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Research Article

Relationship of BMI With Flatfoot and Core Stability in Young Adults -A Case Control Study

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Abstract

Background: Obesity causes severe disability and a lower quality of life. By dividing body weight (kg) by height (m2), one indicator of a person's weight level is the body mass index or BMI. In the meantime, the majority of direct measurements of obesity are closely associated with Body Mass Index (BMI), which is a useful and readily measured index of relative weight. The physical composition has a major impact on BMI. The musculoskeletal system may benefit from core stability in a number of ways, from maintaining low back health to avoiding knee ligament damage. A reduction in the medial longitudinal arch of the foot is known as flatfoot. A frequent malformation affecting adults is flexible flatfoot. More proximal lower limb dysfunctions brought on by bilateral flat feet affect the core stability.

Methodology: Present case control study includes,60 college going students in the age group 18-25 yrs were recruited including 30 with normal foot and 30 with bilateral flat foot. Height and weight was recorded and BMI was calculated. A single-time failure-prone Plank test was used to examine core stability, and the Navicular Drop Test (NDT) was used to evaluate flat feet.

Result: Correlation(r value) between plank time and BMI is -0.357, ND LT [Normal] is -0.312, shows negative correlation hence correlation is not significant and ND RT [Normal] is 0.001 showing positive correlation. In Bilateral flatfoot, correlation between plank time and BMI Bilateral] is -0.1806 which is also a negative correlation hence correlation is not significant. Correlation is significant when BMI with ND RT [bilateral flatfoot] is 0.4109 and ND LT [bilateral flatfoot] is 0.316 .Plank time mean values in normal foot are greater than bilateral flatfoot. Navicular drop of both the sides- right and left in bilateral flatfoot is present more than normal foot.

Conclusion: This study established relationship of body mass index with foot posture and core stability in the young adult population. Analysis revealed that in flatfoot there is a significant correlation between BMI and foot Posture assessed by navicular drop and no correlation with core stability assessed by plank time.

Keywords: Flat Foot; College Students; Core Stability; Navicular Drop; Plank Time

Introduction

According to statistics, over 1.9 billion population who were 18 years of age or older were overweight in 2016, with over 650 million of them being obese. Overweight and obesity are defined by the World Health Organization (WHO) as abnormal or excessive fat accumulation that may have negative health effects. Obesity causes severe disability and a lower quality of life. It is linked to several musculoskeletal diseases, including osteoarthritis, low back pain, gait abnormalities, osteoporosis, and soft tissue problems. The body mass index (BMI), skin girth measurement, waist to hip ratio, and waist circumference can all be used to determine body composition. By dividing body weight (kg) by height (m2), one indicator of a person's weight level is the body mass index, or BMI. A method for determining a healthy body weight is BMI. In the meantime, the majority of direct measurements of obesity are closely associated with Body Mass Index (BMI), which is a useful and readily measured index of relative weight. The physical composition has a major impact on BMI [1].

Flat foot may cause due to age, sex, weight, race, and some other anthropometric parameters. As a result, it is one of the most significant and prevalent issues of the twenty-first century. Plantarflexion, adduction of the talus head, and eversion of the calcaneus work together to produce weight-bearing subtalar pronation. Obese people had flatter feet, a lower range of motion between inversion and eversion, and higher peak plantar pressures when walking, according to a study done on older adults.[1] Increased foot loading was also associated with bodyweight. Adult flat feet can be classified as acquired flat feet or as residual flat foot deformity resulting from a developmental origin. Tightness in the triceps or isolated gastrocnemius is linked to acquired flat foot. Flexible flatfoot is a common cause of back discomfort and many lower limb ailments. Minor alterations in the foot can have a big impact on one's balance and posture. Extensor endurance is another frequently noted risk factor for low back discomfort [1,2].

Our young folks nowadays have increasingly sedentary lifestyles. This might be explained by students who are under a lot of pressure to perform well and have extensive study sessions, which leaves little time for physical activity. In India, a growing proportion of young people are becoming obese, and as they get older, they have a range of physical, mental, and cardiovascular problems. Working adults who have desk jobs, lengthy work hours, and ever-increasing job expectations don't get enough physical movement in their daily lives. Due to their sedentary lifestyles and lack of exercise, many young adults nowadays are overweight or obese. Understanding the connection between flat feet and core strength is essential for the diagnosis and treatment of lower limb injuries and back discomfort. The identification of such a relationship may have implications for and changes to the management techniques for flat foot. From a clinical standpoint, this affects patient care [3].

The core provides proximal stability for distal mobility, serving as an anatomical foundation for the distal segments' motion. The abdominal muscles (transverse abdominis, internal and external obliques, and rectus abdominis) in the front, the paraspinals and gluteal at the back, the diaphragm as the roof, and the pelvic floor and hip musculature at the bottom make up the core, which is described as a double-walled cylinder. The transerversus abdominis muscle and the obliques make up the abdominal wall, which forms a "hoop" around the abdomen. The posterior aspect of the "hoop" is the thoracolumbar fascia, which attaches to the abdominal wall. This structure stabilises the lumbo-pelvic region and increases muscle activity to make up for lost stiffness from injury. Core stability is influenced by both active and passive components. Active muscular forces responsible for intraabdominal pressure, spinal compressive pressures, and the stiffness of the hip and trunk muscles. Increased abdominal pressure and increased trunk rigidity result from simultaneous contractions of the diaphragm, pelvic floor, and abdominal muscles, which further stabilises the spine. It has been proposed that the properties of core muscles influence structures from the ankle to the low back [3].

A study conducted by Suciatiet. Al and his team find out the correlation between flat foot and BMI in primary school students of Indonesia, concluded significant relationship between both; with PR value of 2.36, indicating obese people have 2.36 times risk for flat foot compare to people who have normal BMI.[4] Shyamala Shree et.al in January 2018, conducted a prevalence study to check whether the obesity can cause flat foot or not. They found a strong correlation between obesity and flat foot and no association of gender and age with flat foot. Hence the need to study the relationship of body mass index with flatfoot and core stability in the young adult population.

Objective of the study

The aim of the study to find the relationship of BMI (body mass index) with flat foot and core stability in young adults (18-25years old).

Methodology

- **Study type:** Case control study
- **Study design:** Convenient sampling
- **Study duration:** 1 Month
- **Sample size:** 60
- **30 Cases:** with bilateral flatfoot presen
- **30 Controls:** with flatfoot absent, normal foot

Inclusion criteria

- Young adults between the age of 18 to 25years.
- Individuals willing to participate.

Exclusion Criteria

- Musculoskeletal complaints.
- Any neurological disorder
- Surgery or trauma.

Materials required

- Colour marker
- Index card
- Ruler
- Chair
- Yoga mat
- Stopwatch.

Procedure

A case control study was conducted with a total of 60 subjects including 30 with normal foot and 30 with bilateral flat foot, where height and weight was recorded and BMI was calculated. Demographic data like name, age, gender of the participants were obtained. Institutional ethical approval was taken before undertaking this study. Subject willing to participate and fulfilling the inclusion and exclusion criteria were taken. The participants were educated about the study.

Flat foot were assessed by Navicular drop test [NDT].

The participants were placed in sitting position with 90 degree knee flexion, and the ankle should be in a neutral position and feet flat on the ground without weight bearing. Navicular tuberosity is palpated and a dot is marked on the most prominent point using a colour marker, then an index card was aligned perpendicular to the medial side of the foot. A mark was placed on the index finger at the level of the dot on the navicular tuberosity. Then the subject was asked to stand up with normal bilateral weight bearing and another mark was placed on the index card at navicular tuberosity level. A ruler is used to measure the distance between the two marks (measured in mm). The test is done on both the leg. Navicular drop of 10 mm or more considered as a sign of reduced MLA (medial longitudinal arch) while drop less than 10 mm considered as normal.

Evaluation of core stability was done using a single time to failure prone Plank test .The core stability test is done by using single time to failure prone plank test. The correct position of the plank test was demonstrated to the participants and time of hold on correct position was noted. The participants should maintain a proper posture with fore- arm weight of the body while hands make a fist. The elbow are placed shoulder distance with ankle joint 90 degrees. With the toe touching the ground, the shoulder, trunk, hip, and knees are all held in a straight line. Participants were told to hold a neutral pelvis and spine position throughout the plank test and to breathe normally.

The test was stopped when

- The participant became fatigued.
- The participants unable to hold the correct posture.
- The participants indicated adverse effect from the test (e.g. headache, dizziness etc..)

Data analysis

Data was analyzed using Microsoft excel sheet version 2007.Descriptive analysis of numerical data was expressed in Mean and Standarddeviation. Frequency of categorical data was expressed in percentage. Pearson's correlation test was used for correlating BMI with flat foot and core stability. An Independent t-test was applied to check the difference in mean values of various parameters between case and control groups.

Results

Table 1 shows a total of 60 samples in this study including 30 with bilateral flat (Case group) foot in that 12 male (40%), 18 females (60%) and 30 with normal foot (Control Group) including 27 male (90%), 3 females (10%).

	Male	Female
Bilateral flatfoot	12 (40%)	18 (60%)
Normal foot	27 (90%)	3 (10%)

Table.1: Gender-wise distribution of Normal foot and bilateral flat foot ofadults in the age 18 to 25 years.

Figure 1: Subject in sitting with knee index flexed 90 degree and ankle in neutral position.

Figure 2: Navicular height on an card in sitting position.

Figure 3: Navicular height on an Index card in standing position.

Figure 4: Measurement of Navicular drop using a ruler.

Figure 5: Prone Plank test.

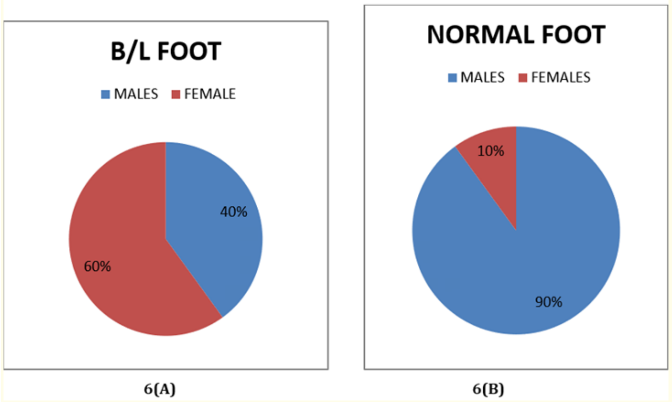

Figure 6: (A) Shows in bilateral flat foot (Case group)12 Males (40%), 18 females (60%) and (B) With normal foot (Control Group) including 27 male (90%), 3 females (10%).

Table 2 showed the age-wise distribution of normal and bilateral flat foot among college students of age subgroup 18-to-25 years.

Age	Bilateral Flatfoot (N = 30)	Normal Foot (N = 30)
18 yrs	0	2 (6.66%)
19 yrs	0	3 (10%)
20 yrs	1 (3.33%)	3 (10%)
21 yrs	1 (3.33%)	1 (3.33%)
22 yrs	7 (23.33%)	4 (13.34%)
23 yrs	10 (33.34%)	14 (46.67%)
24 yrs	6 (20%)	3 (10%)
25 yrs	5 (16.67%)	0

Table 2: Age wise distribution of samples with normal and bilateral flat foot.

In table 2 There was no specific trend followed from age 18-to-25 years of age. There was unequal distribution of participants in each subgroup.

In table 3, figure 7 obese participants including 3 males and 4 females showed presence of bilateral flatfoot and 4 obese participants including 4 males showed absence of flatfoot.

BMI classification	Bilateral flat foot	Normal foot
Underweight	2 (6.67%)	2 (6.67%)
Normal	21 (70%)	24 (80%)
Obese	7 (23.33%)	4 (13.33%)

Table 3: Frequency and percentage of BMI distribution of participants with normal foot and bilateral flatfoot.

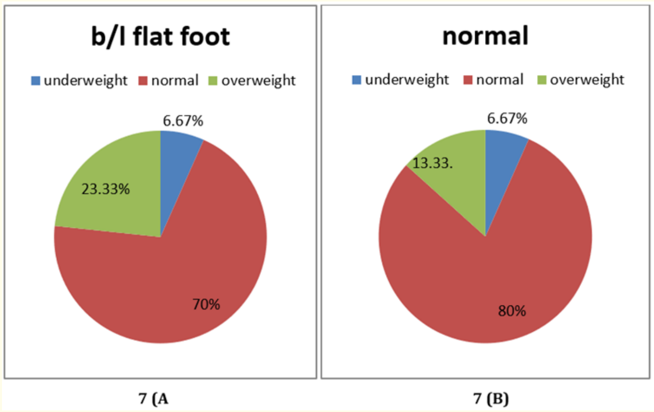

Figure 7: (A) In bilateral flatfoot- shows underweight (6.67%), normal weight (70%) and obese (23.33%). (B) In normal foot shows underweight (6v.67%), normal weight (80%) and obese (13.33%).

Mean values of BMI in both the case and controls almost similar. Plank time values in normal foot are greater than bilateral flatfoot. Navicular drop of both the sides- right and left in bilateral flatfoot is present more than normal foot.

	Bilateral flatfoot (Mean ± SD)	Normal foot (Mean ± SD)	t value	P value
BMI	22.77 ± 4.07	22.10 ± 2.75	0.7436	0.2303, Not Significant ($p > 0.05$)
Plank time	45.46 ± 15.45	85.86 ± 33.17	6.0531	0.000, Significant ($p < 0.01$)
Navicular drop Rt	12.13 ± 1.50	7.66 ± 1.45	11.730	0.000, Significant ($p < 0.01$)
Navicular drop Lt	12.53 ± 1.52	7.7 ± 1.37	12.91	0.000, Significant ($p < 0.01$)

Table 4: Comparison of mean values and t test of BMI, plank time and Navicular drop. Right/Left.

In the above table, in bilateral flatfoot participants BMI Table 5 shows moderately strong correlation with navicular drop rt side (r value = 0.410) and weak correlation with navicular drop lt side (r value=0.316). BMI sows negative correlation with plank time.

R value	Plank time	ND RT normal	ND LT normal
BMI (Normal foot)	-0.357	0.001	-0.312
	Negative correlation	No correlation	Negative correlation
	Plank time	ND RT B/L Flatfoot	ND LT B/L Flatfoot
BMI (B/L Flatfoot)	-0.1806	0.4109	0.316
	Negative correlation	Moderate correlation	Weak correlation

Table 5: Correlation of BMI with plank time and in both bilateral flat foot andnormal foot.

In normal foot, BMI shows negative correlation with plank time and BMI shows no correlation navicular drop right side and negative correlation with navicular drop left side.

Discussion

Sami S. Alabdulwahab and Shaji John Kachanthu included 39 male students and examine BMI, FPI, and core stability. The following were the findings: r = 0.5 and p = 0.001 for BMI and FPI, and r = -0.34 and p = 0.036 for BMI and CS. According to their findings, the foot's arch may be reduced as a result of increased body mass, which raises the foot's stress level. Both directly from increased body weight and indirectly via changes to the foot, the foot is under greater stress. The entire kinetic chain of the lower limb is impacted by this. Obesity showed changed pelvis and knee kinematics at both walking speeds and at the faster speed in a study by Zachary F. Lerner., *et al*. on the impact of obesity on lower limb function. Obese people were found to have a higher lower extremity force requirement per skeletal muscle tissue, which could lead to changed kinematics and an increased risk of musculoskeletal disease or injury [4,5].

Obesity is linked to foot pain and is most closely correlated with fat mass, especially in those who are androids. Having too much weight in the abdomen can change how someone walks or stands, as well as how their feet are loaded. Therefore, education about the negative consequences on those who are at risk as well as the impact of obesity on foot posture and function should be included in therapy. Additionally obesity is linked to diminished physical strength and compromised physical performance. Poor trunk muscle composition (increased levels of fat infiltration) in older adults appears to put them at risk for declining mobility-related function over time. This risk is especially noticeable in those who have experienced at least mild back pain in the past [6].

According to a study by Hazheer Rasif and Jianxong Wang (2017), there is a negative link between core muscle function and body composition characteristics. In men, there was a substantial correlation, while in women, there was only a correlation with front bridge performance-not side bridge time. Their findings showed that dysfunctional core muscles are a consequence of poor body composition. According to the results of a study comparing the effectiveness of routine exercise therapy and core stabilisation exercises in the treatment of chronic non-specific low back pain, the former is more effective in reducing pain than the latter. Poor core muscle function would be more common in young adults who are overweight or obese, increasing their risk of musculoskeletal disorders such low back discomfort and injuries. Both throughout the individual evaluation process and during the rehabilitation process, core muscle strength and stability should be taken into account [7-9].

The relationship between age and flat feet

According to the findings, flat feet and age do not significantly correlate (Table 2). There can be alterations in balance, gait, and joint alignment when there is no medial arch or low arch. As one ages and the musculoskeletal system develops, the physiological phenomena known as flat feet will shift. The findings of this investigation are in line with those of Ezema, Abaraogu, and Okafor's (2013) study, which demonstrated that there were no appreciable variations in the prevalence of flat feet between the ages of 7 and 8 (p = 0.181) and between 9 and 10 years. This study also supports the findings of Hazza., *et al*. (2015), who found a negligible connection (p > 0.05) between age and the occurrence of flat feet.

The relationship between gender and flat feet

Findings of the current study indicated a connection between gender and flat feet (Table 1, figure 6 (A), (B)). Gender is one of the criteria that is thought to influence flat feet. This makes sense when you take into account how different some genders' foot sizes and structures are. According to some literature, sexual dimorphism is caused by variations in men's and women's skeletons. However, a strong correlation was found in this investigation between the presence of flatfoot and females. 60% of female students reported having flat feet, compared to 40% of male students with the same condition. This study supports the findings of Reihanah., *et al*. (2013), who reported that flat feet were more common in females (75.6%) than in boys (72.4%), but that overall, sex did not significantly affect the prevalence of flat feet. In girls, the degree of flat foot weight is likewise higher.

The relationship between body mass index (BMI) and flat feet (Table 3, table 5, figure 7(A), (B))

Our investigations show there was a significant relationship between body mass index and flat feet (p = 0.4, p = 0.3). One risk factor for flat feet is obesity. The study's findings support those of Mickle., *et al*. (2006), who found a strong correlation (p = 0.03) between BMI and flat feet. Furthermore, this study supports the findings of Pfeiffer., *et al*. (2006), who found that children who were overweight (51%), obese (62%), and of normal weight (42%) had significantly different prevalence of flat feet with observations ($p < 0.05$). Feet that constantly bear too much weight (weight-bearing) result in flat feet, which are produced by a reduction in the longitudinal arch. The medial longitudinal arch's ability to operate can be impacted by structural modifications. If childhood obesity or overweight persists into maturity, this condition gets worse.

Limitation

The current study had certain limitations; a limited sample size was used a larger sample size should be used. Gender bias should be eliminated by recruiting equal samples of males and females. Other body composition factors, such as skin girth measurement, waist-hip ratio, and waist circumference, should be taken into account and connected with core stability and foot posture.

Conclusion

This study established the relationship of body mass index with foot posture and core stability in the young adult population. Analysis revealed that in flatfoot there is a significant correlation between BMI and foot Posture assessed by navicular drop and no correlation with core stability assessed by plank time.

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