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A Study to Analyze the Relationship between Body Mass Index, Core Endurance and Flat Foot among College Students

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ABSTRACT

Background: Flat foot, a common deformity which is mostly asymptomatic in adults is characterized by collapse of longitudinal medial arch, abduction of the forefoot, internal rotation and calcaneal eversion. Core endurance and Body mass index are two important factors which affect the quality and performance of standing body balance and walking.
Aim: The aim of the study is to evaluate the relationship between Body Mass Index, Core endurance and Flat foot among college students.
Materials & Methods: 85 students (32 males and 53 females) were selected for the study according to the selection criteria. Body mass index was calculated using Body Mass Index formulae, Core Endurance was assessed using Mc Gill's core endurance test and Flat foot was assessed using Navicular Drop Test. The overall data was collected and taken for analysis.
Results: The Pearson Correlation Coefficient is used to measure the strength of a linear association between two variables. The relationship between the flat foot and body mass index was correlated with an 'r' value of 0.53. The relationship between the flat foot and trunk flexor and extensor core endurance was correlated with an 'r' value of 0.32 and 0.008.
Conclusion: There is a positive relationship between the flat foot and the body mass index, and also positive relationship between the flat foot and trunk flexor and extensor core endurance.

Keywords: *Body Mass Index, Core endurance, Flat foot, Navicular drop test, McGill's core endurance test.*

INTRODUCTION

College students are often perceived to have a privileged position in society and considered immune to ill health and disability. There is growing evidence that a sizeable proportion experience poor physical health and that the prevalence of musculoskeletal disorders is higher in the college students than the community peers.
Flat foot is a common deformity in adults characterized by collapse of longitudinal medial arch, abduction of the forefoot, internal rotation and calcaneal eversion, which has been thought to be a causative

factor for many of the lower limb injuries. Pes Planus, hyper mobile foot and pronated foot are the synonyms usually used to describe flat foot.

The prevalence of flat foot ranges from 12% to 14% in India and among college students was 20%.[1]

The instability resulting from a flat foot causes pathomechanical problems as well as compensatory changes in closed kinematic chain of the lower extremity. Researchers supported the presence of a distal to proximal kinematic chain in healthy adults, where induced flat feet led to immediate shank and thigh medial rotation, anterior pelvic tilting and increased lumbar lordosis as well as thoracic kyphosis. [2]

It is theorized that biomechanical foot disorders such as flat foot affect the entire lower extremity kinetic chain system and the spine causing low back pain. Also, the concept of "anatomy trains" suggested that any tension at a particular part of an "anatomy train" may result in detrimental effects on the other parts of the corresponding fascial line. Few evidences support that flatfoot has been associated with mechanical low back pain.

Core Endurance has been defined as "the body's ability to control the trunk in response to internal and external disturbances, including the forces generated from distal body segments as well as from expected or unexpected perturbations".[3]

Furthermore, preliminary evidence shows that Core endurance training reduces the injury rate. Core endurance can be evaluated from the perspective of maximum strength, power, or even the ability to maintain force overtime which is called strength-endurance. Body weight has been found to be significantly associated with elevated loading of the foot. Minor alterations in body composition may influence base support or core stabilization strategies.

Body adiposity has been consistently linked to a greater risk of musculoskeletal pain and injury in the general population[4] and emerging evidence suggests that even modest increase in body mass index are sufficient to induce musculoskeletal pain and difficulties in ambulation.[5] It is well known that both core endurance and the body mass index affect the quality and performance of standing body balance and walking.

The Foot postural alignment is considered a novel, valuable and reliable diagnostic clinical tool to quantify positional variations of the foot.

The Foot postural index plays an important role in determining the quality of standing activities, such as standing balance, walking and running. A previous study showed a strong relationship between foot arch type and injury risk; in particular, high and low foot arches were shown to increase the risk of musculoskeletal injuries.[6] Human foot biomechanics vary among healthy individuals and range from low to high arch foot types.[7]

Maintained excessive foot pronation during weight-bearing activities generates internal rotational stresses at the lower extremity, which may change patterns of movement and muscle balance at proximal joints. Bilateral flat foot causes more proximal lower limb dysfunctions, which cause altered lumbar pelvic hip stability. Understanding the connection between body mass index and flat foot, core endurance and flat foot is more important for diagnosing and preventing back pain and other lower limb injuries. Determining such a relationship is going to create an impact and modify the treatment methods for flat foot. Previous studies had investigated the correlation between body mass index and core endurance among firefighters and other study analyzed the correlation between body mass index and core endurance in healthy adults. The relationship between body mass index, core endurance and flat foot among college students is not yet analyzed and hence becomes the need for this study.

MATERIALS & METHODS

It is a Correlation study design. This study was conducted at KG College of

Physiotherapy, Coimbatore. A clear explanation was given about the study and a written consent was obtained from each subject. The study was conducted for the period of 6 months. 95 students were selected for the study according to the selection criteria and few students were withdrawn from study due to personal reasons. Finally study was completed with 85 students.

The subjects were included in this study based on the inclusion criteria (Students of KG College of Health sciences whose age ranging between 18-26 years, both males and females, Subjects with flexible flat foot with score ≥ 1 in Navicular drop test) and exclusion criteria (Subjects with congenital flat foot, Red flags for potential serious condition related to low back pain, abnormal resting blood pressure or heart rate, Subjects who receive treatment for any spinal injury, Subjects who have undergone any previous surgery, Malignancy, Subjects who are going to gym for physical fitness, Unwilling and uncooperative subjects).

The outcome measures were Body Mass Index, Core endurance and Flat foot. Body mass index was calculated with Body Mass Index formulae, Core Endurance was assessed using Mc Gill's core endurance test and Flat foot was assessed using Navicular Drop Test. The overall data was collected and taken for analysis.

RESULTS

The demographic characteristics of all subjects including their age and the values of body mass index, McGill's core endurance test and Navicular drop test are included in Table 1.

The correlation of body mass index with flat foot based on Pearson Correlation Coefficient was mentioned in Table 2. The r value was found to be 0.53 and there was a moderate positive linear correlation. The correlation of core endurance with flat foot based on Pearson Correlation Coefficient was mentioned in Table 3. The r value for flexor endurance was found to be 0.32 and 0.008 for extensor endurance. There was a mild positive linear correlation between the core endurance and flat foot. Figure 1 indicates the correlation of Body mass index with Flat foot. Figure 2 indicates the correlation of Flexor core endurance with flat foot and Figure 3 indicates the correlation of Extensor core endurance with flat foot.

Table 1: Baseline Characteristics of the College students

Subject Characteristics	Group A Mean ± Standard Deviation
Age (years)	21.46 ± 2.43
Body Mass Index	24.63 ± 4.29
Flexor Endurance Score	31.13 ± 11.03
Extensor Endurance Score	17.86 ± 8.32
Navicular Drop Test Score	1.14 ± 0.17

Table 2: Correlation of Body Mass Index with Flat foot

Correlation Variables	Mean ± Standard Deviation	'r' Value
Body Mass Index	24.63 ± 4.29	0.53
Flat Foot	1.14 ± 0.17	

Table 3: Correlation of Core Endurance with Flat foot

Correlation Variables	Mean ± Standard Deviation	'r' Value
Flexor Endurance	31.13 ± 11.03	0.32
Flat Foot	1.14 ± 0.17	
Extensor Endurance	17.86 ± 8.32	0.008
Flat Foot	1.14 ± 0.17	

Figure 1: Correlation of Body Mass Index with Flat foot

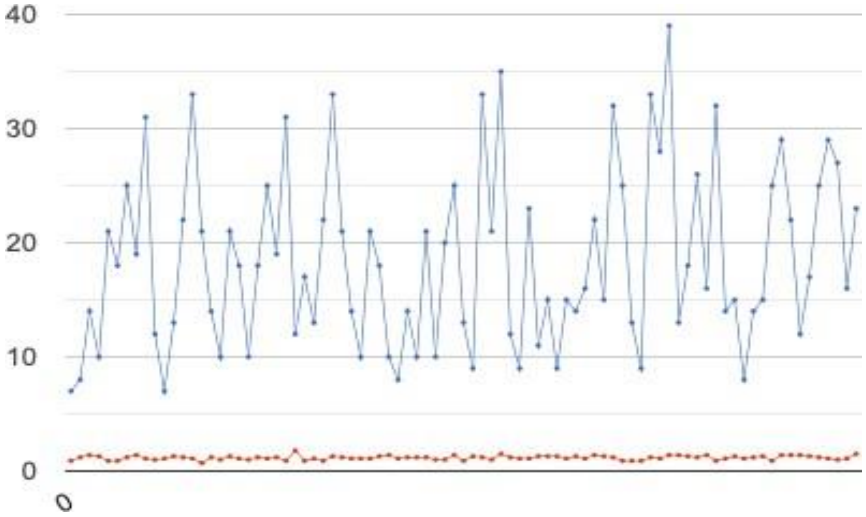


Figure 2: Correlation of Flexor Endurance with Flat foot

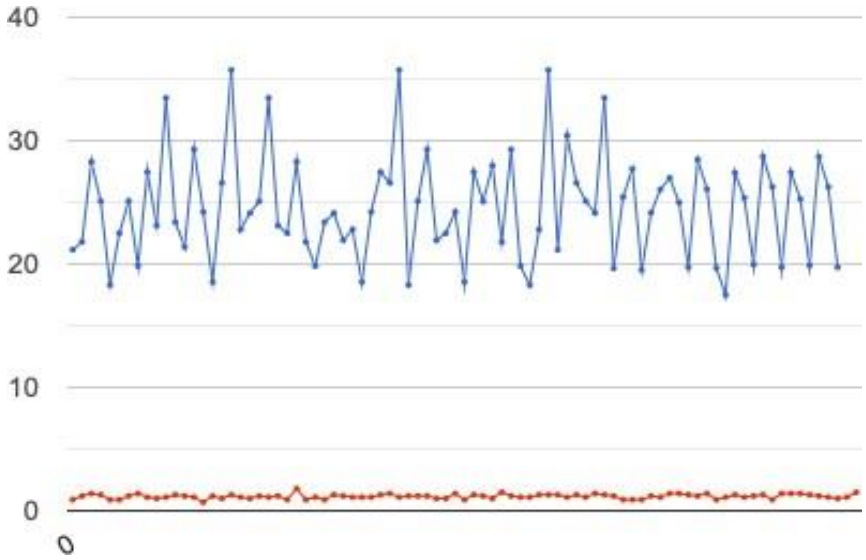
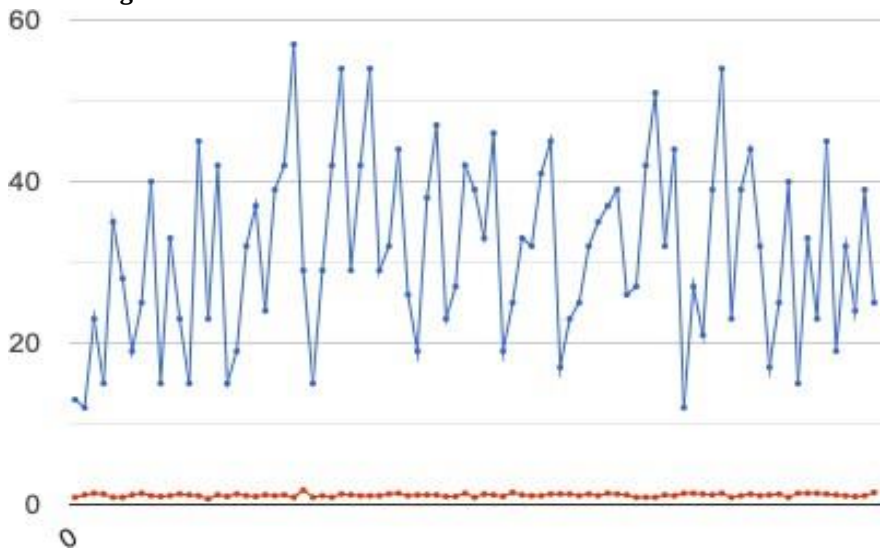


Figure 3: Correlation of Extensor Endurance with Flat foot



DISCUSSION

The purpose of the study was to find out the relationship between the body mass index, core endurance and flat foot among college students. 85 college students were selected using convenient sampling method based on the selection criteria. A clear explanation about the study was given to each subject and the consent form was obtained from each one of them. The height and weight of the subjects were obtained and their body mass index was calculated using body mass index formulae. McGill's core endurance test was used to evaluate the core endurance of all subjects and Navicular drop test was used to assess the flat foot. The entire study duration was 6 months. Statistical analysis was done using Pearson Correlation Coefficient.

Based on the results, there was a moderate positive linear correlation between body mass index and flat foot with 'r' value 0.53. There was a mild positive linear correlation between flexor core endurance and flat foot with 'r' value 0.32. There was a mild positive linear correlation between extensor core endurance and flat foot with 'r' value 0.008.

Individuals with high body mass index values are likely at a biomechanical disadvantage during these tests given the higher body loads that need to be supported against gravity. Excess bodyweight leads to greater mechanical loading of the foot. Most of the adipose tissue accumulates at the abdominal region in obese individuals. Moreover, the rectus abdominal muscle shows the greatest fatty infiltration, followed by the lateral abdominal muscle and erector spinae, in overweight and obese individuals.

Body weight has been found to be significantly associated with elevated loading of the foot, particularly the forefoot and 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.[8]

Flat foot is defined as collapse within the medial arch, abduction of the forefoot, internal rotation and plantar flexion of the talus and calcaneal eversion. Mostly asymptomatic but may end in pain due to prolonged standing which cause abnormal weight distribution.[9]

The musculature that surrounds the centre of gravity plays a vital role in motor function by maintaining a stable base to support the body mass. Alteration of centre of gravity affects the biomechanical distribution of weight to lower limbs. Core stability is critical to take care of the integrity of the backbone, provide resistance to perturbations and furnish a stable base for movement of the extremities.[2]

Maintained excessive foot pronation during weight-bearing activities generates internal rotational stresses at the lower extremity, which may change patterns of movement and muscle balance at proximal joints. Bilateral flat foot causes more proximal lower limb dysfunctions, which cause altered core stability.[10]

Decreased flexor core stability may predispose to flat foot because of entire lower extremity as there is an interaction of the distal segments with the proximal segments based on the concept of kinetic chain theory these changes lead to structural and functional deficits in the knee, hips, pelvis and the lumbar spine due to abnormal forces which act on the body. This study suggests that flexor core endurance has to be considered while treating flexible flat foot subjects.

The limitations of the study include small sample size, study was conducted at one particular college and only college students were assessed. Further studies can be done with larger population, other risk factors can be considered and other outcome measures can be used.

CONCLUSION

In conclusion, Flat foot is more associated with Flexor core endurance and Body Mass Index. It is recommended that assessment and rehabilitation of core muscles should be

added to the treatment program of flexible flat foot subjects.

Declaration by Authors

Ethical Approval: Approved

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Conflict of Interest: The authors declare no conflict of interest.

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