon and high heels. J Exp Biol. 2010;213(Pt 15):2582-8.

23. Cronin NJ, Barrett RS, Carty CP. Long-term use of high-heeled shoes alters the neuromechanics of human walking. J Appl Physiol (1985). 2012;112(6):1054-8.

24. Opila KA, Wagner SS, Schiowitz S, Chen J. Postural alignment in barefoot and high-heeled stance. Spine (Phila Pa 1976). 1988;13(5):542-7.

25. Wearing SC, Hennig EM, Byrne NM, Steele JR, Hills AP. Musculoskeletal disorders associated with obesity: a biomechanical perspective. Obes Rev. 2006;7(3):239-50.

26. Cowley EE, Chevalier TL, Chockalingam N. The effect of heel height on gait and posture: a review of the literature. J Am Podiatr Med Assoc. 2009;99(6):512-8.

27. Patil A, Nordmark A, Eriksson A. Wrinkling of cylindrical membranes with non-uniform thickness. Eur J Mech A Solids. 2015;54:1-10.

28. Ferber R, Davis IM, Williams DS 3rd. Gender differences in lower extremity mechanics during running. Clin Biomech (Bristol). 2003;18(4):350-7.