

Association of musculoskeletal discomfort with the use of high heeled shoes in females

Wardah Hussain Malick, Hifsa Khalid, Zoya Mehmood, Hamid Hussain

Abstract

Objective: To determine the association of musculoskeletal discomfort with the high heeled shoes related variables in females who use such footwear frequently.

Methods: A cross sectional study was conducted on 174 female residents of Islamabad and Rawalpindi, for a time period stretching from July 1, 2018 to December 31, 2018. The participants aged between 18 and 55 years appeared as the frequent users of high heeled shoes. The Nordic Musculoskeletal Questionnaire (NMQ) and Numeric Pain Rating Scale (NPRS) were used as outcome measures to assess the musculoskeletal discomfort and a self-structured questionnaire was used to obtain information related to the high heeled shoes e.g. duration and frequency of high heeled shoe use. Data was analysed by using SPSS version 21.

Results: The data analysis showed a positive association of shoulders' discomfort with the length of high heeled shoes used by women (p value= 0.03<0.05). A positive association was also found between an occurrence of upper back discomfort and length of the heeled shoes (p value= 0.01<0.05). However, no significant association was found between pain intensity and length of the shoe' heel, frequency and duration of high heeled shoe use.

Conclusion: The shoulders' and upper back discomfort in females who frequently used high heeled shoes was associated with the length of the heels in shoes.

Keywords: Female, Heel, Musculoskeletal System, Pain, Shoes. (JPMA 70: 2199; 2020)

DOI: <https://doi.org/10.47391/JPMA.536>

Introduction

Most women consider high-heeled shoes (HHS) as a fashion symbol.¹ The use of this specific footwear is deemed as characteristic of beauty, self-assurance and elegance.² It has been seen that 1 in 10 women wear it for at least three days a week and a recent survey found that one-third of them had permanent problems.³

Many working women select footwear based on aesthetic appearance which influences the footwear design, however comfort and practicality are not necessarily considered as high a priority, thus adverse pathologies become increasingly apparent during prolonged wear.⁴

Therefore, it is important to investigate and understand the effects that shoes of high heel heights have on the musculoskeletal system.

For more than 50 years, concerns regarding the potential impact of HHS on women's health have been expressed in medical circles. Qualitatively consistent alterations to the neuromechanics of walking (gait) and effect on the kinematics and kinetics of bodily structures from the toes

to the spine have been seen because of using HHS.⁵

The frequent and prolonged use of HHS has a direct impact on the spine. Excessive spinal extensor muscles activation, which contributes to the compression of the spine, might be caused by shock and ground reaction forces which leads to excessive axial pressure onto the intervertebral discs.⁶ Thus, wearing HHS for a prolonged time period can result in an increase in paraspinal musculature activation of lumbar and cervical spine, causing long term overload and fatigue in trunk and neck muscles.⁶ Clinically, muscle overuse could be exacerbated by increased lumbar erector spinae muscle activity associated with wearing high heeled shoes and may lead to low back problems.^{7,8} High heeled shoes users exhibit significantly lower maximum and minimal lumbar and thoracic curvature angles as compared to the barefoot condition. Therefore, low back pain might be associated with other factors caused by high heels.⁹

Furthermore, at pre-swing and swing phases of gait, there is a 23% increase in hip flexor work in response to a higher hip extension moment in high-heeled gait, thereby disturbing the normal musculoskeletal action at hip.¹⁰

HHS also contributes to the musculoskeletal changes around knee joint. The higher knee extensor moments and knee flexion angles induced can cause an increased

.....
Department of Physical Therapy, Shifa Tameer e Millat University, Islamabad, Pakistan.

Correspondence: Wardah Hussain Malick. Email: wardahmalick@gmail.com

risk of developing patellofemoral pain and knee osteoarthritis, by increasing joint reaction force.¹¹

As compared to a no heel inclination, the time taken for the knee to reach maximum flexion in gait while wearing HHS is recorded to be longer.¹⁰

The mechanism for knee unlocking that enables knee flexion might also be disturbed because of such footwear. Therefore the discussion suggested that the knee would be more susceptible to injury when high heels are in frequent use.¹⁰

The contractile properties of soleus muscle might also be affected, even more than the gastrocnemius muscle, due to habitual use of HHS.¹² Accordingly, it is reasonable to expect that habitual users of such footwear would be more prone to anterior cruciate ligament injury with physically demanding activities and they would require extra effort for rehabilitation in case of injury.¹²

Additionally, the contact pressure at all metatarsophalangeal joints increases and reaches its maximum at push off phase during locomotion, meanwhile the first metatarsophalangeal joint has the largest magnitude. The first and fifth metatarsophalangeal joints have larger movements in transverse plane among all joints, indicating that these two joints bend more significantly by toe box restraint during locomotion.¹³

An individual's likelihood of experiencing a lateral ankle sprain is thought to increase by wearing HHS. It might also increase due to the flexed and inverted posture of the plantar aspect of the foot while wearing such footwear. HHS might also cause foot and heel pain because there is a definitive change in subtalar joint axis while walking on HHS in comparison to normal shoes.³

High heels shoes could also cause musculoskeletal diseases in the foot and ankle, such as plantar fasciitis,¹⁰ hallux valgus, ankle sprain among many others.¹⁴

Though studies have been conducted on HHS previously including the prevalence of musculoskeletal pain among young females who wear such footwear.¹⁵ However, no research study has yet been conducted in Pakistan to determine the association of HHS related variables (such as heel length, duration and frequency of HHS use) with the musculoskeletal discomfort in females who use such footwear frequently. It is important to determine this association because of the harmful effects of such footwear on the musculoskeletal system, including shoulders and upper back regions.

The aim of this study was to determine the association of musculoskeletal discomfort with the high heeled shoes related variables in females who use such footwear frequently.

Subjects and Methods

A cross sectional survey was conducted from July 2018 to December 2018 on the females residing in the twin cities of Pakistan i.e. Rawalpindi and Islamabad. After approval from the ethical committee, informed consent from the participants and assurance concerning the confidentiality of their data, a total of 174 females fulfilling the eligibility criteria were recruited from the public places of the twin cities including recreational parks, outside the malls, mega marts, supermarkets, tourist attractions and bus stops. The study sample was selected through non probability convenient sampling and the sample size was calculated through Rao Soft on-line software, with confidence interval 95 per cent, margin of error 5 per cent and the population size 3,613,802 (Rawalpindi's female population= 2,663,075 plus Islamabad's female population= 950,727).^{16,17} Resultantly the sample size came out to be 385 females, which were approached to obtain the data from. However, only 174 out of these 385 females were frequent users of high heeled shoes and fulfilled the inclusion criteria of this study.

Females of age between 18 and 55 years who were users of at least 2.5 inches long heels for at least 4 times a week and for at least 4 hours per day were included while females who had a previous history of musculoskeletal injury which was less than a month old, history of structural deformity or bone diseases, amputations or diagnosed musculoskeletal disorders, or those females who had diagnosed neurological or cognitive impairment were excluded from the study.

The Nordic Musculoskeletal Questionnaire (NMQ) and Numeric Pain Rating Scale (NPRS) were used as outcome measures to assess the musculoskeletal discomfort and a self-structured questionnaire was used to obtain information related to the high heeled shoes. All the questions were asked in English language as all the participating females had at least completed the Higher Secondary School Certificate from English medium schools and so they understood the English language well.

NPRS is an 11-point scale, which intends to determine the subjective intensity of pain in which '0' means no pain while '10' means the highest pain imaginable. The patient selects a value consistent with their pain intensity in the last 24 hours.¹⁸ It is a valid and reliable tool with good sensitivity.¹⁹ NMQ is a valid tool for analysis of

musculoskeletal symptoms.²⁰ It has been previously used in English language for participants who can comprehend the language well.²¹ It consists of two sections. Section 1 consists of 40 forced-choice items identifying areas of the body causing musculoskeletal problems. Completion is aided by a body map to indicate nine symptom sites identified as neck, shoulders, upper back, elbows, low back, wrist/hands, hips/thighs, knees and ankles/feet. Section 2 consists of additional questions relating to the neck, shoulders and the lower back with further details on relevant issues. Twenty-five forced-choice questions elicited any accident affecting each area, functional impact at home and work (change of job or duties), duration of the problem, assessment by health professional and musculoskeletal problems in the last 7 days. Respondents were asked if they have had any musculoskeletal trouble in the last 12 months especially in the last 7 days which had obstructed normal activity. NMQ is a repeatable, sensitive and useful as a screening and surveillance tool.²² Data was analysed using SPSS version 21.

The correlation between trouble in different body regions during last twelve months and length of the HHS was analysed by applying Chi square test. The correlation between length of shoe heel and pain intensity was analysed using Spearman's correlation test.

Descriptive statistics were calculated to find out overall percentage and frequency of HHS use.

Results

The total number of female participants recruited was 174, out of which most (73%) were young adults (19-29 years), 12.1% were middle aged (30-39 years), 10.9% were established adults (40-49 years) and 4% of the participants were seniors (50-55 years).²³ Table-1 shows the description of the study sample. The mean age was calculated to be 28.46 ± 8.54 years. The mean height of

Table-1: Description of the study sample.

Variable	Categories	Frequency	Percentage%
Age (years)	19-29 (young adults)	127	73
	30-39 (middle aged adults)	21	12.1
	40-45 (established adults)	19	10.9
	50-70 (seniors)	7	4
Marital status	Unmarried	105	60.3
	Married	69	39.7
Occupation	Employed	108	62.1
	Unemployed	66	37.9

Table-2: Association between musculoskeletal discomfort and length, frequency and duration of high heel use.

Musculoskeletal Discomfort in Body region (trouble during Last 12 months)	Vriables	P value
Neck Discomfort	Length	0.22
	Frequency	0.89
	Duration	0.81
Shoulder Discomfort	Length	0.03
	Frequency	0.87
	Duration	0.37
Upper Back Discomfort	Length	0.01
	Frequency	0.55
	Duration	0.14
Elbow Discomfort	Length	0.22
	Frequency	0.21
	Duration	0.96
Wrist/Hand Discomfort	Length	0.14
	Frequency	0.79
	Duration	0.54
Lower Back Discomfort	Length	0.95
	Frequency	0.12
	Duration	0.49
Hip Discomfort	Length	0.36
	Frequency	0.08
	Duration	0.14
Knee Discomfort	Length	0.34
	Frequency	0.2
	Duration	0.57
Ankle/Foot	Length	0.14
	Frequency	0.3
	Duration	0.5

the participants was 155.26 ± 4.77 centimeters and the mean weight was 60.61 ± 12.01 kilograms.

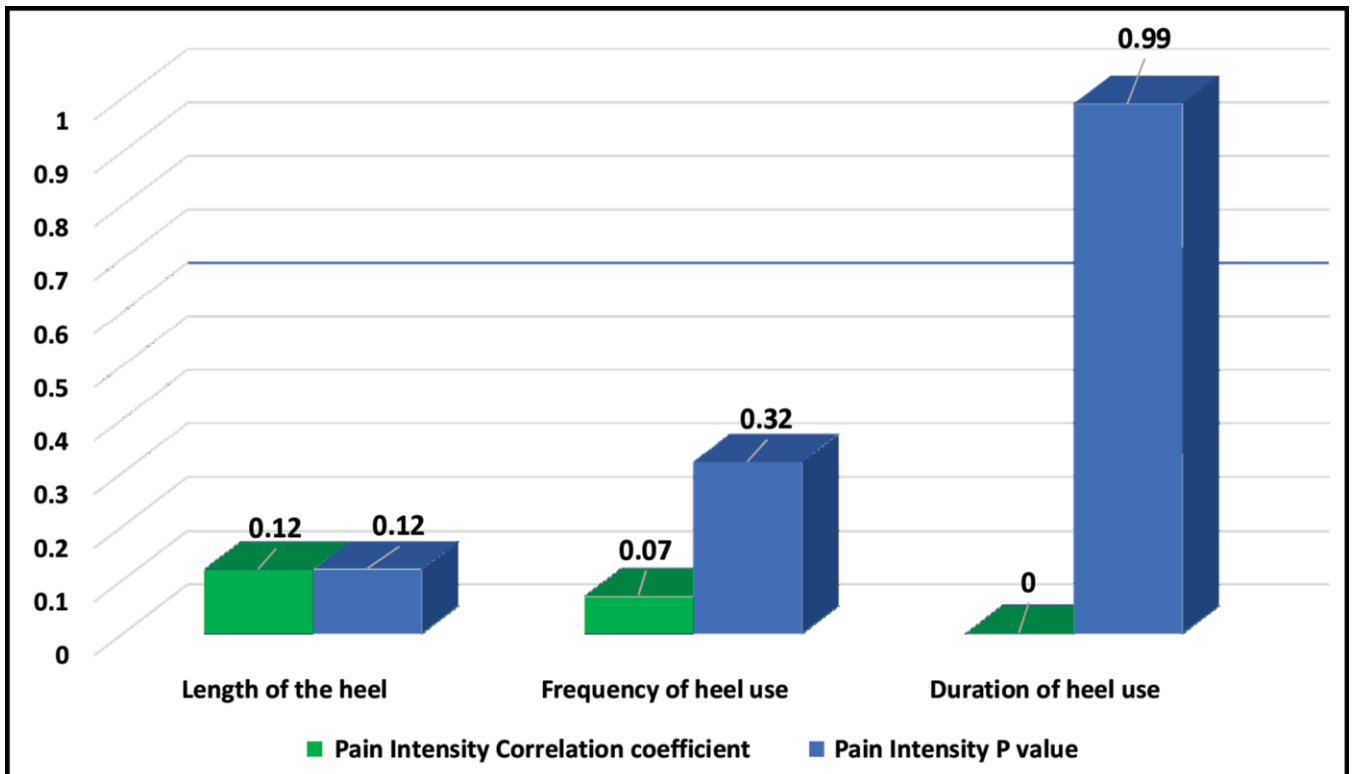
The sample consisted of both working and non-working females (Table-1).

Majority, i.e., 67 (38%) of the females used wedge type of heels and most of them, i.e., 70 (40%) used HHS consisting of a leather sole.

It was determined that 110 (63%) women preferred for frequent use a heel length of 3 inches.

Furthermore, the results of this study also showed that 110 (63%) females wore HHS for 4 days a week and 65 (37%) females wore HHS for a duration of at least 7 hours a day.

The pain intensity caused by HHS use was also determined in this study: 33 (19%) females usually felt no pain (0 on NPRS), 59 (34%) participants reported mild pain (a score between 1 and 3 on NPRS), 68 (39%) participants reported moderate pain (a score between 4 and 7 on



Graph-1: Correlation between pain intensity and length, frequency and duration of high heel use.

NPRS) and 14 (8 %) participants reported severe pain (a score between 7 and 10 on NPRS) because of using HHS frequently.

The participants were also asked if there was a better alternative to high heels for frequent use, to which 72 (41%) females responded with a 'no'.

Table-2 shows the correlation between trouble in different body regions during last twelve months and heel length, frequency and duration of HHS used by the participants, which was analysed by applying Chi square test.

It was determined that trouble in shoulders and length of high heel is significantly correlated (p value: $0.03 < 0.05$).

It was also seen that trouble in upper back and length of high heels is also significantly correlated (P value: $0.01 > 0.05$).

Graph 1 shows correlation between length of HHS and pain intensity, which was analysed using Spearman's correlation test. The correlation between duration of HHS use and pain intensity is also shown in Graph 1.

Discussion

In addition to determining the prevalence of lower back and lower limbs' discomfort because of HHS use, the results also showed an association between shoulders' and upper back discomfort with length of the heels used by women. Cowley E. et al explained in their study that this might be because the higher magnitude of vertical ground reaction forces in HHS contributes not only to discomfort but also increases the risk of injury. This, in combination with the loss of lumbar lordosis, also increases the axial compression of intervertebral discs. Furthermore, the effects are significantly increased with the more active erector spinae muscles, which act to compress the spine.²⁴

It has also been determined that majority of the females in this study preferred wearing 3 inches long heels most of the time and over half of them suffered from lower back discomfort. This correlated with the findings of a previous study which showed that fatigue of lumbar muscles was lesser when the heel was 4 cm (1.5 inches) high or less. However, a considerable increase in muscle fatigue was shown when the heel was higher than 6 cm (2 inches) and the body muscles tensed to improve body balance, thus causing muscle fatigue and pain in the back,

shoulders and neck.²⁵ Moreover, the levels of muscle activation of cervical, thoracic and lumbar paraspinal muscles were higher when wearing HHS than when wearing shoes with normal heels.²⁵

Half of the women who wore 3 inches long heels mostly had discomfort in their knees as well. This might be because the knee does not achieve same amount of flexion in HHS compared to low-heeled shoes. This related to the findings of a previous study which concluded that compared to barefoot gait during pre-swing phase, a 200 per cent increase in concentric knee extensor activity was observed in HHS. This significant increase in moment of force created by the knee extensor muscles, countered the knee flexion moment of force and therefore reduced the amount of knee flexion during the swing phase in high-heeled gait.²⁴

Of the 110 females 79 (71.8%) who frequently wore 3 inches long heels, suffered from discomfort in ankles and feet. Similar results have been reported in a previous study, which suggested that this women who regularly wear HHS are more prone to fatigue of peroneus longus and gastrocnemius lateralis muscles as compared with women who do not wear HHS.²⁶ The eccentricities of the center of pressure under the heel and metatarsal heads are abnormally shifted to the lateral aspect during gait, when fatigued.²⁶ According to another study conducted in the past, the ankle and feet discomfort because of HHS could also be caused by the ankle joint axis moving anteriorly and the line of gravity moving posteriorly toward the ankle joint when wearing HHS. Thus the foot became immediately shorter because of the arch rising.²⁴

It should however be noted that the use of HHS could be beneficial in treating specific pathologies. Cyriax postulated that heel elevation could decrease plantar fascia strain. Recently, further cadaveric studies and finite element modeling confirmed these findings. According to the latter, a heel height of approximately 2 inches would be beneficial in the treatment of plantar fasciitis.²⁴

It is suggested that high heels be treated as a luxury used on special occasions. Females should limit their use to no more than 3 hours at a time and should not wear them for any prolonged walking. Furthermore, fabric or skin on the upper side of shoe should be chosen that expands and try to select a shoe that has a rounded or squared toe. Moreover, a shoe with a straight last will reduce the lateral force on the great toe and reduce hallux valgus deformity.²⁷

The limitation of the study was that the sample size was not large enough to make strong generalization. The

target population resided in the twin cities of Rawalpindi and Islamabad which again limits its generalizability. There is no joint consensus on the heel height cut off value as yet,⁵ and the heel height that might cause musculoskeletal discomfort could not be determined in this study.

Conclusion

The musculoskeletal discomfort in the upper back and shoulders experienced by females who wore HHS frequently has been determined to be associated with heel length of their footwear.

Disclaimer: The manuscript was a part of our research project of Doctor of Physiotherapy programme at Shifa Tameer e Millat University, Islamabad.

Conflicts of Interest: None to declare.

Funding Disclosure: None to declare.

References

1. Yoon JY, An DH, Yoo WG, Kwon YR. Differences in activities of the lower extremity muscles with and without heel contact during stair ascent by young women wearing high-heeled shoes. *J Orthop Sci.* 2009; 14:418-22.
2. Dai M, Li X, Zhou X, Hu Y, Luo Q, Zhou S. High-heeled-related alterations in the static sagittal profile of the spino-pelvic structure in young women. *Eur Spine J.* 2015; 24:1274-81.
3. Kumar NV, Prasanna C, Sundar VS, Venkatesan A. High Heels Footwear Causes Heel Pain and Back Pain: Myth or Reality? *Int J Sci Study.* 2015; 3:101-4.
4. Seferin M, van der Linden J. Protection or pleasure: female footwear. *Work.* 2012; 41:290-4.
5. Barnish MS, Barnish J. High-heeled shoes and musculoskeletal injuries: a narrative systematic review. *BMJ Open.* 2016; 6:e010053.
6. Park K, Kim Y, Chung Y, Hwang S. Effects of the height of shoe heels on muscle activation of cervical and lumbar spine in healthy women. *J Phys Ther Sci.* 2016; 28:956-9.
7. Mika A, Oleksy L, Mika P, Marchewka A, Clark BC. The effect of walking in high-and low-heeled shoes on erector spinae activity and pelvis kinematics during gait. *Am J Phys Med Rehabil.* 2012; 91:425-34.
8. Afzal F, Manzoor S. Prolong wearing of high heeled shoes can cause low back pain. *J Nov Physiother.* 2017; 7:356.
9. Baaklini E, Angst M, Schellenberg F, Hitz M, Schmid S, Tal A, et al. High-heeled walking decreases lumbar lordosis. *Gait & posture.* 2017; 55:12-4.
10. 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; 99:512-8.
11. Ko DY, Lee HS. The Changes of COP and Foot Pressure after One Hour's Walking Wearing High-heeled and Flat Shoes. *J Phys Ther Sci.* 2013; 25:1309-12.
12. Farrag A, Elsayed W. Habitual Use of High-Heeled Shoes Affects Isokinetic Soleus Strength More Than Gastrocnemius in Healthy Young Females. *Foot Ankle Int.* 2016; 37:1008-16.
13. Yu J, Cheung JT, Wong DW, Cong Y, Zhang M. Biomechanical simulation of high-heeled shoe donning and walking. *J Biomech.* 2013; 46:2067-74.

14. Ko DY, Lee HS. The changes of COP and foot pressure after one hour's walking wearing high-heeled and flat shoes. *J Phys Ther Sci*. 2013; 25:1309-12.
 15. Nawaz U, Hashmi MA, Qureshi MY, Qureshi AY, Minhas A, Aziz SA, et al. Prevalence of musculoskeletal pain among young females using different heel heights: a cross-sectional study. *Rawal Med J*. 2019; 44:220-2.
 16. City population. Islamabad. [online] [cited 2018 Jun 12]. Available from URL: <http://www.citypopulation.de/php/pakistan-admin.php?adm1id=5>
 17. City population. Pakistan: Administrative divisions. [online] [cited 2018 Jun 12]. Available from URL: <http://www.citypopulation.de/php/pakistan-admin.php?adm2=728>
 18. Donovan MI. Pain: Clinical manual for nursing practice Pain: Margo McCaffery and Alexandra Beebe Published by the C.V. Mosby Company, St. Louis, Missouri 1989, 353 pages, \$24.95 paper. *J Pain Symptom Manage* 1990; 5:338-9.
 19. Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. *J Clin Nurs*. 2005; 14:798-804.
 20. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied ergonomics*. 1987; 18:233-7.
 21. Abaraogu U, Odebiyi D, Olawale O. Association between postures and work-related musculoskeletal discomforts (WRMD) among beverage bottling workers. *Work*. 2016; 54:113-9.
 22. Crawford JO. The Nordic musculoskeletal questionnaire. *Occup Med*. 2007; 57:300-1.
 23. Park YH, Gerrard J. Black belt tae kwon do: The ultimate reference guide to the world's most popular black belt martial art. USA: Skyhorse Publishing Inc, 2013; pp 272.
 24. 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; 99:512-8.
 25. Han D. Muscle activation of paraspinal muscles in different types of high heels during standing. *J Phys Ther Sci* . 2015; 27:67-9.
 26. Gefen A, Megido-Ravid M, Itzchak Y, Arcan M. Analysis of muscular fatigue and foot stability during high-heeled gait. *Gait Posture*. 2002; 15:56-63.
 27. Frey C, Coughlin MJ. Women's shoe wear: An orthopaedist's advice. *J Womens Health*. 1999; 8:45-9.
-