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An Observational Study on the Association of Foot Posture Index and Categorised BMI Among Young Female Adults Aged Between 18-24 Years

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ABSTRACT

Background: Foot position plays a crucial role in various aspects of posture, gait, athletic performance and even daily life activities among every individual. Previous research suggests variation in foot posture may be associated with body composition. However, the association of foot posture and categorized BMI among young female adults is still unclear.
Objective: This study aims to explore the association between Foot Posture Index (FPI) and categorized BMI among young female adults aged between 18-24 years.
Methodology: Based on the inclusion and exclusion criteria, 50 female college going students aged between 18-24 were included in this study. BMI was calculated with weight in kilogram and height in meter square. The foot posture was evaluated using Foot Posture Index (FPI-6) criteria as an outcome measure with subject in standing position, meanwhile the subjects were instructed to position the upper limbs along the trunk with eyes directed forward, without any movement such as inclinations and rotations that could interfere with the measurement.
Results: Inferential statistics had been carried out in the study by using Fisher's exact test. Level of significance was set at 5%. The Fisher's exact test result showed that there is no significant association (P>0.05) between FPI and categorized BMI.
Conclusion: The study concluded that there is no significant association between Foot Posture and categorized BMI among young female adults aged between 18-24 years.

Keywords: BMI, Foot, Foot Posture Index, Pronation, Young Females, Foot Posture, Foot Position.

INTRODUCTION

The human foot is a fascinating mechanism made to support body weight, provide stability, absorb shock during movement, and to promote effective locomotion.[1,2] The position of foot greatly influences posture, gait, athletic performance and even daily life activities.[3] The foot's alignment in neutral position promotes possible performance of the arches. The risk of numerous foot and lower limb disorders like overpronation or supination is lower when the foot is in neutral position because the arches are adequately supported.[4,5,6]

Pronated feet are often associated with decreased postural stability.[7] The altered alignment can lead to instability, ankle sprains and falls. In high arches, or supinated feet, foot posture can also lead to instability, particularly during activities like standing or walking which means postural stability is affected by foot type and static and dynamic conditions.[8]

An individual's capacity to maintain balance and stability can be significantly impacted by even little alterations to the foot's support surface, arch structure, alignment.[9] The Foot Posture Index (FPI) is a validated clinical tool used to assess foot posture in a static stance, providing insights into pronation, supination and neutral alignment. Foot posture which refers to the alignment and structural characteristics of the foot varies among individuals and is influenced by multiple factors, including genetic predisposition, physical activity, musculoskeletal alignment and body weight distribution.[10]

The ratio of a person's weight to his square of height is calculated by the BMI to determine obesity. Body Mass Index (BMI) is a widely accepted measure for categorizing individuals based on their weight relative to height.[11] It is commonly used to classify individuals into underweight, normal weight, overweight. Moving from normal weight to overweight and obese categories causes the influence of BMI on foot health to become more evident.[12] Excess body weight places increased pressure on the feet, especially the arches and heels and can cause conditions like plantar fasciitis, flat feet (pes planus), diabetic neuropathy, osteoarthritis.[13,14,15] Higher BMI often leads to changes in gait patterns.[16]

Young female adults, particularly those in the age group of 18-24 years, represent a critical population for studying the association between BMI and foot posture. This age group is characterized by significant physical activity levels, lifestyle changes and variations in body composition and musculoskeletal development which may influence foot biomechanics.[17]

Despite existing literature on foot posture and BMI, there remains a gap in research focusing specifically on young female adults. Most studies have either examined broader age groups or included both genders, potentially overlooking gender specific variations in foot biomechanics. Given the anatomical and physiological difference between males and females, it is essential to investigate how BMI influences foot posture in young women to develop targeted interventions and recommendations for foot care.

MATERIALS & METHODS

Study Design & Setting: This observational study was carried out in Mangalore, Karnataka, over an eight-month period from March to November 2023.

Study Participants and Sampling: The study recruited 100 subjects and included 50 subjects after the screening. Current study's inclusion criteria target individuals aged between 18 to 25 years, encompassing only female population. The exclusion criteria were on the following factors those who recently underwent any foot surgery in the past 6 months, those recently had any fracture or dislocation of the foot, females with limb length discrepancy, any neuromuscular disorders, Pregnant women and females with pain or any inflammation over right foot.

Data Collection Tool and Technique: In this study, informed consent was obtained from all participants prior to data collection. The height and weight of the participants were checked to calculate the BMI and Foot posture was analyzed using Foot Posture Index (FPI). The study aimed to explore the association between Foot Posture Index (FPI) and categorized BMI among young female adults aged between 18-24 years.

Outcome Measures: a) BMI is a widely used measure to classify individuals based on their weight relative to height. Height and weight of subjects were collected and BMI was calculated using the formula:

BMI= Weight (kg) / Height (m)^2. Following which the subjects were categorised as underweight, normal, overweight, obese (class 1), obese (class 2) and extreme obese based on the BMI values.[18]

b) Foot posture of subjects was analysed using Foot Posture Index (FPI) with subjects in standing position with their feet relaxed and bearing body weight evenly. All subjects were instructed to position the upper limbs along the trunk with their eyes directed forward, without any movement such as inclinations and rotations that could interfere with the measurement. FPI-6 scale criteria was used to quantify the foot posture. The FPI criteria has six anatomical criteria including talar head palpation, curves above and below malleoli, calcaneal inversion or eversion, talonavicular congruence, medial arch height, and forefoot abduction and adduction were examined. The FPI was interpreted on following criteria as normal, pronated, highly pronated, supinated and highly supinated.[19]

STATISTICAL ANALYSIS

Data was analyzed using SPSS 23.0 software with a sample size of 50. Descriptive statistics were calculated and summarized as frequency and percentage. Inferential statistics had been carried out in the study by using Fisher's exact test and the level of significance was set at 5%.

RESULT

The study analyzed the association between Foot Posture Index (FPI) and categorized Body Mass Index (BMI) among young female adults aged 18–24 years. The demographic characteristics of the participants (n=50) indicated a mean age of 21.24 ± 1.3 years, mean height of 156.84 ± 7.10 cm, mean weight of 52.58 ± 13.11 kg, and mean BMI of 21.23 ± 4.60 kg/m² (Table 1).

Variable	**Mean ± SD (n=50)**
Age (Years)	21.24 ± 1.3
Height (cm)	156.84 ± 7.10
Weight (Kg)	52.58 ± 13.11
BMI (Kg/m^2)	21.23 ± 4.60

Table 1: Demographic Characteristics of the study.

The Fisher's exact test was conducted to evaluate the relationship between BMI classifications (underweight, normal weight, overweight, and obesity) and FPI categories (normal and pronated). Among participants, 55% in the normal FPI group had a normal BMI, whereas 40% in the pronated FPI group had a normal BMI. 33% of underweight individuals exhibited normal FPI, while 30% had pronated posture. 8% of obese individuals showed normal FPI, whereas 10% displayed pronation. The statistical analysis produced a p-value of 0.404, indicating no significant association between BMI and FPI (Table 2, Fig. 2).

		FPI		**Total**	**p value**
		NORMAL	**PRONATE**		
BMI	Under weight	13	3	16	
		33%	30%	32%	
	Normal	22	4	26	
		55%	40%	52%	0.404
	Over weight	2	2	4	
		5%	20%	8%	
	Obesity (class 1)	3	1	4	
		8%	10%	8%	
Total		40	10	50	
		100%	100%	100%	

Table 2: Fisher`s exact test of Association between BMI and Foot Posture Index (FPI)

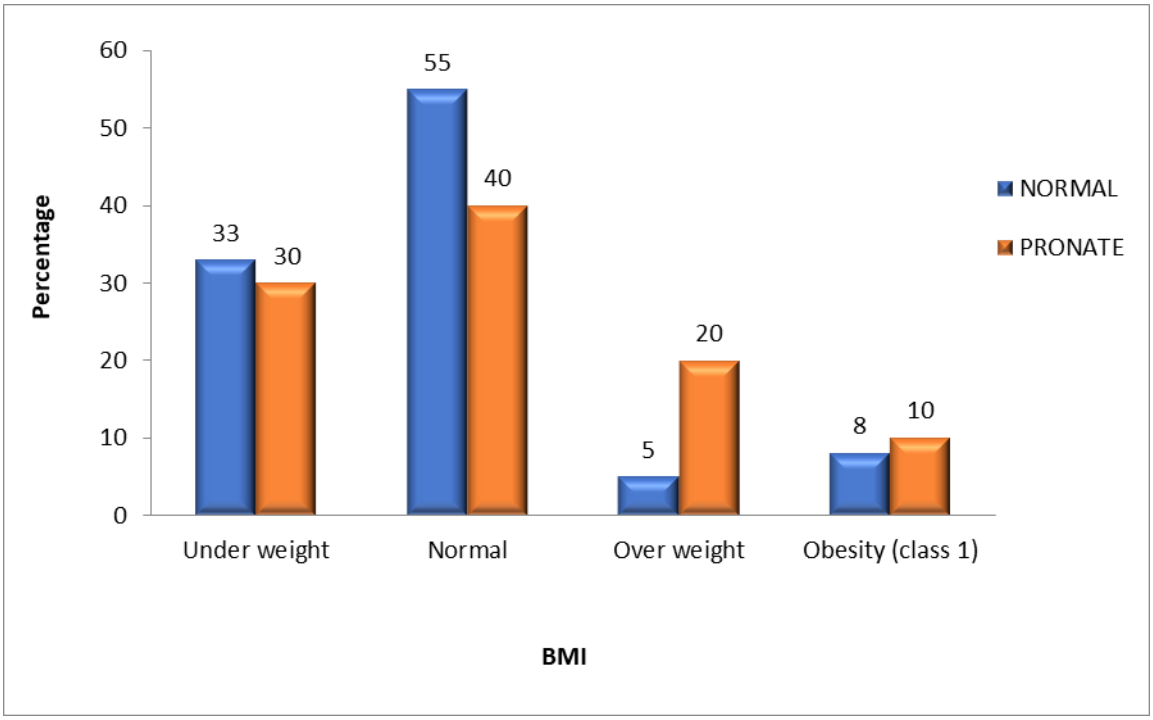

Figure 1: Percentage distribution of subjects on the basis of BMI in normal and pronated FPI

DISCUSSION

The results of our study indicate that there is no significant correlation between Foot Posture Index (FPI) and Body Mass Index (BMI) among young female adults aged 18–24 years. This finding supports the growing body of evidence suggesting that foot posture is influenced by multiple factors beyond BMI.

Our study categorized participants based on BMI classifications and found that the majority exhibited normal foot posture, regardless of BMI status. Although some participants showed pronated foot posture, the distribution was relatively uniform across BMI groups, indicating that increased body mass alone may not contribute to alterations in foot posture. This is consistent with findings from Fayaz R. Khan et al. who reported that FPI-6 had no significant correlation with BMI, age, ankle flexibility, or whole-body flexibility. Their results suggest that biomechanical adaptations in foot structure are multifactorial and not solely driven by weight.[20]

Additionally, Gravante et al. examined the role of obesity in plantar pressure distribution and postural stability. While they found that obese individuals exhibited greater plantar contact areas and pressures, their study did not identify significant shifts in the centre of pressure, implying that excess weight does not directly influence postural changes of the foot.[21]

Similarly, Park et al. observed that obese individuals experienced increased plantar pressures and reduced medial longitudinal arch height. However, their study emphasized that foot biomechanics are influenced by a combination of anatomical and functional factors, such as plantar fascia thickness, ankle joint range of motion, and muscle strength.[22]

A potential explanation for the lack of correlation between BMI and foot posture in our study is the presence of compensatory mechanisms within the musculoskeletal system. Individuals with higher BMI may exhibit adaptations in lower limb strength, joint mobility, and neuromuscular control, which could help maintain normal foot posture despite increased body mass. Furthermore, lifestyle factors, such as physical activity levels and footwear choices, may play a critical role in determining foot posture and stability.

The findings of our study have important implications for practitioners working in

biomechanics, physiotherapy, and podiatry. While BMI has been widely considered as a factor influencing foot posture, our results highlight that clinical assessments should incorporate a broader range of variables. Evaluating plantar pressures, muscle strength, joint flexibility, and gait biomechanics may provide a more comprehensive understanding of foot posture abnormalities.

For individuals with higher BMI, interventions focusing on improving lower limb strength, enhancing mobility, and optimizing footwear support may be more beneficial than solely addressing weight-related concerns. This approach aligns with previous research suggesting that functional characteristics, rather than weight alone, contribute to foot biomechanics.

Despite its insights, our study has certain limitations that must be addressed in future research. The relatively small sample size and unequal distribution across BMI categories may have influenced the findings. A larger and more diverse participant pool including balanced representation across BMI classifications would enhance the reliability of future studies.

Additionally, our study was limited to female participants, which may restrict the generalizability of the results. Future research should explore gender differences in foot posture and BMI associations, as previous studies have identified potential sex-related variations in musculoskeletal adaptations. Furthermore, incorporating dynamic assessments, such as gait analysis and pressure mapping, would provide deeper insights into the biomechanics of foot posture in different BMI groups.

CONCLUSION

The results of this study indicate that there is no significant correlation between the Foot Posture Index and BMI categorization among young female adults aged 18-24 years. Among the 50 subjects examined, BMI alone was not a reliable predictor of foot posture. These findings highlight that foot structure is influenced by multiple factors beyond BMI, reinforcing the idea that a comprehensive approach is necessary when assessing foot posture. While BMI remains a valuable tool for evaluating an individual's overall fitness, it does not solely determine foot positioning.

Declaration by Authors

Ethical Approval: Approved

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