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Special Article

Pain and functional disability related to foot and ankle among high heel users: Analytical cross-sectional study

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Abstract

Objective: To assess the intensity of pain and functional disability related to the foot and ankle among high-heel users.

Methods: A total of 208 female participants aged 18 years or older were included in this analytical cross-sectional study. Participants who met the inclusion criteria and provided informed consent were included in the study. Pain and functional disability were assessed using the Numeric Pain Rating Scale (NPRS) and Foot and Ankle Disability Index (FADI), respectively, and data regarding heel use, including duration and frequency per day and per week, were collected through a structured questionnaire. The data were not normally distributed; therefore, non-parametric tests were applied. Spearman correlation was used for correlation analysis, while multivariate multiple regression was applied to identify independent predictors of pain and functional disability.

Results: A total of 208 female participants were included, with a mean age of 24.25 ± 6.39 years and a mean BMI of 22.03 ± 3.25 kg/m^2. The mean NPRS score was 4.90 ± 2.21, and the mean FADI score was 83.35 ± 18.27. Pain distribution showed 13.9% with no pain, 29.3% with mild pain, 39.9% with moderate pain, and 16.8% with severe pain. NPRS and FADI scores showed significant variation ($p = 0.001$ and $p = 0.002$), while BMI was not significantly associated with either outcome. Multivariate multiple regression analysis demonstrated that age was the only significant independent predictor, with higher pain intensity ($\beta = 0.152$, $p < 0.001$) and lower functional ability ($\beta = -1.106$, $p < 0.001$), whereas BMI and heel-use characteristics showed no significant associations with either outcome.

Conclusion: Most participants experienced mild to moderate foot pain, with moderate pain being the most common category. Increasing age was significantly associated with higher pain intensity and greater functional disability, as reflected by higher NPRS scores and lower FADI scores. In contrast, BMI, heel height, and the frequency of daily and weekly heel use were not significantly associated with either outcome. Age was identified as a significant predictor of higher pain intensity and reduced functional ability, whereas heel-use characteristics did not predict either outcome.

Level of Evidence III; Analytical Cross-sectional Study.

Keywords: Ankle joint; Disability evaluation; Pain measurement; Tarsal bones.

Introduction

High-heeled shoes (HHSs) are becoming a growing trend among women as the trend continues to shift toward luxury. Although some claims suggest no significant change or even a reduction in muscle activity, high-heeled shoes have been associated with improper muscle use, leading to discomfort and occasional injuries[1]. The ankle-foot complex changes more noticeably the higher the heel, triggering a chain reaction that affects the entire body, from the ankle and foot to the knee and even the spine[2].

The human foot consists of 26 bones, including the calcaneus, talus, metatarsals, and phalanges, and is anatomically divided into the hindfoot, midfoot, and forefoot. The medial and lateral longitudinal arches play a crucial role in load transmission, shock absorption, and postural stability, while the foot is functionally organized into five rays, each comprising a metatarsal and its associated phalanges[3].

High-heeled shoes are widely worn by women due to fashion trends and sociocultural influences, despite growing evidence of their adverse effects on musculoskeletal health[4]. From a

Study performed at the School of Allied Health Sciences, CMH Lahore Medical College & Institute of Dentistry (NUMS), Lahore, Pakistan.

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public health perspective, prolonged use of inappropriate footwear has been associated with foot pain, discomfort, and functional limitations[5].

Biomechanically, elevation of the heel relative to the forefoot alters normal foot mechanics, resulting in increased plantar pressure over the forefoot and metatarsophalangeal joints[6]. This altered load distribution disrupts normal gait mechanics, reduces ankle range of motion, and increases stress across the lower extremities[7].

Sustained use of HHSs is associated with increased muscle activation and fatigue, contributing to impaired postural control and musculoskeletal discomfort[8]. Additionally, prolonged heel elevation shifts the body's center of mass anteriorly, compromising balance and increasing the risk of instability and falls[9].

Clinically, repetitive exposure to HHSs has been linked to forefoot pathology, abnormal load transmission, and chronic foot pain[10]. These biomechanical and postural adaptations may predispose wearers to long-term musculoskeletal disorders, emphasizing the need for footwear designs that balance aesthetic appeal with functional safety and musculoskeletal health[11].

The available literature shows that wearing HHSs has a noticeable impact on foot health and overall biomechanics, especially among working women. Several studies have reported a high prevalence of moderate to severe foot pain, with prolonged standing and increased heel height identified as key contributing factors[12,13]. Research conducted among young females has also highlighted foot-related problems, such as edema and callosities linked to high-heel use[14]. Among healthcare professionals, heel pain tends to increase with greater heel height and longer duration of wear[15], and pain intensity has been found to be associated with heel height, duration of use, and body mass index (BMI)[16]. Similarly, occupational studies among nurses reveal a high occurrence of foot and ankle pain that affects both quality of life and work performance[17]. Biomechanical findings further suggest that habitual use of high heels alters gait patterns, reduces transverse arch height, and increases ground reaction forces[18]. Systematic reviews support these observations, linking high-heel use to musculoskeletal pain, hallux valgus, and an increased risk of injury, while the evidence regarding osteoarthritis remains limited[19]. Top of FormBottom of FormThese findings underscore the need for greater awareness of footwear choices and their potential risks and advocate preventive measures to mitigate foot-related issues among working women.

This study was conducted to address a contextual gap in the existing literature, as despite substantial global evidence on high-heel-related foot morbidity, limited data are available from South Asian populations, particularly Pakistan, where cultural practices, occupational demands, and footwear-use patterns differ from those reported in other regions and may influence risk profiles, highlighting the need for locally relevant evidence on foot pain associated with high-heel use in this population. The objective of this study is to assess the intensity of pain and functional disability related to the foot and ankle among high-heeled users.

Methods

Study design and eligibility criteria

This was an analytical cross-sectional study and is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology Statement (STROBE). This study was approved by the Institutional Review Board of the CMH LMC and IOD, Lahore, Pakistan.

The study was conducted in a medical college in Lahore, Pakistan. The study lasted four months after the synopsis was approved. All patients signed the informed consent form prior to initiating the study. All information and data collected were kept confidential. Participants remained anonymous throughout the study. The participant's personal identity and any personal information were hidden in all publications of this research project. The subjects were informed that there were no disadvantages or risks associated with the study procedure. The study population was female high-heeled users aged 18-35 years. They must be wearing high heels ≥ 2.5 inches at least 2-3 times per week for 2-3 hours per day[20]. Patients with fractures, skin diseases such as dermatitis, degenerative diseases, RA, and any disease or deformity involving the ankle and foot are excluded. The sample size of 208 was calculated using the Cochrane formula (1977)[21].

Study variables

Data were collected from females aged 18 to 35 years at CMH LMC and CMH Lahore who had signed the informed consent form and met the inclusion criteria. The non-probability convenience sampling technique was used to collect data from participants on the Foot and Ankle Disability Index (FADI) questionnaire and the Numeric Pain Rating Scale (NPRS).

- **Urdu form of the Foot and Ankle Disability Index (FADI-U):** This self-contained tool measures functional limitations associated with foot and ankle diseases. There were two subscales comprising a total of 26 items: 22 items in the activity subscale and 4 in the pain subscale. A five-point Likert scale (0 to 4) was used to score each item, with a total score of 104 points. The Cronbach's alpha coefficient (0.96-0.97) indicated excellent internal consistency[22].
- **NPRS:** The intra-class correlation coefficient (ICC) for all subjects was 0.76. Scores range from 0 to 10 points, with higher scores indicating greater pain intensity. The scale ranged from 0 (no pain at all) to 10 (worst imaginable pain). The NPRS has demonstrated good reliability, with high test-retest reliability, indicating that individuals tend to provide consistent ratings when asked to rate their pain intensity on separate occasions[23].

Outcome measures

The primary outcome of this study was to assess the intensity of pain and functional disability (FADI-U) related to the foot and ankle among high-heel users.

Statistical analysis

Descriptive statistics were used to describe the study population. Quantitative information, including age and heel height, was presented as mean + standard deviation (SD). Frequency and percentage were calculated from the collected data. Normality of the data was assessed using the Shapiro-Wilk test, and because the data were not normally distributed, nonparametric tests were used. To analyze all results, a 95% confidence interval was used. A p-value of less than 0.05 indicates statistical significance. Statistical analysis was performed using SPSS software version 26. Multivariate multiple regression analysis was conducted using R software version 4.5.2 to evaluate the effects of age, BMI, heel height, and the frequency of daily and weekly heel use on pain intensity and functional disability.

Results

The study sample was predominantly young adults aged 18-24 years (78.4%), with most participants having a normal BMI (68.3%), indicating a relatively homogeneous baseline anthropometric profile. High-heel use was frequent, with a mean daily wearing duration of 5.10 ± 1.62 hours and a weekly duration of 4.30 ± 1.85 days, reflecting regular exposure. The mean heel height was 4.15 ± 1.12 inches, with most participants wearing heels in the moderate range. Overall pain levels were moderate, with a mean NPRS score of 4.90 ± 2.21, and the largest proportion of participants reported moderate pain (39.9%), as shown in Table 1.

A statistically significant age-related trend was observed in both pain and functional outcomes. Pain intensity increased progressively with age, as reflected by median NPRS scores (18-24: 3 [3], 25-35: 4 [3], > 35: 6 [4]; p = 0.001). In parallel, functional ability declined with increasing age, demonstrated by decreasing FADI scores across groups (18-24: 92 [23], 25-35: 88 [34], > 35: 70 [31]; p = 0.002), indicating worsening foot-related functional status with advancing age, as shown in Table 2.

Pairwise comparisons further highlighted that significant differences in pain intensity were primarily present between the youngest group and older participants, with 18-24 vs 25-35 years (p = 0.012) and 18-24 vs > 35 years (p < 0.001), while no significant difference was observed between 25-35 and > 35 years (p = 0.236). For functional ability, a statistically significant difference was observed only between 18-24 and > 35 years (p < 0.001), whereas other comparisons were not significant (p > 0.05), suggesting that functional decline is more evident at the extremes of the age distribution, as shown in Table 3.

Correlation analysis demonstrated a weak but statistically significant positive association between age and pain intensity (NPRS: ρ = 0.286, p = 0.001), alongside a weak negative correlation with functional ability (FADI: ρ = -0.211, p = 0.002), indicating increased pain and reduced function with advancing age. In contrast, BMI showed no statistically significant relationship with either pain (ρ = 0.050, p = 0.474) or functional outcomes (ρ = 0.038, p = 0.584), as shown in Table 4.

Table 1. Demographics of study participants (n = 208)

Variables	Mean ± Standard deviation	n (%)
Age (years)	24.25 ± 6.389	
18-24		163 (78.4)
25-35		22 (10.6)
> 35		23 (11.1)
Height (Inches)	63.40 ± 2.033	_
Weight (Kg)	57.20 ± 8.874	_
BMI (Kg/m²)	22.03 ± 3.249	
< 18.5		27 (13.0)
18.5-24.9		142 (68.3)
25-29.99		38 (18.3)
> 30		1 (0.5)
Time of wearing high heels (Hours)/day	5.10 ± 1.62	_
Heel height (inches)	4.15 ± 1.12	_
Heel height categories (inches)	_	
2.5-3		42 (20.2)
3.1-4		68 (32.7)
4.1-5		57 (27.4)
5.1-6		31 (14.9)
> 6		10 (4.8)
Number of days wearing high heels/week	4.30 ± 1.85	_
Pain on NPRS	4.90 ± 2.21	_
Categories of pain	_	
No pain (0)		29 (13.9)
Mild (1-3)		61 (29.3)
Moderate (4-6)		83 (39.9)
Severe (7-10)		35 (16.8)

Values are presented as mean ± standard deviation or number (percentage). BMI: Body mass index; NPRS: Numerical Pain Rating Scale; kg/m²: kilograms per square meter.

Table 2. Summary measures of outcome variables

Outcome variables	Median (IQR)	p-value
Pain on NPRS	Median (Q3-Q1)	
18-24	3 (3)	0.001
25-35	4 (3)	
> 35	6 (4)	
Disability on FADI	Median (Q3-Q1)	
18-24	92 (23)	0.002
25-35	88 (34)	
> 35	70 (31)	

Data are presented as median (interquartile range). P-values were obtained using the Kruskal-Wallis test. NPRS: Numerical Pain Rating Scale; FADI: Functional Ankle Disability Index. A p-value < 0.05 was considered statistically significant.

Multivariate multiple regression analysis was conducted using R software version 4.5.2 to evaluate the effect of age, BMI, heel height, and the frequency of daily and weekly heel use on pain intensity and functional disability (Figures 1A, 1B, 2A, and 2B). The analysis showed that age was the only

Table 3. Pairwise comparison between age group of participants with FADI and NPRS (Kruskal-Wallis test)

Outcome	Age group	Test statistic	p-value
FADI	> 35- (25-35) years	31.449	0.080
	> 35- (18-24) years	50.155	0.000
	(25-35) – (18-24) years	18.706	0.171
NPRS	(18-24) - (25-35) years	-34.147	0.012*
	(18-24) - > 35 years	-55.193	0.000*
	(25-35) - > 35 years	-21.046	0.236

Pairwise comparisons were performed using the Kruskal-Wallis test. Values represent test statistics and corresponding p-values. FADI: Functional Ankle Disability Index; NPRS: Numerical Pain Rating Scale. $p < 0.05$ indicates statistical significance.

Table 4. Correlation of age and body mass index with pain intensity (NPRS) and functional ability (FADI)

Independent variable	Outcome measure	Spearman's ρ	p-value
Age (years)	NPRS	0.286	0.001*
	FADI	-0.211	0.002*
Body mass index (kg/m²)	NPRS	0.050	0.474
	FADI	0.038	0.584

*Spearman's rank correlation coefficient (ρ). Lower FADI scores indicate greater functional disability. Statistically significant at $p < 0.05$.

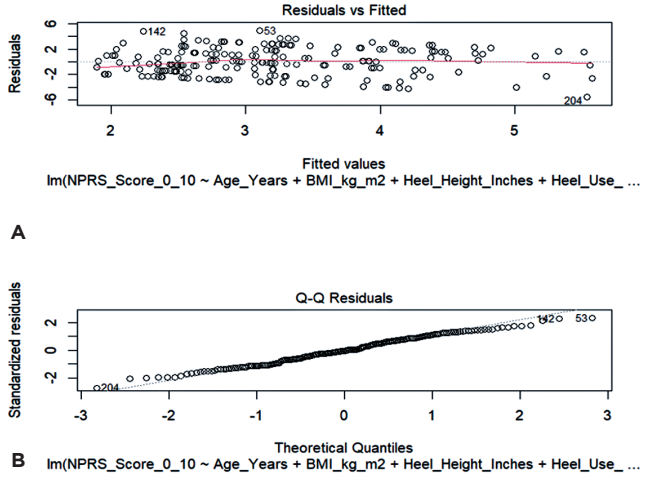

Figure 1. Multivariate multiple regression analysis for NPRS (0-10).

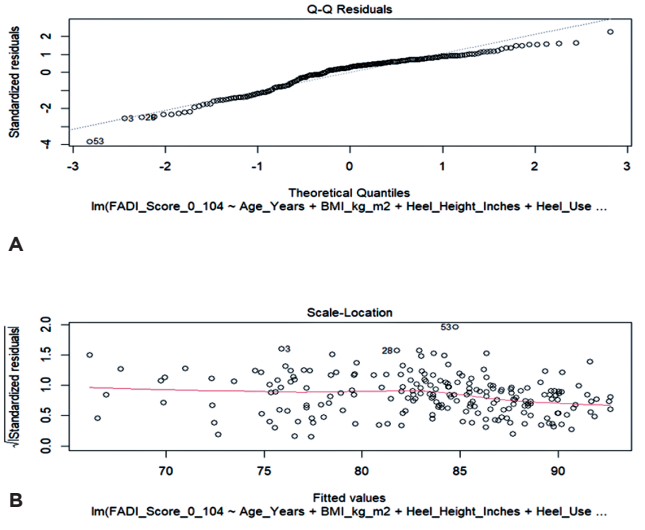

Figure 2. Multivariate multiple regression for FADI score (0-104).

variable significantly associated with both outcome measures. An increase in age was linked with higher NPRS scores (β = 0.152, $p < 0.001$), indicating greater pain intensity, and lower FADI scores (β = -1.106, $p < 0.001$), reflecting reduced foot and ankle function.

For the NPRS model, hours of daily heel use showed a borderline association with pain intensity (β = 0.203, p = 0.087), whereas BMI, heel height, and weekly hours of heel use did not show significant relationships with NPRS scores after adjustment. The overall regression model for NPRS was statistically significant ($F = 6.395$, $p < 0.001$) with an adjusted R^2 of 0.115, as shown in Table 5.

In the FADI model, variables other than age were not significantly associated with functional disability. The model remained statistically significant overall ($F = 4.397$, $p < 0.001$) and explained 7.6% of the adjusted variance in FADI scores.

These findings indicate that advancing age may play an important role in increasing foot pain and decreasing functional ability among women who wear high heels, as shown in Table 6.

Discussion

Although high heels remain widely used in women's fashion, their impact on foot and ankle health remains clinically relevant. In the present study, age was significantly associated with both increased pain and reduced functional ability, while BMI showed no significant relationship with either outcome. Multivariate analysis further confirmed age as the only independent predictor of pain ($\beta = 0.152$, $p < 0.001$) and functional disability ($\beta = -1.106$, $p < 0.001$), whereas heel-related exposure variables, including heel height and duration of use, were not significant after adjustment.

Our findings are consistent with previous research demonstrating an association between high-heel use and pain in the ankle and foot [24,25]. However, in contrast to the findings reported by Qurrat-ul-Ain et al.[25], no significant relationship was observed between heel height and foot discomfort in the present study, suggesting that heel height alone may not be the primary determinant of symptoms.

Females wearing heels ≥ 2.5 inches for limited durations predominantly reported mild to moderate pain. Similar findings have been reported previously, in which foot discomfort was common among high-heel users despite a statistically non-significant relationship between heel height and pain[24]. These observations suggest that factors such as the duration and frequency of exposure may have a greater influence on pain than heel height alone[23,24].

Most participants in the present study reported either no discomfort or moderate discomfort, which is consistent with previous literature reporting a considerable prevalence of foot pain among high-heel users[26,27]. The absence of a significant association between heel height and pain further suggests that individual biomechanical characteristics, foot morphology, and pain tolerance may substantially contribute to symptom presentation[24,26].

Previous biomechanical studies have demonstrated that high-heel use alters gait kinematics, posture, balance, and foot stability[28]. Despite these reported biomechanical alterations, most participants in the present study experienced no difficulty standing, walking, or performing routine daily activities, suggesting possible adaptation among habitual users.

Functional outcomes in our sample, reflected by relatively higher FADI scores, indicated lower levels of disability despite the presence of mild to moderate pain. Comparable NPRS findings have also been observed in earlier studies investigating high-heel users, indicating that pain may occur even when functional impairment remains relatively minimal[23,25].

Table 5. Multivariate multiple regression for NPRS score (0-10)

Variables	β	SE	t	p
(Intercept)	-0.63339	1.66795	-0.380	0.7045
Age (Years)	0.15226	0.02907	5.237	4.08e-07***
BMI (kg/m^2)	0.01365	0.04646	0.294	0.7692
Heel Height (Inches)	-0.35178	0.30880	-1.139	0.2560
Heel Use Hours/Day	0.20300	0.11800	1.720	0.0869.
Heel Use Days/Week	0.07843	0.18385	0.427	0.6701

Model Statistics: $R^2 = 0.1367$ | Adjusted $R^2 = 0.1153$ | $F(5,202) = 6.395$ | $p = 1.542e-05$ | Residual Standard Error = 2.116 (df = 202). β = regression coefficient; SE = standard error; t = t-statistic; p = p-value; R^2 = coefficient of determination; Adjusted R^2 = adjusted coefficient of determination; F = F-statistic; NPRS = Numeric Pain Rating Scale; BMI = Body Mass Index. Significance notation: *** p < 0.001, ** p < 0.01, * p < 0.05, p < *0.1*.

Table 6. Multivariate multiple regression for FADI score (0-104)

Variables	β	SE	t	p
(Intercept)	96.8446	13.8482	6.993	3.85e-11***
Age (Years)	-1.1063	0.2414	-4.583	8.01e-06***
BMI (kg/m^2)	0.2317	0.3858	0.601	0.549
Heel Height (Inches)	3.1077	2.5638	1.212	0.227
Heel Use Hours/Day	-0.9113	0.9797	-0.930	0.353
Heel Use Days/Week	-0.1585	1.5264	-0.104	0.917

Model Statistics: $R^2 = 0.09816$ | Adjusted $R^2 = 0.07584$ | $F(5,202) = 4.397$ | $p = 0.0008018$ | Residual Standard Error = 17.57 (df = 202). β = regression coefficient; SE = standard error; t = t-statistic; p = p-value; R^2 = coefficient of determination; Adjusted R^2 = adjusted coefficient of determination; F = F-statistic; FADI = Foot and Ankle Disability Index; BMI = Body Mass Index. Significance notation: *** p < 0.001, ** p < 0.01, * p < 0.05, p < 0.1

Similarly, previous evidence has shown that high-heel use does not significantly reduce physical activity levels or increase fatigue among working women[29]. Consistent with these findings, most participants in the present study were able to perform daily physical activities without major limitations.

The present findings are also comparable to the work of Kaur and Chitkara, who reported reduced dynamic stability among habitual high-heel wearers using the Four-Square Step Test[31]. While their findings highlighted impaired balance control during functional movement, the present study demonstrated that, after adjustment, heel-related variables were not independently associated with pain or functional disability.

From a clinical perspective, the findings suggest that prolonged and habitual high-heel use may contribute to foot discomfort and biomechanical stress in some individuals. Educating women, particularly those who wear high heels for occupational purposes, about appropriate footwear practices, regular rest periods, and foot care may help reduce discomfort and functional strain. Additionally, the absence of an independent association between heel height and pain after adjustment indicates that individual factors and cumulative exposure may be more important contributors than heel height alone.

Limitations

The analytical cross-sectional design does not permit establishing causal relationships between high-heel use and foot and ankle outcomes. The study was conducted in a single medical setting using convenience sampling, with a predominantly young sample, which may have influenced the multivariate multiple regression findings and limited the generalizability of the results to older or occupational populations. Potentially relevant factors, such as walking surface, footwear fit, gait characteristics, and shoe design features, were not controlled for in the present study. The lack of a non-high-heel user group limits the ability to compare outcomes with individuals who do not wear high heels, thereby restricting the interpretation of results in a broader comparative context. The FADI may not fully capture all biomechanical aspects associated with high-heel use.

Strengths of the study and clinical relevance

A key strength of this study is its analytical cross-sectional design with multivariate modeling, which enabled the simultaneous evaluation of multiple independent variables influencing pain and functional disability. The independent variables included age, BMI, heel height, frequency of daily and weekly heel use, while the dependent variables were pain intensity, measured by the NPRS, and functional disability, measured by the FADI. The use of validated outcome measures enhances the reliability and clinical applicability of the findings, and adjustment for multiple covariates strengthens the internal validity of the results.

Clinically, the findings are relevant, as they demonstrate that age is a consistent predictor of both higher pain intensity and reduced functional ability among high-heel users, whereas heel-use characteristics and BMI did not show independent associations. This highlights the importance of incorporating age-related musculoskeletal considerations into clinical assessment and decision-making rather than relying solely on footwear exposure patterns.

Conclusion

Most participants experienced mild to moderate foot pain, with moderate pain being the most common category. Increasing age was significantly associated with higher pain intensity and greater functional disability, as reflected by higher NPRS scores and lower FADI scores. In contrast, BMI, heel height, and the frequency of daily and weekly heel use were not significantly associated with either outcome. Age was identified as a significant predictor of higher pain intensity and reduced functional ability, whereas heel-use characteristics did not predict either outcome.

Authors' contributions: Each author contributed individually and significantly to the development of this article: KI*(https://orcid.org/0009-0003-2684-3989) Data collection; NM *(https://orcid.org/0000-0002-7667-1869) Conceived and planned the activities that led to the study, interpreted the results of the study, formatting of the article; RA *(https://orcid.org/0000-0002-7667-1869)Statistical analysis; PW *(https://orcid.org/0000-0002-4833-0928) Participated in the review process, approved the final version. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID).

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