International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Co-Relation of Body Mass Index with Foot Posture Index Scale amongst Adolescent Population of Mumbai

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Abstract: ***Background: There is a diversity of person with their diverse body composition. Majority changes in body composition occurs in adolescent with the changes in the body composition along with the feet during adolescent stage. The Foot Posture Index (FPI-6) stands out from other foot type classification methods as valid, reliable, and multidimensional this scale was used to assessed the posture of the foot. The purpose of this study was to correlate the BMI with the FPI-6 scale. Aim and Objective: To find out Co-relation of Body mass index with foot posture index scale amongst adolescent population of Mumbai. Methods: This is a co-relation study that involves participation of adolescents between the age group of 13-19 years. The body composition was assessed by measuring height and weight and BMI was calculated. Foot posture was assessed using the Foot Posture Index Scale-6. The data collected was then analysed and statistics was carried out using IBM SPSS statistics version 29.0.2.0. Results: There is a weak positive correlation of BMI with both right and left feet (p-value=0.603, p-value=0.569) respectively. Conclusion: The study concludes that the feet in this study were classified as normal with a tendency to pronation, particularly in the adolescent with the higher BMI.***

Keywords: Posture, BMI, Feet, Adolescent

1. Introduction

Globe, where we meet diverse kinds of person with their diverse personality, behaviour along with this each and every person has contrasting type of body composition. Majority changes in body composition occurs in adolescent due to genetics, hormonal changes other factors also play a vital role in it. It is widely accepted that increase in obesity results from an imbalance between energy intake and expenditure increased fast food consumption has also been linked with obesity in the recent years [2]. Overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health.

The body composition can be assess by Body mass index (BMI) it is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. According to WHO Body mass index (BMI) is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m2).

Classification of body mass index:
Underweight-18.5 kg/m2
Normal-18.5-24.9 kg/m2 Overweight->25 kg/m2

Obesity and underweight is associated with a number of musculoskeletal conditions such as osteoarthritis, low back pain, gait disturbances, osteoporosis, soft tissue complaints, and is responsible for impaired quality of life. [3] A meta-analysis that was done to examine the relationship between body mass index and the risk of knee osteoarthritis showed obesity as a robust risk factor for knee OA. [3] Weight bearing subtalar pronation is accomplished by the coupled movements of eversion of the calcaneus and plantarflexion and adduction of the head of the talus.

Study done on older adults showed that in comparison to non-obese individuals, obese individuals showed flatter feet, reduced inversion-eversion range of motion and higher peak plantar pressures while walking; bodyweight was found to be associated with elevated loading of foot. [3] To prevent such condition from occurring we use FPI-6 scale to detect any change in the foot structure due to body composition. There are several methodologies for assessment. Among them, we highlight the Foot Posture Index (FPI-6) for being valid and reliable and for allowing a multidimensional assessment in all planes of movement. [4] Also, it gives foot specific outcome measure that was developed in order to quantify variation in the position of the foot easily and quickly in a clinical setting. [4]

FPI-6 has six items that are used to quantify and to classify foot posture. [4]
The six clinical criteria employed in the FPI – 6 are:

- Talar head palpation
- Supra and infra lateral malleolar curvature
- Calcaneal inversion/eversion
- Prominence in the region of the talonavicular joint
- Congruence of the medial longitudinal arch
- Abduction / Adduction of the forefoot

Aim:
To find out Co-relation of Body mass index with foot posture index scale amongst adolescent population of Mumbai.

Objectives:
To assess the posture of foot by using FPI-6 scale in adolescent. To assess the body composition by using body mass index (BMI). To co-relate body composition and posture of the foot.

2. Methods

Type of Study-Correlation study
Study Setting-School and higher secondary college premise of Mumbai
Study Population-age group between 13-19 years **Sampling Method**-Convenience sampling **Sample Size** – 214
Sample size calculation-calculated using open Epi version 3, with 90% confidence level

Inclusion Criteria

1) Participants between the age of 13-19 years
2) Both Male and female
3) Participants willing to participate in the study

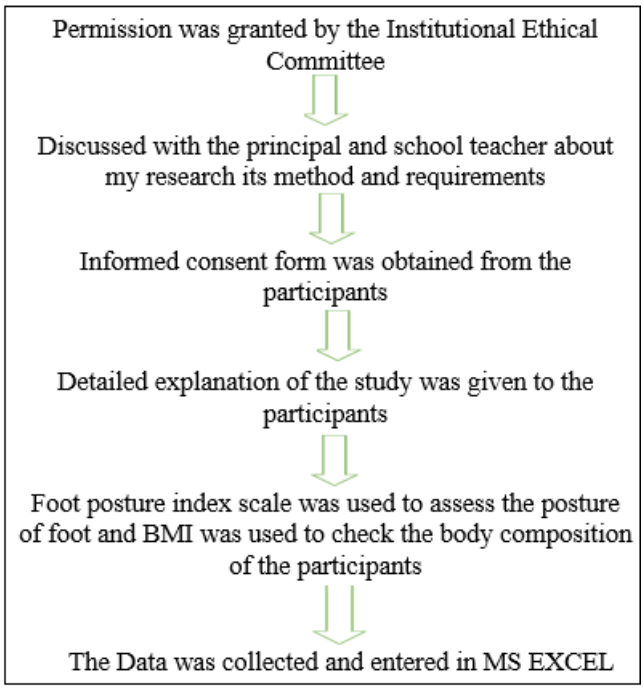
Exclusion Criteria

1) Participates with neurological, musculoskeletal disabilities
2) History of trauma or injury to the lower extremity in the past year affecting activities of daily living
3) Any individual suffering from cognitive defects and not able to perform the study

Materials Used

1) Pen/Pencil
2) Weighing Machine
3) Measuring Scale
4) Foot Posture Index Scale 6

Methodology



Assessment of foot posture:

The body composition was assessed by measuring height and weight and BMI was calculated. Foot posture was assessed using the Foot Posture Index.

The participant was told to stand in their relaxed stance position with double limb support. The participant was instructed to stand still with their arms by the side and looking straight ahead. Below mentioned criteria was checked and scoring was done.

The six clinical criteria employed in the FPI – 6 are:

1) Talar head palpation
2) Supra and infra lateral malleolar curvature
3) Calcaneal inversion/eversion
4) Bulging in the region of the talonavicular joint
5) Congruence of the medial longitudinal arch
6) Abduction / Adduction of the forefoot

3. Result

Data was collected and entered in MS EXCEL.

Basic descriptive statistics like Mean and standard deviation of the test performed and was analysed in MS EXCEL. Data was tested for normality.

The Data was not normally distributed for right foot and for the left foot so spearman's Correlation Test was performed.

IBM SPSS statistics version 29.0.2.0 was used for Correlation Test. The Study was conducted on 214 adolescent.

Table 1: Mean And Standard Deviation of Variables

Variables	Mean	Standard deviation
Age (years)	16.4439	2.26302
Weight (kg)	50.5631	12.0384
Height (cm)	157.388	9.38604
BMI	20.36308	4.84038
FPI Right	1.48131	2.01103
FPI Left	1.82243	2.41402

Table 2: Frequency and Percentage of participants in the Underweight, Normal, Overweight Category

BMI	Frequency	Percentage
Normal	100	46.72%
Underweight	82	38.31%
Overweight	32	14.96%

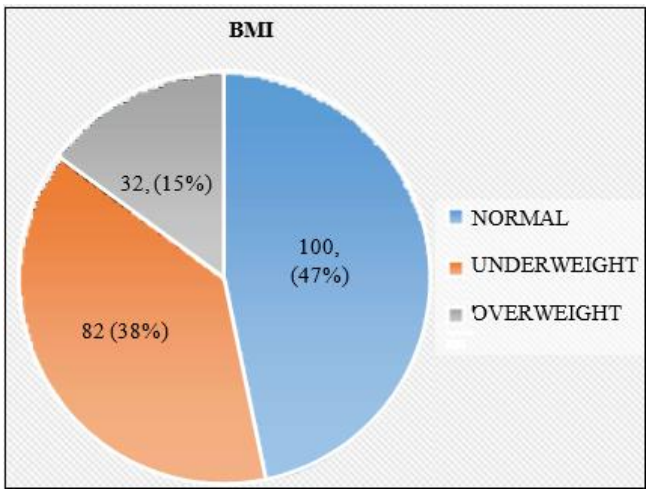


Figure 1: BMI

Inference: Pie chart showing 100 individual (46.72%) with normal BMI, 82 individual (38.31%) were underweight and 32 individual (14.96 %) were overweight.

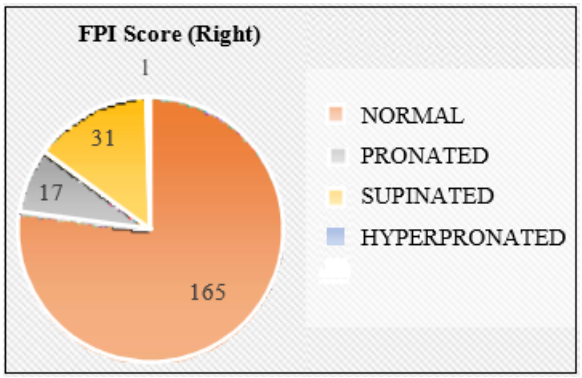


Figure 2: FPI Score (Right)

Inference: Pie Chart Showing Values Of Right Foot In Normal, Pronated, Supinated And Highly Pronated Foot.165 individual with Normal FPI Score, 31 individual with Supinated, 17 individual with Pronated, 1 individual with Highly pronated foot.

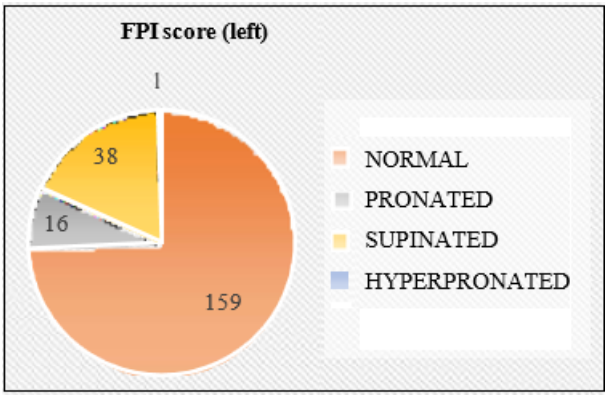


Figure 3: FPI Score (Left)

Inference: Pie chart showing values of Left foot in Normal, Pronated, Supinated and Highly pronated foot.159 individual with Normal FPI Score, 38 individual Supinated, 16 individual Pronated, 1 individual Highly pronated foot.

Table 3: Test of Normality

TESTS OF NORMALITY						
	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
FPIRIGHT	0.137	216	0.000	0.974	216	0.001
FPILEFT	0.124	216	0.000	0.980	216	0.003
a. Lilliefors Significance Correction						

Inference: Shapiro-Wilk Normality test was performed to correlate BMI and FPI-6 Scale score and the Normality was found to be 0.001 (right) and 0.003 (left) which is < 0.05 hence **Spearman's correlation test** was used.

Statistical Analysis: Spearman's Correlation Test:

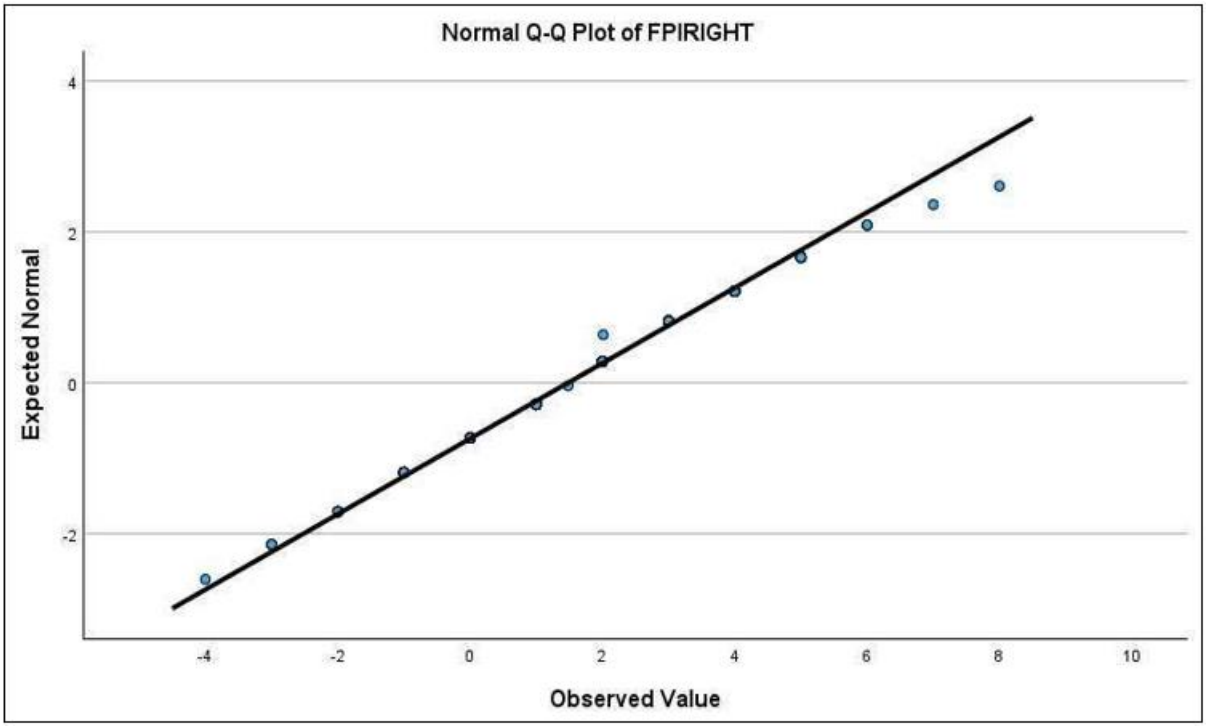
Table 4

Correlations				
			BMI	FPIRIGHT
Spearman's rho	BMI	Correlation Coefficient	1.000	0.036
		Sig. (2-tailed)		0.603
		N	214	214
	FPIRIGHT	Correlation Coefficient	0.036	1.000
		Sig. (2-tailed)	0.603	
		N	214	216

Table 5

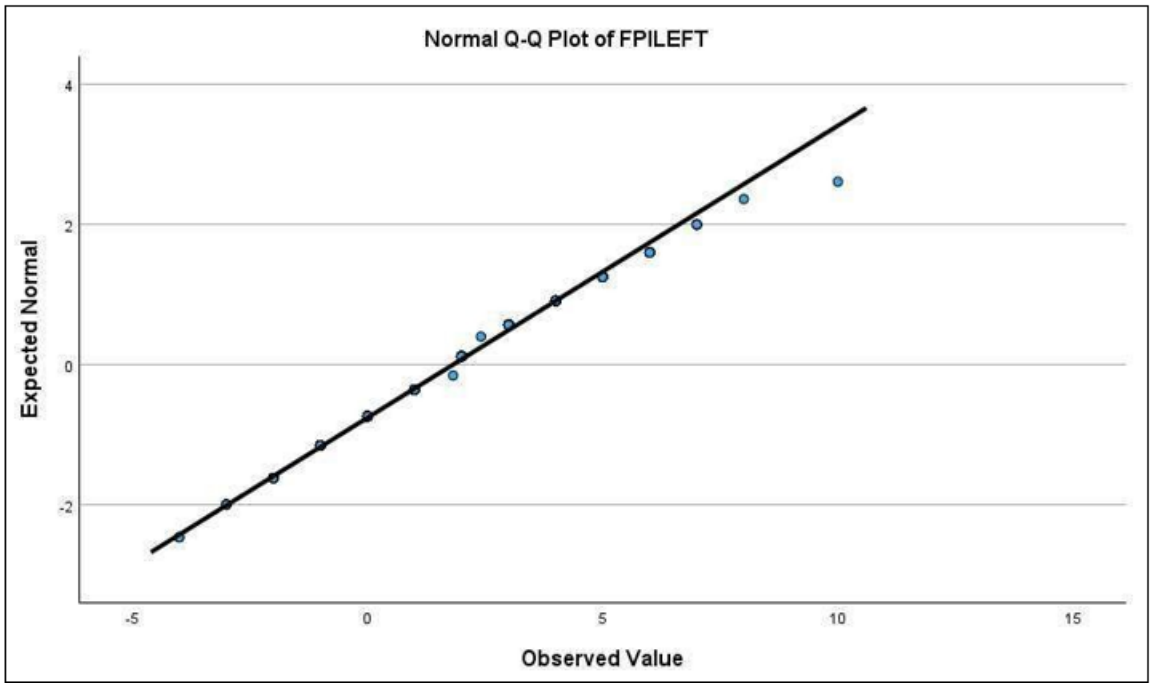
Correlations				
			BMI	FPILEFT
Spearman's rho	BMI	Correlation Coefficient	1.000	0.039
		Sig. (2-tailed)		0.569
		N	214	214
	FPILEFT	Correlation Coefficient	0.039	1.000
		Sig. (2-tailed)	0.569	
		N	214	221

Inference: As shown in Table 4, the correlation coefficient for the right foot was found to be (r=0.036) which indicates a very weak positive correlation between BMI and FPI-6 As shown in Table 5, the correlation coefficient for the left foot was found to be (r=0.039) which indicates a **very weak positive correlation** between BMI and FPI-6.



Graph 1

Inference: As shown in the above graph, there is a weak positive correlation of BMI and FPI score of right feet



Graph 2

Inference: As shown in the above graph, there is a weak positive correlation of BMI and FPI score of left feet.

4. Discussion

The aim of this study was to check correlation between BMI and FPI-6 Scale score.

A total of 214 adolescent population participated in this study. The body composition of the participants was first calculated by calculating the weight and height of the individual and the foot posture was analysed using the foot posture index scale. [3].

The statistical data was not normally distributed and data analysis revealed very weak positive correlation between BMI and FPI (right) with the coefficient of correlation being 0.036 and as seen in Table 4 and also a very weak positive correlation between BMI and FPI (left) with the coefficient of correlation being 0.039 as seen in Table 5.

According to current study the mean BMI noted was 20.36 + 4.84 kg/m2 and we have found FPI Score of majority of participants was Normal, with some degree of Supination, and few degree of Pronation which was seen particularly in overweight participants.

One of the possible explanation for this weak correlation can be the complex interplay of various factors influencing both BMI and foot posture. While BMI primarily reflects overall body composition and weight distribution, foot posture is influenced by biomechanical, genetic, and environmental factors.

The transitional nature of adolescence, marked by rapid growth and hormonal changes, could contribute to variations in foot development that are not exclusively linked to BMI. Hormonal fluctuations during this period may impact musculoskeletal structures, affecting foot posture independently of body weight.

Additionally, the study shed light on the importance of considering lifestyle factors such as physical activity levels and footwear choices, which can influence both BMI and foot posture. It's considerable that adolescents with similar BMI values engage in different activities or wear different types of shoes, leading to variations in foot posture.

The study done by Mickle KJ and Munro BJ also shows similar results where 19 overweight and 19 non-overweight students were taken and the results showed overweight children displayed a significantly lower plantar arch height compared with that non-overweight children. [11]

Similarly this study also shows relation with a previous study done by Carvalho BK and Penha where 1394 adolescents from Amparo and Pedreira regions in São Paulo, Brazil were taken in the study and BMI, gender and FPI was analysed. The results showed the feet in this study were classified as normal, with a tendency to pronation, particularly in boys. [7].

The reason for the pronated feet in overweight participants is due to reduction in the arch of the foot due to increased body mass causing increased elevated loading of the foot. There is increasing amount of stresses applied to the foot directly via increased body weight and indirectly via alterations to the foot [3].

When the foot goes into Pronation-The primary joint involved in pronation is the subtalar joint, located between the talus

bone and the calcaneus (heel bone). Pronation at the subtalar joint involves a combination of eversion (outward turning) and dorsiflexion (upward movement).

When the foot goes into Supination-Supination at the subtalar joint involves a combination of inversion (inward turning) and plantarflexion (downward movement).

Thus the result of the present study is consistent with the above mentioned studies it can be concluded that body mass index is independent from the score of FPI-6 scale.

5. Conclusion

This study concluded that the BMI and FPI-6 score in adolescent population is weakly correlated which means that structure of foot is not dependent on BMI of individual.

6. Recommendation for Future Study

- The study can be conducted on larger population and with equal distribution of BMI.
- Can be correlated between different age group.

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