

Association between Body Mass Index and Foot Posture Alignment in Nursing Professionals

Chetali Sanghani¹, Isha Shripad²

¹BPT, D. Y. Patil Deemed to be University, School of Physiotherapy, Nerul, Navi Mumbai, Maharashtra, India
Email id: sanghanichetali@gmail.com

²Assistant Professor, D. Y. Patil Deemed to be University, School of Physiotherapy, Nerul, Navi Mumbai, Maharashtra, India.
Corresponding author Email: isha.shripad@dypatil.edu

Abstract: *This study examines the correlation between body mass index BMI and foot posture index FPI among nursing professionals, highlighting the prevalent issue of work - related musculoskeletal disorders in the nursing field. Nurses, who are essential in providing holistic care across the health continuum, often face physical challenges due to prolonged periods of standing and patient handling tasks, leading to conditions such as low back pain, varicose veins, and foot problems. Through a cross - sectional study involving 69 participants, the research investigates the impact of BMI on the foot posture, utilizing the Foot Posture Index scale for evaluation. The findings reveal a moderate significant association between BMI and FPI, indicating that nurses with higher BMI are more prone to developing pronated foot posture, which can further contribute to musculoskeletal discomfort and injuries. The study underscores the importance of considering BMI in the rehabilitation management of lower extremity injuries and suggests the implementation of preventive strategies, such as the use of orthotics and ergonomic measures, to mitigate the risk of foot malalignment and its consequent health implications.*

Keywords: Nursing professionals, body mass index BMI, foot posture index FPI, musculoskeletal disorders, pronated foot posture

1. Introduction

Nursing is a profession within the healthcare sector focused on the care of individuals, families, and communities so they may attain, maintain, or recover optimal health and quality of life. [1] Nurses collaborate with other healthcare providers such as physicians, nurse practitioners, physical therapists, and psychologists. The aim of the nursing community worldwide is for professional nurses to ensure quality care for all, while maintaining their credentials, code of ethics, standards, and competencies. [2] Nurses care for individuals of all ages and backgrounds along the wellness continuum in a holistic manner based on the individual's physical, emotional, psychological, intellectual, social, and spiritual needs. The profession combines physical science, social science, nursing theory, and technology in caring for individuals and communities. Nursing as a profession is very high in demand due to the amount of hospitals being built and the increasing amount of patients.

Nursing as a profession requires long hours of standing, they have tremendous amount of pressure especially in the ICUs. Owing to this nurses suffer from work related musculoskeletal disorders like osteoporosis. The top three injured parts of the body by annual prevalence among nurses are the lower back, neck and shoulder. The nursing profession is one of the most risky occupations for low back pain. The primary cause for MSDs in nursing is patient handling tasks such as lifting, transferring, and repositioning of patients. A manual handling operation in hospitals means moving or supporting a load by a person's hands or arms, or by some other form of body effort. Among the different types of work tasks of hospital staff, patient handling is the most important risk factor for low - back pain and a higher number of daily patient transfers increases the risk of a back injury [3] Nurses have one of the highest rates of back and other musculoskeletal injury of all occupations. Back injuries are most frequent, with annual prevalence ranging from 30% to 60%, along with neck (about 40%) and shoulder injuries

(about 47%). The percentage of nurses who reported ever changing jobs for a neck, shoulder or back MSD was 6%–11%, respectively. 43% participants had pronated foot, 14% participants had highly pronated foot, 16% participants had supinated foot. [4] Handling patients may cause not only LBP, but also neck, shoulder, and arm pain, as it potentially exerts an excessive burden on the neck, shoulders, and arms [5]. Especially patient handling tasks that involve reaching, pushing, and pulling can lead to neck and shoulder pain in nurses [6].

Prolonged standing leads to various foot and ankle problems including flat foot. This leads to more stress on the bottom of their feet, and standing for long hours is only going to make the pain worse. All these conditions can arise from or get aggravated by standing for extended periods. It can also lead to circulatory problems in the legs and lead to pain, varicose, and swelling of the legs. Temporary discomfort in the legs and feet and stiff joints may occur and lead to degenerative damage of the joints. Foot posture (high or low arch) influences the lower limb and can contribute to injuries [7]. Pronated feet could contribute to low back pain, degenerative joint disease [8], hallux abductor - valgus [9], general lower limb pain [10, 11] patellar tendinitis, and foot pain [12, 13]. A supinated foot type has a positive correlation with ankle sprains and iliotibial band syndrome [14]. The foot posture index is considered a novel, valuable and reliable diagnostic clinical tool to quantify positional variations of the foot. The FPI measures foot posture in three planes and two anatomical segments and take into consideration six assessment criteria. Foot posture alignment deviations, including pronation and supination, may be evaluated using the FPI [15]

The number of individuals with excessive body weight is rapidly increasing in many countries. In terms of global burden of disease, more than one - third of all adults are currently overweight or obese. [16] Body adiposity has been consistently linked to a greater risk of musculoskeletal pain and injury in the general population. Moreover, a higher BMI

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has profound effects on soft - tissue structures, such as tendons, fascia and cartilage. Obesity is considered a predictor of postural stability, and a high BMI is an important risk factor for geriatric falls [17]. In addition, the negative consequences of a higher BMI extend well beyond physiological aspects; obese individuals are less efficient and at greater risk for injury than normal - weight individuals in a large number of work - related tasks and daily activities that involve upright standing positions. [18]. Such abnormalities associated with increased BMI may influence the foot posture index (FPI).

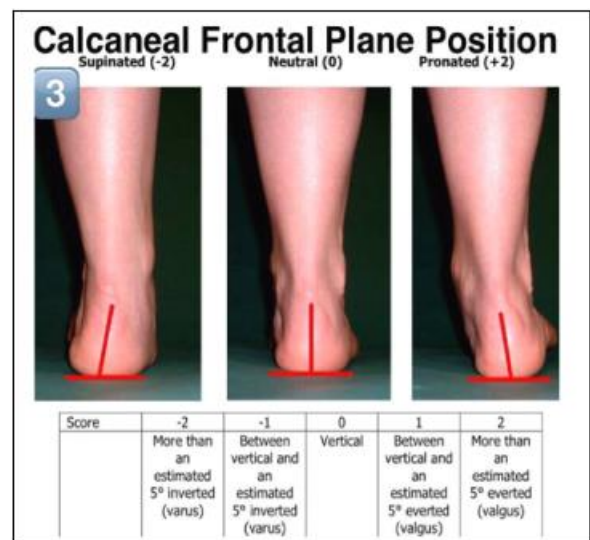
Higher BMI has profound effects on soft tissue structures such as tendons, fascia and cartilage. Relationship between Increasing body mass index and foot posture index is that excess body weight leads to greater mechanical loading of the foot. Body weight has been to be significantly associated with elevated loading of the foot particularly the forefoot and the mid foot which suggests that obesity increases the stresses applied to the foot directly via increased body weight and indirectly via alterations to the foot structure that is a relatively pronated foot. This could lead to various musculoskeletal conditions like plantar fasciitis or heel, knee pain etc. Since body mass index is a major factor responsible in weight bearing distribution, the study was conducted to find whether there is an association between body mass index and foot posture in nursing professionals.

2. Methodology

This study was a cross sectional study. Ethical approval was obtained from the ethics approval committee of the Institute. The sampling method used was purposive sampling. Participants were recruited based on inclusion and exclusion criteria. The inclusion criteria was both males and females nursing professionals working in a hospital set up, aged between 22 - 55 years, with minimum of 5 years of experience with working hours between 10 to 12 hours a day. Individuals

with any previous history of lower limb fracture, recent acute injury (in the past 3 months), history of any neurological condition which might affect the foot posture, previous history of nerve injury and history of spine and abdominal surgery were excluded from the study. A total of 69 participants were recruited in the study.

After the screening of the participants, written informed consent was taken from the participants. Demographic data including name, age, gender, height, weight, BMI (Asian scale classification), work experience, duration of work/day were noted in the case evaluation form. Evaluation: Patient was asked to sit on the chair. The Foot Posture Index scale was explained to the participants. The participants were asked to mark the most appropriate answer to best of their knowledge. Based on the answers given by the participants, the rearfoot and forefoot score was noted and the participants were categorized as having normal foot posture, pronated foot or supinated foot posture.



Outcome measure 1: Foot Posture Index scale

	- 2	- 1	0	+1	+2
Talar head palpation	Talar head palpable on lateral side/but not on medial side	Talar head palpable on lateral/slightly palpable on medial side	Talar head equally palpable on lateral and medial side	Talar head slightly palpable on lateral side/palpable on medial side	Talar head not palpable on lateral side/but palpable on medial side
Supra and infra lateral malleoli curvature (viewed from behind)	Curve below the malleolus either straight or convex	Curve below the malleolus concave, but flatter/more than the curve above the malleolus	Both infra and supra malleolar curves roughly equal	Curve below the malleolus more concave than curve above malleolus	Curve below the malleolus markedly more concave than curve above malleolus
Calcaneal frontal plane position (viewed from behind)	More than an estimated 5° inverted (varus)	Between vertical and an estimated 5° inverted (varus)	Vertical	Between vertical and an estimated 5° everted (valgus)	More than an estimated 5° everted (valgus)
Prominence in region of TNJ (viewed at an angle from inside)	Area of TNJ markedly concave	Area of TNJ slightly, but definitely concave	Area of TNJ flat	Area of TNJ bulging slightly	Area of TNJ bulging markedly
Congruence of medial longitudinal arch (viewed from inside)	Arch high and acutely angled towards the posterior end of the medial arch	Arch moderately high and slightly acute posteriorly	Arch height normal and concentrically curved	Arch lowered with some flattening in the central position	Arch very low with severe flattening in the central portion - arch making ground contact
Abduction/adduction of forefoot on rearfoot (view from behind)	No lateral toes visible. Medial toes clearly visible.	Medial toes clearly more visible than lateral	Medial and lateral toes equally visible	Lateral toes clearly more visible than medial	No medial toes visible. Lateral toes clearly visible.

Scores between:

0 and + 5 indicate normal feet,

+ 6 to + 9 indicate pronated feet,

≥ + 10 indicate highly pronated feet,

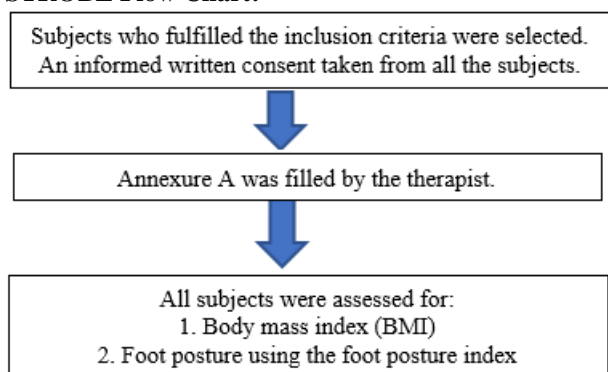
- 1 to - 4 indicate supinated feet,

- 5 to - 12 indicate highly supinated feet

Outcome measure 2: Body Mass Index (Asian Scale Classification)

Nutritional status	BMI (kg/m ²)
Underweight	<18.5
Normal	18.5 - 22.9
Overweight	≥23
At Risk	23 - 24.99
Obese I	25 - 29.99
Obese II	≥30

STROBE Flow Chart:



3. Results

The analysis was carried out using SPSS 26 software. The correlations between the variables BMI and FPI were assessed using Crosstabulation and Chi - Square Analysis.

Sixty - eight subjects were recruited for the study in which the subjects had a mean age, height and weight of 38.08±7.67 years, 2.33±0.22cms and 61.55±11.84kgs respectively. The demographic details are present in table 1.

Table 1: Demographic data of the participants

	Age	Weight	Height
N= 68	38.08±7.67	61.55±11.84	2.33±0.22

Table 2: Association of BMI with FPI using contingency table

Variables	Normal foot posture	Pronated foot posture
BMI > 22.9	10	6
BMI < 23	3	49

In this cross tabulation, we found out that 49 nurses were overweight with pronated foot followed by 10 nurses having a normal BMI and normal foot. There were 6 nurses with normal BMI having a pronated foot and 3 overweight nurses with normal foot posture.

Table 3: Chi - Square Analysis

	X ²	df	p - value
Pearson Chi - Square	25.466	1	<0.001

Pearson’s Chi - square analysis was used to find an association of BMI with Foot Posture Index. There was a statistically significant association between BMI and FPI with $\alpha = 25.466$, degree of freedom as 1 and p value < 0.001. The strength of association shows moderate significance between the BMI and foot posture index with Phi 0.612 with p < 0.001 and Cramer’s value 0.612 with p < 0.001.

4. Discussion

This study investigated how the FPI was affected by an overweight BMI. Our results suggested that the FPI is affected by an increased BMI. These results showed that pronated and flatter feet were more common in obese men and women (Aurichio et al., 2011). In fact, according to Wearing et al. (2012), obesity is thought to have an aberrant effect on the structure of the foot.

Nurses who were assessed in the present study and worked in various ICU settings were more likely to have pronated feet because of prolonged standing and being overweight. While working in a hospital, body weight is supported by concrete surfaces such as hospital floors and concrete steps, which do not provide much shock absorption. We discovered a link between BMI and foot posture. Overweight nurses were shown to be more prone to pronated foot positions. In terms of global burden of disease, more than one - third of all adults are currently overweight or obese. [16] Body adiposity has been consistently linked to a greater risk of musculoskeletal pain and injury in the general population. In addition, the negative consequences of a higher BMI extend well beyond physiological aspects; obese individuals are less efficient and at greater risk for injury than normal - weight individuals in a large number of work - related tasks and daily activities that involve upright standing positions. Such abnormalities associated with increased BMI may influence the foot posture index (FPI).

The statistical test performed was the Chi - square analysis was performed on nominal data. In this analysis out of 68 nurses 28% of the nurses have normal BMI and 72% of the nurses are overweight. Out of the nurses with normal BMI 63% nurses have normal foot and 36% of the nurses have pronated foot. Out the overweight nurses 2% of the nurses have normal foot and 98% of the nurses have pronated foot. Out of all the data 17.65% of the nurses with normal BMI have normal foot.10.29% of nurses with normal BMI have pronated foot, 1.47% of overweight nurses have normal foot and 70.59% overweight nurses have pronated foot. The above data shows the alpha value as 25.466, degree of freedom as 1 and p value as <0.001. Thus, this association shows moderate significance between the BMI and foot posture index.

Body weight has been found to be significantly associated with elevated loading of the foot, particularly the forefoot and midfoot, which suggests that obesity increases the stresses applied to the foot directly via increased body weight and indirectly via alterations to the foot structure, i. e., a relatively pronated foot posture. [9] Body adiposity has been consistently linked to a greater risk of musculoskeletal pain and injury in the general population [19], and emerging evidence suggests that even modest increases in body mass index (BMI) are sufficient to induce musculoskeletal pain and

difficulties in ambulation. [20] Nursing as a profession requires long hours of standing, they have tremendous amount of pressure especially in the ICUs. Owing to this nurses suffer from work related musculoskeletal disorders like osteoporosis. Prolonged standing leads to various foot and ankle problems including flat foot. This leads to more stress on the bottom of their feet, and standing for long hours is only going to make the pain worse. All these conditions can arise from or get aggravated by standing for extended periods. It can also lead to circulatory problems in the legs and lead to pain, varicose, and swelling of the legs. Temporary discomfort in the legs and feet and stiff joints may occur and lead to degenerative damage of the joints. Foot posture (high or low arch) influences the lower limb and can contribute to injuries. [7]

A study was conducted by Sami S. AlAbdulwahab in which the authors found that there is a significant correlation between BMI and both the FPI. A total of 39 healthy adult subjects with a mean age of 24.3 ± 6.4 years and over - weight BMI values between 25 and 29.9 kg/m² participated in this study. Foot biomechanics were analysed using the FPI. The Spearman correlation coefficient indicated a significant correlation between BMI and both the FPI and core stability. The study concluded that an overweight BMI influences foot posture alignment and body stability. [21] A study was conducted by Thaís Rabiatti Aurichio, in which the authors found the postural characteristics of the feet of older people and their relationship with the BMI. They evaluated 227 older women and 172 older men with respect to the BMI, the arch index (AI) and the foot posture index (FPI). The obese women presented mean values for the AI significantly greater than those of the normal and overweight women. The means for some of the criteria of the FPI were significantly higher in the obese men. There was a positive correlation between the BMI and the AI and some of the FPI criteria. The conclusion was that obese women presented flatter feet while obese men presented more pronated feet, indicating a relationship between high BMI values and postural characteristics of the feet of subjects studied. [22] A study was conducted by Paul A Butterworth in which the authors found out that there were sixty - eight participants, including 47 females (69%), who underwent assessments of body mass index, foot pain and foot structure. Plantar pressures were also obtained, using a floor - mounted resistive sensor mat system. Multiple regression analysis was used to determine which variables were most strongly associated with plantar loading patterns. Obese individuals exhibited flatter feet, reduced inversion - eversion range of motion, and higher peak plantar pressures when walking. After accounting for foot structure and walking speed, bodyweight was found to be significantly associated with elevated loading of the foot, particularly the forefoot and midfoot. These findings suggest that obesity increases the stresses applied to the foot directly, via increased bodyweight, and indirectly, via alterations to foot structure, which may partly explain the link between obesity and the development of foot pain. Clinicians dealing with foot problems should consider the effect of increased bodyweight on plantar loading in obese patients. [23]

A study was conducted by Alyssa B Dufour in which the authors included 2445 men and women (4888 feet) from the Framingham Foot Study (2002 - 2008). A foot examination

assessed presence of disorders and pain on each foot. Body mass index (BMI, kg/m²) was assessed. Foot posture (normal, cavus, planus) and dynamic foot function (normal, supinated, pronated) were defined using plantar pressure measurement system. The results stated that average age was 68 ± 11 years, 56% female, average BMI 28 ± 5 kg/m². 18% of feet had pain, 25% hallux valgus, 2% claw toes, 18% hammer toes, 7% overlapping toes. In men, severe - obesity was associated with foot pain and claw toes. In women, overweight, moderate - obesity and severe - obesity were associated with foot pain. Both men and women were at increased odds of foot pain as BMI increased. Data suggested foot posture and dynamic foot function had no effect, thus are unlikely mechanisms. [8] A study conducted by Aditi R. Sawant in which the authors assessed 159 nurses from various Intensive Care Units. The Foot Posture Index, a validated tool for assessing foot posture was used to assess foot deviations in nurses. The result stated that in total 159 participants were evaluated, with 6 (4%) being males and 153 (96%) being females. The mean age of the participants was (Mean=40.67) and standard deviation (SD=9.6). Prevalence percentage of foot posture deviations were found to be bilateral as demonstrated by Foot Posture Index. Out of 159 participants 43% participants had pronated foot, 14% participants had highly pronated foot, 16% participants had supinated foot, 7% had normal highly supinated foot posture and 20% participants had normal foot. Pronated foot posture was the most common foot deviation. Moreover, when BMI was compared with the pronated foot deviation, there was a positive association between pronated foot and the nurses who were overweight. [24] Our study findings are in agreement with the above literature.

Pronated feet could contribute to low back pain, degenerative joint disease [8], hallux abducto - valgus [9], general lower limb pain [10, 11] patellar tendinitis, and foot pain [12, 13]. Consequently, BMI should be considered during rehabilitation management for lower extremity injuries and body balance.

5. Conclusion

There is a moderate significant association between the body mass index and the foot posture in the nursing professionals.

6. Limitations

A larger and diverse sample size can be considered to replicate the study results. More factors could be taken into consideration for foot posture alignment along with BMI. e. g. core stability, joint flexibility, ligament laxity, age etc.

7. Clinical implications

With the above understanding and factors in the study preventive strategies and measures can be taken to combat the problem. External appliances such as orthotics, ergonomic rest intervals can be proven helpful to reduce the incidence of foot malalignment.

8. Future Scope of the study

Different population case control study can be done. Intervention to be given and progression to be seen.

The authors report there are no competing interests to declare.

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