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PREVALENCE OF PRONATED AND SUPINATED FOOT TYPE AMONG OVERWEIGHT AND OBESE INDIVIDUALS AND ITS ASSOCIATION WITH HEEL PAIN

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ABSTRACT

Background: Overweight and obesity increase mechanical stress on the foot and are associated with musculoskeletal disorders such as chronic plantar heel pain (CPHP). Altered foot posture, particularly pronation, may further influence plantar pressure and pain. **Objective:** To determine the prevalence of pronated and supinated foot types among overweight and obese individuals and their association with heel pain. **Methods:** This observational study included 100 participants (aged 35-50 years) recruited from the Physiotherapy OPD of Khalsa University Amritsar. BMI was calculated from height and weight measurements. Foot posture was assessed using the Foot Posture Index (FPI-6) and pain using the Numeric Pain Rating Scale (NPRS). **Results:** The mean BMI was 29.12 ± 3.17 kg/m². Mean FPI scores were 6.04 ± 2.98 (left) and 6.75 ± 2.97 (right), indicating predominance of pronated foot posture. A significant correlation existed between left and right FPI scores ($p < 0.001$, $r = 0.910$). Obese individuals reported higher pain scores (5.00 ± 0.91) compared with overweight individuals (3.44 ± 2.17). Pronated foot type was more common in both overweight and obese groups. **Conclusion:** Higher BMI is associated with increased prevalence of pronated foot posture and greater heel pain, suggesting that excess body weight may influence foot biomechanics and contribute to CPHP.

KEYWORDS: Obesity, BMI, Foot Posture Index, Pronated Foot, Heel Pain.

INTRODUCTION

The global prevalence of overweight and obesity has increased substantially and represents a major public health concern. According to the World Health Organization, more than 1.5 billion adults were overweight in 2008 and over 500 million were obese, with projections estimating over 700 million obese individuals worldwide.[1,2] Obesity is associated with several health complications, including musculoskeletal disorders that impair mobility and physical function.[3,4]

Excess body weight increases mechanical stress on the foot and ankle, predisposing individuals to conditions such as plantar fasciitis, arthritis, bursitis, posterior tibial tendon dysfunction, and footwear-related problems.[4]. Overweight individuals also demonstrate gait alterations, including shorter step length, slower walking speed, increased step width, greater ankle dorsiflexion, reduced plantar flexion, increased Q-angle, and out-toeing. These changes may represent compensatory mechanisms to improve stability and accommodate increased thigh girth.[3]

Biomechanically, increased body mass requires greater muscle forces and joint moments, leading to higher metabolic energy expenditure during walking.[5] The feet, as the body's base of support, are exposed to elevated ground reaction forces, resulting in increased plantar pressure and potential damage to foot structures.[6]

Chronic plantar heel pain (CPHP) is a common foot disorder, accounting for approximately 15% of adult foot complaints requiring professional care.[7] It is most prevalent in individuals aged 40-60 years, although it can occur between 7 and 85 years, with a slightly higher prevalence in females.[8] The condition typically presents as pain under the medial heel during weight-bearing,

especially during the first steps in the morning or after periods of rest.[9]

CPHP is a broad clinical term encompassing several conditions such as subcalcaneal bursitis, neuritis, calcaneal spur, peripheral nerve entrapment, fat pad degeneration, and plantar fasciitis.[9] Approximately one in ten individuals may develop CPHP during their lifetime.[8] Among these, plantar fasciitis is the most common cause and is usually diagnosed clinically, although ultrasonography may assist in confirmation.[9]

The etiology of CPHP is multifactorial, involving both intrinsic and extrinsic risk factors. Intrinsic factors include increasing age, higher body weight and BMI, foot structure (pes planus or pes cavus), subtalar pronation, limb length discrepancy, reduced ankle dorsiflexion, tight Achilles tendon, muscle imbalance, increased plantar fascia thickness, and calcaneal spur.[10,11]

Extrinsic factors include prolonged weight-bearing, inappropriate footwear, previous injury, and running variables such as surface, speed, frequency, and distance.[11]

Overall, chronic plantar heel pain results from a complex interaction of biomechanical, anatomical, and lifestyle factors, often leading to limitations in daily and sporting activities.[12] Thus, the present study was planned with the objectives to determine the prevalence of pronated and supinated foot types among overweight and obese individuals and their association with heel pain.

MATERIALS AND METHODS

Participants of the Study

The present observational study was conducted on 100 participants (both male and female) aged 35-50 years using a convenience sampling technique from the OPD of the Department of Physiotherapy, Khalsa University, Amritsar. The sample size was calculated using G-Power software. The inclusion criteria were - pronated and supinated foot types, overweight and obese individuals, and individuals suffering from heel pain. The exclusion criteria were - spinal deformity, neurological disorders, talus or calcaneum fractures, cardiovascular diseases, and pregnancy.

Participants were informed about the purpose, objectives, and procedures of the study in understandable language, and voluntary informed consent was obtained prior to participation. The study was approved by the institutional ethics committee.

Procedures

Anthropometric Measurements

Height was measured during inspiration using a stadiometer to the nearest 0.1 cm, and body weight was measured using a digital weighing scale to the nearest 0.1 kg. Body mass index (BMI) was calculated using the formula:

BMI = weight (kg) / height² (m²).

Foot Posture Index (FPI)

The Foot Posture Index (FPI-6) was used to assess foot posture. It is a system for observing and rating static foot posture incorporating six criteria with the participant standing in a relaxed bipedal position. These criteria include: talar head palpation, curves above and below the lateral malleoli, frontal plane alignment of the calcaneus, prominence of the talonavicular joint, congruence of the medial longitudinal arch and abduction/adduction of the forefoot on the rearfoot. Each criterion is scored on a five-point scale ranging from −2 to +2, and the combined score ranges from −12 (highly supinated) to +12 (highly pronated).[13,14]

Numeric Pain Rating Scale (NPRS)

Pain intensity was assessed using the Numeric Pain Rating Scale (NPRS). This scale ranges from 0 to 10, where higher scores indicate greater pain severity.

Statistical Analysis

Statistical analysis was performed using SPSS version 15 for Windows. The following statistical methods were used: arithmetic mean, standard deviation, t-test and Pearson's Correlation Test.

RESULTS

Table 1 presents the descriptive statistics of the participants. The mean age was 42.80 ± 5.26 years. The mean weight and height were 76.60 ± 13.95 kg and 159.21 ± 10.50 cm, respectively. The mean BMI was 29.12 ± 3.17 kg/m², indicating that most participants were in the overweight to obese category.

The mean Foot Posture Index (FPI-6) score was 6.04 ± 2.98 for the left foot and 6.75 ± 2.97 for the right foot, suggesting a tendency toward pronated foot posture. The mean Numeric Pain Rating Scale (NPRS) score was 3.90 ± 2.01, indicating mild to moderate heel pain among the participants.

Table 2 presents the correlation between the Foot Posture Index (FPI) scores of the left and right feet. The mean FPI score for the left foot was 6.04 ± 2.98, while for the right foot it was 6.69 ± 3.07. A strong positive correlation was observed between the FPI scores of both feet ($r = 0.910$, $p < 0.001$), indicating a statistically significant and highly consistent bilateral foot posture pattern among the participants.

Table 1: Descriptive statistics of the various demographic variables of the participants.

Variables	N	Mean	S.D.
Age (year)	100	42.80	5.26
Weight (kg)	100	76.60	13.95
Height (cm)	100	159.21	10.50
BMI (kg/m^2)	100	29.12	3.17
Left FPI	100	6.04	2.98
Right FPI	100	6.75	2.97
NPRS	100	3.90	2.01

Table 2: Presentation of foot posture index (FPI) in relation with the left and the right foot.

Variables	N	Mean FPI	SD	r-value	p-value
Left foot	100	6.04	2.98	0.910	<0.001
Right foot	100	6.69	3.07		

Correlation is significant at level $p<0.001$

Table 3: Presentation of numeric pain rating scale (NPRS) in relation with overweight and obese individuals.

Variables	N	Mean	S.D.	p-value	r-value
Overweight	68	3.44	2.17	<0.001	0.093
Obese	32	5	0.91		

Table 3 presents the comparison of NPRS scores between overweight and obese individuals. The mean NPRS score in overweight participants (n = 68) was 3.44 ± 2.17, whereas obese participants (n = 32) showed a higher mean score of 5.00 ± 0.91. The difference was statistically significant ($p < 0.001$), indicating greater heel pain among obese individuals, although the correlation between BMI category and pain intensity was weak (r = 0.093).

Table 4 presents the distribution of supinated foot posture among overweight individuals. In the left foot (n = 8), the mean Foot Posture Index (FPI) score was −1, while in the right foot (n = 7) the mean FPI score was also −1, indicating a mild degree of supination. The relatively small number of cases suggests that supinated foot posture was less prevalent among overweight participants compared with other foot types.

Table 5 presents the Foot Posture Index (FPI) scores for pronated feet among overweight individuals. In the left foot (n = 30), the mean FPI score was 8.16 ± 1.34, while in the right foot (n = 45) it was 7.71 ± 1.14. The results were statistically significant ($p < 0.001$) for both feet, indicating a notable prevalence of pronated foot posture among overweight participants.

Table 6 presents the Foot Posture Index (FPI) scores for pronated feet among obese individuals. The mean FPI score for the left foot (n = 39) was 7.30 ± 1.32, while the right foot (n = 30) showed a higher mean value of 8.63 ± 1.33. The results were statistically significant ($p < 0.001$), indicating a strong prevalence of pronated foot posture in obese participants, particularly in the right foot.

Table 7 presents the distribution of foot posture types among overweight and obese individuals. Among overweight participants, 76 exhibited pronated feet, 15 showed supinated feet, and 37 had neutral foot posture. In contrast, among obese individuals, 69 demonstrated pronated feet, none showed supination, and 3 had neutral foot posture, indicating a marked predominance of pronated foot type in the obese group.

Table 4: Presentation of supinated foot in left and right foot in overweight individuals.

Variables	n	Mean FPI
Left foot	8	-1
Right foot	7	-1

Table 5: Presentation of pronated foot in the left and right feet of overweight individuals.

Variables	n	Mean FPI	S.D.	p-value
Left	30	8.16	1.34	<0.001
Right	45	7.71	1.14	<0.001

Correlation is significant at level p<0.001.

Table 6: Presentation of pronated foot in left and right foot of obese individuals.

Variables	n	Mean FPI	S.D.	p-value
Left	39	7.30	1.32	<0.001
Right	30	8.63	1.33	<0.001

Correlation is significant at level p<0.001.

Table 7: Presentation of pronated, supinated and neutral foot in overweight and obese individuals.

	Pronation	Supination	Neutral
Overweight	76	15	37
Obese	69	0	3

DISCUSSION

The present study investigated the association between body mass index (BMI), foot posture, and chronic plantar heel pain (CPHP). It remains unclear whether increased BMI existed before the onset of CPHP or whether pain led to reduced physical activity and subsequent weight gain.[15,16] However, several studies indicate that higher BMI may act as a significant risk factor for plantar heel pain because overweight individuals experience greater vertical forces under the heel during gait.[10]

The findings of the present study indicated that overweight and obese individuals aged 35–50 years experienced increased plantar heel pain, with a positive correlation between BMI and pain intensity. A positive association between pronated foot posture and increased BMI was also observed. These findings are consistent with previous studies reporting a relationship between higher BMI and plantar heel pain in non-athletic populations.[17,18]

Biomechanically, obesity alters plantar pressure distribution across the foot. Previous research has shown that obese individuals exhibit significantly higher plantar pressures under the heel, midfoot, and metatarsal regions during standing and walking compared with non-obese individuals.[6] Increased adiposity results in greater loading on the foot, which may lead to soft-tissue damage and musculoskeletal pain in the lower extremity.[19,20,21]

Plantar heel pain is typically characterized by tenderness at the calcaneal tuberosity near the plantar fascia attachment.[9] Several studies have reported increased body weight as a major contributing factor for plantar heel pain.[10]

Musculoskeletal pain may alter gait patterns as individuals attempt to reduce discomfort. Chronic musculoskeletal pain is common among obese individuals, and weight reduction has been reported to improve symptoms and functional mobility.[22]

Foot posture also plays an important role in plantar loading patterns. Research indicates that pronated or flatter feet are associated with altered plantar pressure distribution, including increased medial loading and reduced lateral pressure.[23,16]

Excessive subtalar eversion may increase strain on the plantar aponeurosis, affecting the normal windlass mechanism of the foot and contributing to plantar heel pain.[17]

Foot arch characteristics are also important predictors of heel pain. Both flat feet and high arches have been identified as potential risk factors affecting plantar fascia stress and foot mechanics.[18]

The Foot Posture Index (FPI-6) used in this study has demonstrated good reliability and validity for assessing static foot posture in clinical and research settings.[19]

Overall, the findings support existing evidence that increased BMI, altered plantar pressure distribution, and pronated foot posture may contribute to the development of chronic plantar heel pain. Increased physical activity such as prolonged standing, running, or stair climbing may further aggravate symptoms.[24,25]

The limitations of the present study include a relatively small sample size, restriction of participants to the 35–50-year age group, absence of specific pathological classification of heel pain, and lack of assessment of foot dominance, which may influence plantar loading patterns.

CONCLUSIONS

The findings of the present study indicate that foot pronation is associated with obesity. Individuals with increased body weight tend to demonstrate a higher prevalence of pronated foot posture. As body weight increases, the mechanical load placed on the foot also increases, which may contribute to alterations in foot alignment and an increased likelihood of developing a pronated foot type. The study also revealed a positive correlation between obesity and heel pain. This suggests that individuals with higher body weight are more likely to experience greater intensity or frequency of heel pain. Increased body mass leads to higher plantar pressure and loading on the heel during weight-bearing activities, which may contribute to the development or aggravation of heel pain.

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