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RESEARCH ARTICLE

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EVALUATING THE CORRELATION BETWEEN HIGH HEELS USE AND URINARY INCONTINENCE IN HEALTHY WOMEN: CROSS SECTIONAL STUDY

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ABSTRACT

Background: Pelvic floor dysfunction (PFD), including urinary incontinence (UI), is a prevalent concern among women and has significant effects on quality of life. Urinary incontinence, defined as the involuntary leakage of urine, can result from weakened pelvic floor muscles (PFMs). PFMs play a critical role in supporting pelvic organs and maintaining continence. Multiple factors can contribute to PFM dysfunction, including age, childbirth, obesity, and lifestyle habits. Among lifestyle factors, prolonged use of high-heeled shoes has been speculated to influence pelvic alignment and muscle function, potentially increasing the risk of urinary incontinence. However, this relationship remains understudied, especially in young, healthy women. **Objective:** The aim of this study was to evaluate the correlation between heel height in regularly worn footwear and urinary incontinence symptoms among healthy women aged 18–35 years in the Surat district. **Methodology:** This cross-sectional study was conducted among 429 healthy female participants selected through non-probability sampling. Participants were categorized into three groups based on the regular heel height worn: <3 cm, 3–5 cm, and 5–7 cm. The Urogenital Distress Inventory – Short Form (UDI-6) was used to assess lower urinary tract symptoms. Data were analyzed using one-way ANOVA and regression models to explore the association between heel height and various symptoms of urinary incontinence. **Results:** Statistical analysis revealed that women who wore heels in the 5–7 cm range reported significantly higher incidences of frequent urination, urgency-related leakage, physical activity-related leakage, difficulty urinating, and pelvic pain compared to the other groups ($p < 0.001$). The 3–5 cm heel group demonstrated the lowest symptom scores, suggesting a potential protective range. There was no significant difference in symptom scores between those wearing <3 cm heels and the 3–5 cm group. **Conclusion:** The study establishes a statistically significant correlation between higher heel heights (5–7 cm) and increased urinary incontinence symptoms. Moderate heel heights (3–5 cm) may not adversely affect pelvic floor function and could be considered safer for long-term use. These findings highlight the need for awareness among women about the musculoskeletal and urogenital consequences of prolonged high-heel usage. Further longitudinal studies are recommended to explore causality and long-term effects.

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INTRODUCTION

Pelvic floor dysfunction describes the medical situations related to changes within the pelvic floor, including urinary incontinence, bladder and bowel dysfunction, pelvic organ prolapses, sexual dysfunction and pelvic pain⁽¹⁾Urinary incontinence is defined as, "involuntary leakage on effort or exertion, or on sneezing or coughing". Out of 3000 women, 656 women reported urinary incontinence and prevalence was 21.87% in India⁽²⁾The prevalence of urinary incontinence in healthy young females was 29.36% in Gujarat.

In young healthy female age between 18-45 years, 50.85% had stress, 9.16% had urge and 40 % had mixed type of urinary incontinence.⁽³⁾The female pelvic floor is a muscular diaphragm formed by the levator ani and coccygeus muscles that supports the urethra, vagina, and rectum. Menopause causes structural and functional changes in these muscles, reducing pelvic support and increasing the risk of urinary incontinence, pelvic organ prolapses, and genitourinary syndrome of menopause.⁽⁴⁾The pelvic floor muscles form a hammock-like support for the pelvic organs and consist of the

pelvic diaphragm, urogenital diaphragm, and urogenital triangle muscles. They maintain urinary continence, support pelvic organs, and regulate bowel and bladder function. Weakness of these muscles increases the risk of urinary incontinence and pelvic organ prolapse.⁽⁵⁾ Pelvic floor muscles contain 70% type I (slow-twitch) and 30% type II (fast-twitch) fibers. Type I fibers provide endurance and maintain urethral closure, while type II fibers generate strength during activities that increase intra-abdominal pressure. Pelvic floor contractions support continence, inhibit detrusor overactivity, and are influenced by body posture and lumbopelvic alignment.⁽⁶⁻⁸⁾ A combined effect of rotational alignment between segments and the cumulative effect of foot hyper pronation on pelvic tilt revealed that only the shank significantly affected pelvic alignment, acting as a mediator between a foot and a thigh with the thigh having a crude significant effect on the pelvis⁽⁹⁾

Objectives:

- To evaluate the effects of wearing shoes with different heel heights on pelvic floor muscle function using population-based questionnaire research.

METHODOLOGY

Study Design: A cross-sectional study was conducted to assess the association between high-heel usage and pelvic floor dysfunction among healthy women.

Study Population and Setting: Healthy women residing in Surat city were recruited from diverse occupational settings, including the fashion and retail industry, corporate offices, hotels, modeling and event agencies, and educational institutions (universities and colleges).

Sampling Method and Sample Size: A non-probability sampling technique was employed, and a total of 429 participants were enrolled over a study duration of October 2024 to April 2025.

Inclusion Criteria: Women aged 18–35 years who wore high-heeled shoes for 6–8 hours daily⁽³⁾, with a minimum of one year of cumulative usage (including walking, standing, and sitting), were included.

Exclusion Criteria: Participants with a limp, history of pelvic surgery, diabetes mellitus, history of urinary incontinence, pregnancy, or cognitive impairment were excluded.

Tools and Materials: Data were collected using a consent form, a structured record sheet, and the Urogenital Distress Inventory-6 (UDI-6), a validated 6-item questionnaire assessing irritation, stress, and obstructive/voiding symptoms. Each item is scored from 0 (No) to 4 (Quite a bit); the total score is calculated as (sum of item scores × 6.25). A UDI-6 score ≥ 33.33 indicates significant distress attributable to urinary incontinence.

Procedure: Eligible participants were identified per inclusion/exclusion criteria and provided informed consent. Each participant completed the UDI-6 questionnaire, alongside demographic and footwear-use data. Participants were subsequently stratified into three groups based on heel height (<3 cm, 3–5 cm, 5–7 cm) for comparative analysis.

Ethical clearance was obtained from the Institutional Ethics Committee of The Sarvajani College of Physiotherapy before initiating participant recruitment and data collection.

STATISTICAL ANALYSIS AND RESULTS

Group Descriptive Statistics: Table 1 presents the descriptive statistics (mean, standard deviation, and standard error) for each urinary/pelvic symptom item of the UDI-6 questionnaire, stratified by the three heel-height groups (<3 cm, 3–5 cm, and 5–7 cm), with 143 participants in each group. Across all six symptom domains, the 5–7 cm heel-height group consistently reported the highest mean scores, while the 3–5 cm group showed the lowest mean scores. The <3 cm group displayed values comparable to the 3–5 cm group.

One-Way ANOVA (Welch's): Welch's one-way ANOVA was used to compare group means owing to unequal variances across groups. Table 2 summarizes the results for each symptom domain. Statistically significant differences ($p < .001$) were observed across the three groups for all six symptom domains, confirming that heel height is meaningfully associated with variation in urinary and pelvic floor symptom severity. Regression Model Coefficients (Reference Group: 3–5 cm). Multiple regression models were constructed for each symptom domain using the 3–5 cm heel-height group as the reference category. Table 3 summarizes the estimated coefficients, standard errors, t-values, and p-values for each comparison. Across every symptom domain, wearing 5–7 cm heels were associated with a statistically significant increase in symptom severity relative to the 3–5 cm reference group (all $p < .001$). In contrast, no significant difference was observed between the <3 cm group and the 3–5 cm reference group for any outcome (all $p > .70$), indicating that lower and moderate heel heights produced comparable urogenital symptom profiles.

Women wearing 5–7 cm heels demonstrated significantly higher scores across all six UDI-6 symptom domains — frequent urination, urgency-related leakage, activity-related leakage, small-volume leakage, difficulty urinating, and pelvic pain/discomfort — compared to women wearing 3–5 cm or <3 cm heels (all $p < .001$). The 3–5 cm heel-height group consistently showed the lowest symptom scores, suggesting a potential protective range for pelvic floor function. No statistically significant difference was found between the <3 cm and 3–5 cm groups for any symptom, indicating that heel heights up to 5 cm do not adversely affect pelvic floor function to the same degree as 5–7 cm heels.

DISCUSSION

This population-based study of 429 women in Surat provides robust statistical evidence that heel height is significantly associated with pelvic floor function, as measured across all six domains of the UDI-6 questionnaire. Rather than a simple linear dose-response relationship, our data reveal a distinct U-shaped pattern: women wearing 3–5 cm heels consistently reported the lowest symptom burden, women in the <3 cm group showed comparable outcomes, and women wearing 5–7 cm heels showed markedly and consistently worse symptoms across every measured domain. Many young women prefer to wear high-heeled shoes in their daily life with the change of aesthetics, they want to look taller and more fashionable.

Table 1. Descriptive statistics of UDI-6 symptom scores across heel-height groups

Symptom (UDI-6 Item)	Heel Height Group	N	Mean	SD	SE
Frequent urination	3–5 cm	143	0.587	0.754	0.0630
	5–7 cm	143	0.951	0.883	0.0738
	< 3 cm	143	0.622	0.829	0.0693
Urine leakage related to urgency	3–5 cm	143	0.175	0.494	0.0413
	5–7 cm	143	0.734	0.927	0.0775
	< 3 cm	143	0.161	0.469	0.0393
Urine leakage related to physical activity	3–5 cm	143	0.168	0.489	0.0409
	5–7 cm	143	0.706	0.918	0.0768
	< 3 cm	143	0.161	0.539	0.0451
Small amounts of urine leakage (drops)	3–5 cm	143	0.245	0.547	0.0457
	5–7 cm	143	0.713	0.844	0.0706
	< 3 cm	143	0.266	0.569	0.0475
Difficulty emptying bladder / difficulty urinating	3–5 cm	143	0.154	0.433	0.0362
	5–7 cm	143	0.622	0.887	0.0741
	< 3 cm	143	0.140	0.484	0.0404
Pain or discomfort in lower abdominal/pelvic/genital area	3–5 cm	143	0.210	0.487	0.0407
	5–7 cm	143	0.874	1.040	0.0870
	< 3 cm	143	0.238	0.556	0.0465

Table 2. Welch's one-way ANOVA results comparing symptom scores across heel-height groups

Symptom (UDI-6 Item)	F	df1	df2	p-value
Frequent urination	7.98	2	283	< .001
Urine leakage related to urgency	23.55	2	270	< .001
Urine leakage related to physical activity	21.49	2	271	< .001
Small amounts of urine leakage (drops)	17.32	2	276	< .001
Difficulty emptying bladder / difficulty urinating	18.10	2	269	< .001
Pain or discomfort in pelvic/abdominal area	25.03	2	268	< .001

Table 3. Summary of regression coefficients for all UDI-6 symptom outcomes (reference group: 3–5 cm heel height)

Outcome / Predictor	Estimate	SE	t	p-value
Frequent urination — Intercept	0.5874	0.0689	8.530	< .001
5–7 cm vs 3–5 cm	0.3636	0.0974	3.734	< .001
< 3 cm vs 3–5 cm	0.0350	0.0974	0.359	0.720
Urgency-related leakage — Intercept	0.1748	0.0555	3.148	0.002
5–7 cm vs 3–5 cm	0.5594	0.0785	7.124	< .001
< 3 cm vs 3–5 cm	-0.0140	0.0785	-0.178	0.859
Physical activity leakage — Intercept	0.1678	0.0566	2.967	0.003
5–7 cm vs 3–5 cm	0.5385	0.0800	6.731	< .001
< 3 cm vs 3–5 cm	-0.0070	0.0800	-0.087	0.930
Small-volume leakage (drops) — Intercept	0.1880	0.0530	3.546	< .001
5–7 cm vs 3–5 cm	0.2863	0.0780	3.669	< .001
< 3 cm vs 3–5 cm	0.0233	0.0742	0.315	0.753
Activity-related leakage (covariate)	0.3384	0.0449	7.532	< .001
Difficulty urinating — Intercept	0.1538	0.0530	2.900	0.004
5–7 cm vs 3–5 cm	0.4685	0.0750	6.245	< .001
< 3 cm vs 3–5 cm	-0.0140	0.0750	-0.186	0.852
Pelvic/abdominal pain or discomfort — Intercept	0.2098	0.0616	3.404	< .001
5–7 cm vs 3–5 cm	0.6643	0.0872	7.623	< .001
< 3 cm vs 3–5 cm	0.0280	0.0872	0.321	0.748

However, the use of high-heeled shoes with excessive emphasis on design or fashion may increase the risk of falls and various musculoskeletal disorders and deformities.⁽¹⁰⁾

⁽¹¹⁾The high-heeled shoes also affect the rotational motion of the ankle complex during walking⁽¹²⁾. The position of the ankle is associated with the pelvis inclination and PFM activation⁽¹³⁾. The relationship between high heel wearing and the PFM activity has not been fully studied.

Statistical findings and their clinical significance:

Descriptive statistics showed that across all six UDI-6 items — frequent urination, urgency-related leakage, activity-related leakage, small-volume leakage, difficulty urinating, and pelvic pain/discomfort — the 5–7 cm heel group had the highest mean scores, while the 3–5 cm group had the lowest. Welch's one-way ANOVA confirmed these differences were highly significant across all domains (all $p < .001$), indicating that

heel-height group membership meaningfully explains variance in symptom severity even after accounting for unequal variances between groups. Regression modeling using the 3–5 cm group as the reference category clarified the direction and magnitude of these effects. Women wearing 5–7 cm heels had significantly elevated symptom scores relative to the reference group across all outcomes, with the largest effect observed for pelvic/abdominal pain or discomfort ($\beta = 0.664$, $p < .001$) and urgency-related leakage ($\beta = 0.559$, $p < .001$), followed by activity-related leakage ($\beta = 0.539$, $p < .001$), difficulty urinating ($\beta = 0.469$, $p < .001$), small-volume leakage ($\beta = 0.286$, $p < .001$), and frequent urination ($\beta = 0.364$, $p < .001$). By contrast, the <3 cm group did not differ significantly from the 3–5 cm reference group on any outcome (all $p > .70$), indicating that low heel heights do not confer any additional protective or harmful effect beyond what is seen with

moderate heels. Together, these findings support a threshold model in which pelvic floor symptom risk rises sharply only once heel height exceeds approximately 5 cm, rather than increasing proportionally with any heel elevation. Wearing heeled shoes with a 3–5 cm heel height and ≥ 3 cm thickness for a long period of time is good for the pelvic floor function of women.⁽¹⁴⁾ PFM function is a key contributor to urinary continence and pelvic organ support⁽⁵⁾. The PFMs are made up of 70% slow-twitch (type I) and 30% fast-twitch (type II) fibers⁽⁶⁾. The PFM is mainly composed of type I muscle fibers, which are responsible for maintaining the constant muscle tone needed to close the urogenital hiatus⁽¹⁵⁾. The type II fibers fatigue faster than the type I fibers but are mainly responsible for PFM strength and power to prevent urinary leakage during sudden actions⁽¹⁶⁾. PFMs have been shown to contribute importantly to urethral closure at rest and to the increase in intraabdominal pressure during strain (e.g. sneezing or exercise)⁽¹⁷⁾.

Biomechanical interpretation: One significant aspect affecting PFM activity is the pelvic tilt angle brought on by the shift in ankle mobility^(18, 19). The ankle experiences unstable plantar flexion when wearing heeled shoes, which could lead to increased PFM activity when standing. The pelvis tilts more posteriorly when wearing high-heeled shoes, resulting in a compensatory posture with gluteal contraction⁽²⁰⁾. It implies that PFM contraction in active ankle positions causes the thigh, leg, back, and abdominal muscles to be used simultaneously to maintain posture. Rehabilitation methods should take into account the significance of co-activating the pelvic floor and abdominal muscles in PFD.

These statistical patterns are consistent with, and help explain, existing biomechanical literature. Wearing heeled shoes with a 3–5 cm heel height and ≥ 3 cm heel thickness has previously been associated with favorable pelvic floor function when used over prolonged period. Chen and Huang demonstrated that specific standing postures involving varied ankle positioning facilitate pelvic floor muscle (PFM) activity through enhanced pelvic tilt, and proposed ankle positioning as an adjunct to PFM training for stress urinary incontinence (SUI).⁽²¹⁾ This offers a plausible mechanism for our finding that moderate heel height was protective: a 3–5 cm heel may induce a degree of ankle plantarflexion and pelvic tilt that optimally engages the pelvic floor musculature, without the excessive biomechanical strain seen at greater heights. Conversely, Kannan *et al.* found that Pelvic floor muscle is most effective when performed with the ankle in a neutral or dorsiflexed position, and cautioned that the pronounced plantarflexion required by high heels may reduce pelvic floor support and increase leakage during activity⁽¹³⁾. This aligns closely with our regression findings, in which the 5–7 cm group showed the largest, most statistically robust increases specifically in activity-related leakage and urgency-related leakage — symptoms directly linked to dynamic pelvic floor support during movement. Neli j Cronin review highlights that both acute and chronic use of high-heeled shoes affects balance and locomotion in young, healthy women. High heels alter postural stability, gait mechanics, and neuromuscular control, suggesting the need for appropriate footwear recommendations and preventive rehabilitation strategies⁽²²⁾. Pelvic floor muscle training is an effective, evidence-based treatment for stress urinary incontinence, improving muscle function, reducing urinary leakage, and promoting beneficial adaptations in

dynamic pelvic floor anatomy and overall continence mechanisms⁽²³⁾.

Balancing risk with autonomy: While our findings support caution regarding heels of 5–7 cm, they should not be interpreted as a blanket contraindication to heeled footwear. High heels carry recognized aesthetic, psychological, and psychosexual value, and evidence indicates that any counseling on their risks — including musculoskeletal effects — should preserve women's autonomy and freedom of choice. Complementing our findings, longitudinal data show that persistent use of high, narrow-heeled shoes during early adulthood is associated with increased risk of knee or hip osteoarthritis,⁽²⁴⁾ reinforcing that cumulative harm appears concentrated at higher, narrower heel profiles rather than at moderate heel use generally.

Implications for pelvic floor muscle and clinical practice: Since Pelvic floor muscle remains an effective, evidence-based treatment for stress urinary incontinence and produces measurable changes in dynamic pelvic floor anatomy,⁽²⁵⁾ our findings suggest that footwear counseling — recommending heel heights in the 3–5 cm range with adequate thickness, and cautioning against prolonged use of heels ≥ 5 cm — could serve as a practical, low-cost adjunct to standard Pelvic floor muscle protocols, particularly for women with pre-existing urinary symptoms or stress urinary incontinence.

Limitations: As a cross-sectional study, causal inference is limited, and heel-height exposure was likely self-reported. Duration of wear, cumulative exposure, BMI, parity, and occupational standing time were not fully controlled for and may confound the observed associations. Prospective, biomechanically instrumented studies are needed to confirm causality and refine the optimal heel-height range identified here.

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