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Research Article

Does Wearing Heeled Footwear Have an Effect on Lower Back Function in Women?: A Cross-Sectional Study

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A B S T R A C T

Introduction: Pain is a concept that can occur due to many reasons. Females are more prevalent than males in terms of pain. The total occurrence of discomfort in the lower back is 28.8 % and thus the prevalence in females was 60.9% which is higher than in males which accounts for 39.1%. The important point that must be noted is the reports of many research studies showing that long-term usage of high-heeled footwear can adversely on various body parts. But still, women like to wear them. The foot, knee, and back pain are found to be 78.94% of women who wear > 5 cm heel height and 53.12% of women who wear < 5 cm heel height—back discomfort results from the user tipping their foot forward, which impacts pressure on their lower back. The negative impacts like low back ache, changes in gait, and sprain of the ankle were due to the increase in the curvature of the lumbar spine.

Aim: The study aimed to analyse the correlation between high-heeled footwear usage and its impact on low-back mechanics.

Method: This study was done for 100 female subjects wearing heeled footwear and the type of sampling was convenient sampling. The 100 female subjects are recruited based on the criterion of inclusion. Then the subjects were provided with informed consent before the study. They were provided with foot posture index (FPI) and Oswestry disability index (ODI).

Results: Both descriptive and inferential statistics were used to tabulate and analyse the data that had been gathered. The Pearson Correlation Coefficient (r) has a value of 0.232. While there is a positive connection and association between the Foot Posture Index (FPI) and the Oswestry Disability Index (ODI), women's lower back discomfort worsens when their Foot Posture Index score (high-heeled footwear) increases.

Conclusion: It is concluded that there is a significant association between foot posture and low back pain among women who wear heeled footwear. This can be used as a routine during the assessment for low-back pain.

Keywords: High Heel, Lumbar, Foot Posture, Lower Back, Discomfort, Footwear, Oswestry

Introduction

Pain is a concept that can occur for many reasons with more incidences among females (31.3%) as compared to males and males (20.9%).[1] Among adults of all ages lower back pain seems to be a major cause of disability. The height of heel and forefoot stress are correlated with each other. Thus, a heel height of 2 inches puts 57% of force, heel height of 3 inches puts 76% of force on the forefoot. The flexion angle of the trunk is decreased by one with every increase of 1 cm in heel height.[1] Bento et al. reported that the total occurrence of discomfort in the lower back was 28.8 %. Thus, the prevalence in females was 60.9% which is higher in males accounting for 39.1%.[2] The health and well-being of humans are affected by fashion in the means of heeled feet which shortens the calf muscle and curvature of the spine. The fashion style in the current era is rising with the usage of high-heeled footwear.[3] In a recent study, it was found that during walking, the kinematics of the ankle joint is affected by the usage of high-heeled footwear. A studyshowed that subjects who wear high-heeled footwear have limited ROM during jogging and running, while in the stance phase, it is shown that weight bearing is more on hip, knee, and ankle joints when compared to the subjects who wear low-heeled footwear.[3] Lumbar spondylosis is also caused by wearing high-heeled footwear which raises the lordotic curvature of the lumbar spine and raises the lumbar vertebrae's compressive force.[3]

An increase in knee flexion and ankle flexion together with femoral obliquity is seen in women who wear high-heeled footwear. This increased knee flexion and ankle flexion are compromised by the curvature of the spine.[3]

Wearing high-heeled footwear leads to the ankle joint's plantar flexion, which causes the centre of gravity of the body to shift forward. This would act as a compensating mechanism by reducing the base angle of the sacrum and sagittal lumbar spinal curvature.[4] In a study done they found that the strength of the soleus muscle is greatly affected by high-heeled footwear. The body weight is directly transmitted to the ground because of disruption in the foot arches which is caused by the usage of high heels. The functional activity and balance of the body are also affected by high-heeled footwear. It can also affect the posture by affecting the muscles of the cervical and lumbar. For the trunk muscles activation, balance and posture are key components.[3]

Women who wear high-heeled footwear aged between 20 and 29 years old have been shown to develop hallux valgus. In case of impaired balance, the muscles of the trunk region provide a stability factor. The balance of the body is greatly disturbed by the usage of high-heeled footwear, thus the muscles of the trunk region are prone to work harder to maintain the balance of the body.[3]

The musculoskeletal issues, fall risk, and amplification of the traditional female-like gait are caused due to the influence of high-heeled footwear on women who wear it. Those who regularly use high-heeled footwear seem to have increased plantar flexion of the ankle which leads to insufficiency of gastrocnemius, soleus, and tibialis anterior.[5] Previous research studies revealed that knee pain, back pain, OA knee, low back pain, gait abnormalities, cadence, and mobility are all affected because of high-heeled footwear.[5]69% of women are shown to wear high-heeled footwear in many surveys. The important point that must be noted is the reports of many research studies showing that long-term usage of high-heeled footwear can adversely affect various body parts. But still, women like to wear them.[4] The increase in the need for consumption of oxygen and elevated heart rate is seen additionally in women who wear high-heeled footwear which contributes to having a higher metabolic rate than flat shoes.[4]

The compensatory mechanism that was discovered to be the first reaction as plantar flexion of the ankle that comes with wearing high-heeled footwear is flexion of the knee. The trunk and pelvis begin to adjust for the forward shifting in the line of gravity later on, following the exhaustion of the muscles of the knee. Moreover, without modifying the spine's curvature, the compensatory mechanism of the kinematic chain may mostly occur in the pelvis and lower limbs.[4]

Foot, knee, and back pain are found to be 78.94% of women who wear > 5 cm heel height and 53.12% the women who wear < 5 cm heel height. The various problems like an ankle sprain and unstable ankle, wear & tear injuries and increase in the neck muscle activity, shortening of the gastrocnemius muscle, decrease in strength of plantar flexor muscles, limited ROM of the ankle joint, and rise in tendoachilles stiffness.[6]

By wearing high-heeled footwear, the curvature of the lumbar,the tibialis muscle and the centre of mass of the body are all affected. Cadence, stride length, and patterns of gait are impaired by more weight bearing on the toes, leg pain, ankle sprain, and back pain which is caused by high-heeled footwear. The usage of heeled footwear will affect the tibial anterior muscle biomechanically which becomes a shortened muscle.[7–9]

The abductors of the knee and pronators of the ankle must be improved to achievebalanced walking in the one-leg stance in the late phase.[7] Wearing high-heeled footwear is found to be more prone to sprain of the ankle joint since there is an abnormal force occurring for the stabilisation in the ankle joint and wearing high-heeled footwear will cause unstability.[10–12] Previous research studies revealed that while walking the spine's movement is influenced by the height of the heels.[12]

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Back discomfort results from the user tipping their foot forward, which impacts pressure on their lower back.[13] The negative impacts like back pain, low back ache, changes in gait, and sprain of the ankle were due to the increase in the curvature of the lumbar spine.[1] The electromyography study on muscles of the spine has been studied for the difference in the height of the heel. The evidence shows that an increase in activation of the cervical paraspinal muscle and paraspinal muscles of the lumbar is produced due to standing while wearing high-heeled footwear. The rise in lumbar paraspinal activation is seen while walking. An extended duration of standing results in microtrauma to the foot and causes the calcaneum to migrate medially, inferiorly, and evert itself at the subtalar joint. As a result of internal femur rotation, the pelvis shifts posteriorly and the femur head moves posteriorly. To preserve postural equilibrium, the body's centre of mass and trunk move forward, forcing the pelvis to tilt forwardly and causing lumbar lordosis. Furthermore, some degrees of knee adduction are seen.[14]

The stable posture is affected because of the femur & tibia's internal rotation and foot eversion. This is caused due to prolonged standing wearing heels in which the body's weight is impacted which can cause foot alterations.[14] When a person has unilateral calcaneal eversion, their pelvis tilts laterally, resulting in variations in lower limb length that may eventually manifest as lumbar scoliosis.[14]

Wearing heels is one situation that might make walking more difficult since it changes the normal posture of the ankle-foot combination. A forward slant increases the amount of weight that is transmitted to the balls of the toes and foot, increasing the risk of injury to the soft tissues supporting the foot underneath. The changes in the ankle-foot complex in terms of motion and alignment are obvious.[15] Walking in heeled footwear significantly reduces the action of the plantar flexor muscle of the ankle, whereas the flexors of the hip joint work more as the foot moves from the stance phase to the swing phase. A compensating increased flexor of hip joint pull-off occurs when the plantar flexors of the ankle reduced efficiency during the late stance is seen. Wearing high heels causes the body to exercise large muscles and uses more of the knee and hip.

The posture, balance, gait, and foot stability are significantly affected and changes in the ankle posture are also affected because of heeled footwear.[16]

Concerning studies on high-heeled footwear and low back health, there were limited resources on the assessment methods, duration of footwear usage, and correlation between them. Our study aimed to find out the impact of wearing heeled footwear on low back mechanics, thereby it can be included as a routine in all foot assessments and to frame a management routine using the same.

Methodology

This cross-sectional study was performed after getting approval from the Institutional Human Ethics Committee for Student Research (IHEC-I/1908/23). The type of sampling used was simple random sampling. Participants were provided with informed consent before the study. The study setting was at a private sales company in OMR, Chennai. Female subjects between the age group of 18 to 30 years, with normal BMI, those wearing heeled footwear greater than 2 inches height for more than a year, those using heeled footwear every day, those working for 8 hours per day, subjects whose nature of work involves standing for more than 3 hours per day, were included for the study. Subjects more than 30 years of age, overweight, obese, those who use flat footwear, with congenital foot deformities/ postural deformities/ lower limb/ spinal pathology, recent injuries or surgery to the spine or lower limb, limb length deficits, pelvic inflammatory diseases were excluded from the study. The subjects were requested to fill in the Oswestry questionnaire and were assessed using the foot posture index. The findings were documented and analysed statistically.

Foot Posture Index

The Foot Posture Index (FPI) is a reliable and valid method for assessing the posture of the foot which helps to find out if the foot is normal, pronated, or supinated. It contains a total of 6 items namely they are (1) palpation of the talus head, (2) observing the curves below and above the malleoli of the lateral side, etc. Each item has a score ranging from -2 to +2. The overall result ranged from -12 to +12. Normal foot scores range from 0 to +5, pronated feet are shown by +6 to +9, strongly pronated (leaning inwards) feet are shown by ≥ +10, supinated (leaning outwards) feet are shown by -1 to -4, and highly supinated feet are shown by -5 to -12.

Oswestry Disability Index (ODI)

This questionnaire is to evaluate low back discomfort. It consists of ten questions with scores ranging from 0 to 5, covering topics such as pain intensity, lifting, self-care, walking, standing, sitting, social life, quality of sleep, capacity to travel, and ability to work. A score of 0 to 4 implies no disability, 5 to 14 implies mild impairment, 15 to 24 implies moderate impairment, 25 to 34 implies serious impairment, and 35 to 50 implies completely disabled.

Procedure

100 subjects were chosen as per inclusion criteria. They were given a consent form to read and sign if they agreed to participate. The consent form also contained information on confidentiality and the use of their data is only for research purposes. Then the participants were assessed using FPI and ODI. The duration of the study was 6 weeks. After the completion of 6 weeks, the responses from the

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subjects were collected and analysed statistically, after which the results were documented.

Data Analysis

Both descriptive and inferential statistics were used to tabulate and analyse the data that had been gathered. Version 24 of the Statistical Package for Social Sciences (SPSS) was used to evaluate every parameter. By Pearson in addition, the coefficients of correlation between the standard deviation and mean were used to determine the connection and the correlation of the variables.

Results

The study had 100 individuals in total, with the mean age being 23.10 ± 2.47 years (Table 1). The FPI and the ODI scores were calculated and the results were analysed (Table 2). As shown in Table 3, the value of the Pearson correlation coefficient (r) was 0.232. While there was a positive connection and association between FPI and ODI, women's lower back discomfort worsens when their FPI score (high-heeled footwear) increases.

Elsayed WH et al., in their study, evidenced that wearing heeled footwear for a short-term duration doesn't affect the activity of the erector spinal muscle of the lumbar region and posture of the spine in the sagittal plane but in case of long-term use, it may affect the angles of the spine as a compensatory mechanism.[4]

A study done by Nadeem et al. found an association between low back ache and usage of heeled footwear.[17] Further the duration of heeled footwear usage is the cause of back pain, not the heel height.[18]

Hence the prevalence of lower back discomfort was 54% which was seen in subjects who use heeled footwear and it is evidenced there is a positive correlation between heeled footwear and low back pain. The intensity and presence of low back pain are associated with long-term usage of heeled footwear and the height of the heel. The tendency for the pelvis to tilt posteriorly is more with high heels, adopting a compensatory posture for heels may require

Table 1.Descriptive Statistics regarding the Participants' Demographic Details

Variables	N	Lowest	Highest	Mean	SD	Skewness	
						Statistic	Std Error
Age	100	20.00	29.00	23.10	2.47	1.17	0.241

Table 2.Descriptive Statistics about the Participants' FPI and ODI

Variables	n	Lowest	Highest	Average	SD	Skewness	
						Statistic	Std Error
FPI (Rt)	100	-3.00	11.00	6.24	2.64	-1.72	0.241
FPI (Lt)	100	-4.00	11.00	7.17	2.44	-2.49	0.239
ODI	100	16.00	31.00	21.28	2.70	-3.96	0.241

FPI: Foot Posture Index, ODI: Oswestry Disability Index, Rt: Right, Lt: Left

Table 3.Pearson Correlation Coefficient showing the Relation Exists among the Participants' FPI and ODI

Pearson Correlation Coefficient			FPI	ODI
Pearson's (r)	FPI	Correlation coefficient	1.000	0.232
		Sig. (2-tailed)	-	0.020
		N	100	100
	ODI	Correlation coefficient	0.232	1.000
		Sig. (2-tailed)	0.020	-
		N	100	100

FPI: Foot Posture Index, ODI: Oswestry Disability Index

Discussion

The present research aimed to discover the prevalence of low back function in women wearing heeled footwear and to find whether foot posture has an impact on low back mechanics in women uswing heeled footwear. The correlation between FPI and ODI was statistically analysed and it found out there is a positive correlation with the value of Pearson correlation coefficient (r) is 0.232.

greater gluteal contraction, causing an increase in gluteal prominence. The stable posture due to prolonged standing wearing heeled footwear leads to body weight impaction on the foot which can cause foot alterations. The subjects also demonstrated more pronated feet in FPI which can alter to biomechanics of the spine leading to non-specific low back pain. The findings can be correlated with the conclusions drawn from Wang et al. who mentioned that

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there is an increase in lordosis of the lumbar spine and flexion in the knee joint, ankle joint, hindfoot, forefoot, and hallux.[19]

Another study done by Dharmayat et al. concluded that the curvature of the lumbar spine is influenced by the posture of the foot and these changes in spinal curvature are correlated with low back pain. Thus, this suggests that foot posture assessment must be included as an important factor in evaluating the individual with low back pain.[14]

Limitations

- The study sample size is small.
- Intervention impact was not done.
- The type of heel was not considered.

Future Recommendations

- This study can be done with different age groups among women.
- This study can be done in a larger population.
- The study results can be compared with different heel-type footwear.

Conclusion

The study can conclude that there is a strong association between foot posture and low back pain among women who wear heeled footwear.

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Conflict of Interest: None

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