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PREVALENCE OF FLAT FOOT AMONG MEDICAL STUDENTS AND ITS IMPACT ON QUALITY OF LIFE AND FUNCTIONALLY

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ABSTRACT

Background and Aim: Human foot morphology is highly variable and is influenced by a broad array of factors, including age, sex, ethnicity, body mass, genetic disorders, and musculoskeletal foot conditions such as hallux valgus and osteoarthritis. Aim of the present study was to find the incidence of flat foot or pes planus in patients visiting Banas Medical College & research, Palanpur, Gujarat, India. **Material and Methods:** It was a cross-sectional study in which two hundred 1st year MBBS students, of age between 17 to 25 years from Banas Medical College & research institute had volunteered. The Navicular drop test (NDT) was measured applying Brody Method. Each subject was asked to sit in relaxed position with hip and knee flexed at 90 degree and the foot gently placed flat on a firm supporting surface. **Results:** Out of 200 students 10 students determined as positive navicular drop test means the value of navicular drop was above 10 mm and 190 students have navicular drop test was below 10 mm considered as negative navicular drop test. Minimum value of arch height in sitting position is range from 4.5 to 5 and the maximum value of arch height is range from 6 to 6.5. Minimum value of arch height in standing position is range from 4.5 to 5 and the maximum value of arch height is range from 6 to 6.5. **Conclusion:** In this study arch height measured during the sitting and standing position. Navicular drop test calculate and it was 5 % means out of 200 only 10 students have positive navicular drop test.

KEYWORDS: Arch Height, Flat Foot, Navicular drop test, Quality of Life.

INTRODUCTION

Foot arches are important components for body support. Foot arch deformity caused by growth abnormalities cause serious limitations in daily activities. Poor foot structure, such as flat feet or high arched feet were thought to cause excessive foot movement during gait, which in turn is the pre-cursor to foot injuries.[1] Healthy feet are the main factor for activity in daily life, whether in movement related to work or exercise. Neglecting foot health may result in chronic injuries such as foot ulcers. It is a significant obstacle for susceptible people who are suffered from negative long-term consequences and substantial healthcare expenses.[2] The longitudinal arch is a unique load-sharing four-layered structure (plantar fascia, intrinsic plantar muscles, plantar arch extrinsic muscles, and plantar ligaments) to serve the propulsive functions. The arch supports the foot with the stiffness essential to perform as a lever that transfers the forces generated by calf muscles as the feet thrust against the ground. The arch also preserves sufficient elasticity to work like a spring to store and then release mechanical energy. It works synergistically to increase longitudinal arch stiffness during weight-bearing activities.[3] However, the role of the transverse arch is still enigmatic, and researchers were clueless about a persistent transverse arch if it has no functional importance.[4]

That foot length and width increased markedly in the standing position compared to the sitting position to attend to the consequence of the structural deformation of the foot skeleton from supporting the body weight. Likewise, for this same comparison they verified that there was a decrease in the height of the navicular, the height of the dorsum to 50% of the length of the foot and the arch height index (AHI). In evaluating the foot structure, the medial longitudinal arch is a significant loading region of the foot and is very sensitive to foot type. The morphology of the plantar curve, derived from the alignment and height of the arch, is recognized by various authors.[5] Pes planus is a medical condition where the curvature of MLA is more flat than normal and entire sole of the foot comes into near complete or complete contact with the ground. The height of MLA is most important measurement in determining the degree of pes planus.[6] The true prevalence of flatfoot is

unknown, primarily because there is no consensus on the strict clinical or radiographic criteria for defining a flatfoot. But some authors reported that the prevalence of flexible flatfoot in children, (2 to 6 years of age) is between 21% and 57%, and the percentage has decreased to 13.4% and 27.6% in primary school children.[7]

Human foot morphology is highly variable and is influenced by a broad array of factors, including age, sex, ethnicity, body mass, genetic disorders, and musculoskeletal foot conditions such as hallux valgus and osteoarthritis.[8] Foot shape impacts many aspects of an individual's life, including standing balance, movement during walking, sporting performance, predisposition to lower limb injury, and footwear ft.[9] Sub-optimal footwear ft has a signifcant impact on an individuals comfort, risk of foot pathology development, and falls risk. Medial longitudinal arch is the largest arch of the foot and the most important arch of the foot from a clinical point of view. The bony shape, the ligaments of the foot, and the muscular tones all play an important role in supporting the arches. Based on the structure of the medial longitudinal arch, three types of the foot have been proposed: (1) normally aligned or normal foot, (2) low arched or pronated foot, or pes planus, and (3) high arched or supinated foot, or pes cavus. Aim of the present study was to find the incidence of flat foot or pes planus in patients visiting Banas Medical College & research, Palanpur, Gujarat, India.

MATERIAL AND METHODS

It was a cross-sectional study in which two hundred 1st year MBBS students, of age between 17 to 25 years from Banas Medical College & research institute had volunteered. None of the participant had any lower extremity deformity, injury or neuromuscular disorder at the time of assessment. The materials used for this study were ruler scale, marker, pencil and blank paper [Fig-1].

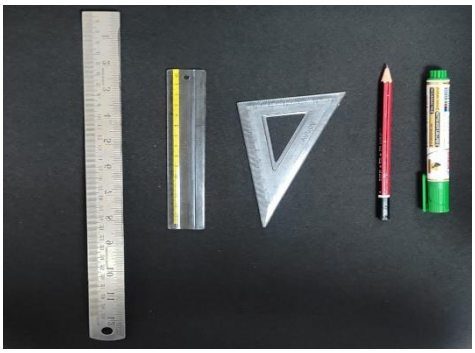

Fig. 1

Fig. 2

The Navicular drop test (NDT) was measured applying Brody Method.[3] Each subject was asked to sit in relaxed position with hip and knee flexed at 90 degree and the foot gently placed flat on a firm supporting surface [Fig-2]. The observer ensured that the ankle and subtalar joints were placed in neutral position. The height of navicular tuberosity in this position was marked on the index card [Fig-3]. The subject was then asked to stand with equal weight on both the feet. Now the new height of Navicular tuberosity was marked on index card [Fig-4]. The difference e prbetween the marks on the index card (ND) was measured with rular scale [Fig-5]. The NDT was measured for both feet in each subject.

Fig. 3

Fig. 4

Fig. 5

Navicular drop test

For checking navicular drop test, the subject was first positioned in standing i.e. weight bearing position. Using a small rigid ruler, the height of the navicular bone was measured from the floor to the most prominent part of navicular tuberosity when in the neutral talar position. Again the height of the navicular bone was measured in relaxed sitting position i.e. non weight bearing. The

difference in measurement is the navicular drop and drop>10mm will be regarded as pesplanus**.**

Statistical analysis

The normality of the data was tested using Shapiro-Wilk test. Mean, slandered deviation, minimum and the maximum value is calculated. The Navicular drop test (NDT) compared with foot parameretrs. The criteria to determine flat foot was NDT of ≥ 10 mm. Using this criteria, the prevalence was calculated of 1st year medical students. A p-value of less than 0.05 was considered statistically.

RESULTS

Participants in the present study were adults, in the age group of 17 to 25 years. Total participants were 200 in which 68 are girls and 132 are boys [table no.1]. Then start measuring the arch height on sitting position and standing position simultaneously. The participants not have any foot pathology during the measuring of arch height then measured 200 participants and start calculating them. The normality of distribution was tested with Shapiro-Wilk test.

Table 1: Gender wise distribution.

Total	Male	Female
N= 200	132	68

Out of 200 students 10 students determined as positive navicular drop test means the value of navicular drop was above 10 mm and 190 students have navicular drop test was below 10 mm considered as negative navicular drop test. Means the incidence of pes planus is 5 % from 200 students [Table no. 2].

Table 2: Navicular drop test.

Total	Positive navicular drop test (AH1)	Negative navicular drop test (AH2)
N= 200	10	190

Distribution of the arch height measurement, mean value, slandered deviation, minimum value, maximum value, Shapiro- wilk test value and p – value of Shapiro – wilk test shown in table no. 3.

Table 3: Distribution of the arch height measurement.

	Arch height (sitting position)	Arch height (standing position)	Navicular drop test
Mean	5.755	5.995	0.450
Std. Deviation	0.790	0.641	0.531
Kurtosis	-0.838	-0.976	4.491
Std. Error of Kurtosis	0.992	0.992	0.992
Shapiro-Wilk	0.930	0.933	0.728
P-value of Shapiro-Wilk	0.157	0.176	< .001
Minimum	4.300	4.700	0.000
Maximum	6.900	7.000	2.100

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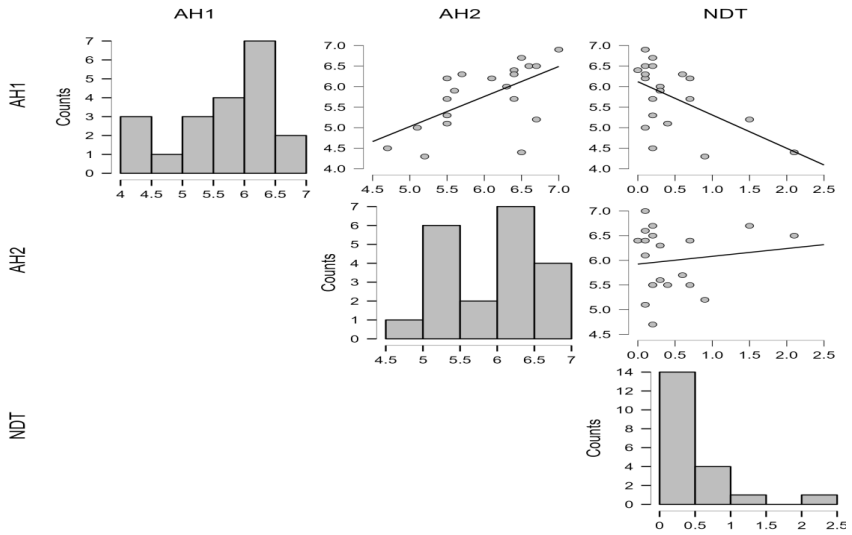


Graph no. 1: Showing.

1. Minimum value of arch height in sitting position is range from 4.5 to 5 and the maximum value of arch height is range from 6 to 6.5.
2. Minimum value of arch height in standing position is range from 4.5 to 5 and the maximum value of arch height is range from 6 to 6.5.

DISCUSSION

Navicular drop was measured with a novel technique (Video Sequence Analysis, VSA) using 2D video. Flat reflective markers were placed on the medial side of the calcaneus, the navicular tuberosity, and the head of the first metatarsal bone. The navicular drop was calculated as the perpendicular distance between the marker on the navicular tuberosity and the line between the markers on calcaneus and first metatarsal head. The distance between the floor and the line in standing position between the markers on calcaneus and first metatarsal were added afterwards.[10]

Table 2: Mean navicular drop (ND) in men and women.

Parameters	All (n = 280)		Women (n = 136)	Men (n = 144)
	Mean ± SD	**Range**	**Mean ± SD**	**Mean ± SD**
Navicular drop (mm)	5.3 (± 1.7)	1.3 – 13.4	5.2 (± 1.6)	5.3 (± 1.8)

Measure and Categorize the different types of the arch of foot of adult Bangladeshi males using digital Photography and Caliper

The height of the medial longitudinal arch of the foot is commonly thought to be a predisposing factor to injuries. High-arched runners exhibited more bony, ankle and lateral injuries but low-arched runners revealed a higher risk of soft tissue, knee and medial injuries. Again, both high and low-arched people had greater rearfoot eversion excursions than those with normal arch structure.

Table 1. Arch Height, Truncated Foot Length and Arch Height Index of Right Foot in Sitting and Standing Position with Difference and Level of Significance (n=110)

Variables	Measurement				Difference in sitting and standing position	
	Sitting position(10%WB)		Standing position (50%WB)			
	Mean	± SD	Mean	± SD	Proportion	p
Arch height	7.00 cm	0.55 cm	5.60 cm	0.44 cm	0.80	0.000**
Truncated foot length	18.07 cm	1.03 cm	18.77cm	1.07cm	1.04	0.000**
Arch height index	0.388	0.032	0.299	0.024	0.77	0.000**

**= significant at 5% level of significance

The study population consisted of 243 school children in Qom, with an average age of 11.47±0.82 years, weight 39.4±10.86 kg, and height 145.94±7.91 cm. To assess the foot condition, the foot arch index Staheli, Arch Index (AI or Arch Index), and anthropometric factors were used to assess the amount of fat (by Jackson Pollock) and BMI. To calculate the relationship between variables, the chi-square test (Ci-square), with confidence interval of 95% and to check the repeatability of the data, the correlation coefficient (Interclass correlation coefficient) was run.[11]

Navicular position test a reliable measure of the navicular bone position during Rest and Loading[12]

Lower limb injuries are a large problem in athletes. However, there is a paucity of knowledge on the relationship between alignment of the medial longitudinal arch (MLA) of the foot and development of such injuries. A reliable and valid test to quantify foot type is needed to be able to investigate the relationship between arch type and injury likelihood. Feiss Line is a valid clinical measure of the MLA. However, no study has investigated the reliability of the test.[12]

Morphology of medial longitudinal arch among young indian adult

Indian database on morphology of Medial Longitudinal Arch (MLA) especially in young adults is extremely limited. So the present study was undertaken to estimate quantitative morphology of MLA and to evaluate influence of demographic variables on it, in Indian young adult population from Gujarat region. Various dimensions of MLA were measured with custom made Bronnack device in 1500 (670- male, 830- female) healthy volunteers of age 17-21 yrs in non weight bearing & weight bearing positions which were plotted on paper for additional measurements.

		Height (cm)	Weight (kg)	BMI (kg/m²)	RND (mm)	LND (mm)
Male (N=250)	Mean (±SD)	169.6 (±8.16)	68.1 (±15.6)	23.62 (±4.91)	6.7 (±4.1)	6.9 (±4.2)
	Median (IQR)	170 (165 to 175)	65.50 (57 to 77)	23.02 (20.14 to 26.22)	6 (4 to 8)	6 (4 to 9)
	Range	140-190	36-114	15.41 – 39.04	0-19	0-22
Female (N=250)	Mean (±SD)	156.5 (±7.05)	52.7 (±10.4)	21.5 (±3.96)	7.2 (±4.4)	6.3 (±4)
	Median (IQR)	156.25 (15.5-160)	50 (45-58)	20.75 (18.38-23.28)	6 (4-10)	7 (3-8)
	Range	125.5-182	36-90	15.72 – 35.38	0-21	0-18
Total (N=500)	Mean (±SD)	163.07 (±10.07)	60.41 (±15.36)	22.56 (±4.58)	7 (±4)	6.6 (±4.1)
	Median (IQR)	162.5 (155.5-170.5)	57 (49-69)	21.6 (13.14-25.28)	6 (4-9)	6 (4-9)
	Range	125.5-190	36-114	15.41 – 39.04	0-21	0-22

[Table/Fig-3]: Distribution of height, weight, BMI and Navicular Drop (ND) among study sample.
(RND = Right Navicular Drop; LND = Left Navicular Drop)

	Correlation with	Spearman's rho	p-value
RND	Height	-.109	.014
	Weight	-.123	.006
	BMI	-.075	.095
LND	Height	.068	.127
	Weight	.033	.466
	BMI	-.002	.958

[Table/Fig-5]: Correlation between Navicular Drop with BMI, weight and height.
(RND = Right Navicular Drop; LND = Left Navicular Drop) *Spearman's correlation test

	Sample size	Right side	Left side	Bilateral
Males	250	53 (21.2%)	54 (21.6%)	32 (12.8%)
Females	250	71 (28.4%)	48 (19.2%)	36 (14.4%)
Total	500	124 (24.8%)	102 (20.4%)	68 (13.6%)

[Table/Fig-6]: Prevalence of flat foot in study sample.

Prevalence of flat foot among medical students[13]

Flat foot also called pes planus/fallen arches is common deformity in adults. The present study was undertaken to investigate the prevalence of flat foot among medical students and to find out the association of flat foot with age, gender, body mass index (BMI), foot length and its impact on quality of life and functionality. A total of 300 medical students of age group 17-23 years were investigated for the presence of flat foot by using navicular drop (ND) test, arch index (AI) and foot posture index (FPI). The data obtained was subjected to statistical analysis using SPSS software. Prevalence of bilateral flat foot was 11.6%. Unilateral was 3% and the correlation of ND, AI, FPI with gender, age was not significant and with BMI, weight was highly significant.

Table 1: Correlation of ND with age, gender, height, weight, BMI, foot size.

	Correlation with	Spearman's rho	P value
Right ND	Age	-0.075	0.195
	Gender	0.057	0.327
	Height	0.128**	0.026
	Weight	0.354**	0.000
	BMI	0.380**	0.000
	Foot length	0.199**	0.001
Left ND	Age	-0.081	0.162
	Gender	-0.054	0.354
	Height	0.044	0.445
	Weight	0.247**	0.000
	BMI	0.305**	0.000
	Foot length	0.092	0.112

Table 2: Correlation of AI with age, gender, height, weight, BMI, foot size.

	Correlation with	Spearman's rho	P value
Right AI	Age	-0.081	0.161
	Gender	0.077	0.184
	Height	0.105	0.070
	Weight	0.237**	0.000
	BMI	0.259**	0.000
	Foot length	0.159**	0.006
Left AI	Age	-0.040	0.490
	Gender	-0.048	0.409
	Height	0.049	0.397
	Weight	0.227**	0.000
	BMI	0.268**	0.000
	Foot length	0.072	0.212

Prevalence of flat foot among 18 -25 years old physiotherapy students[14]

Pes-planus (’flat foot’) is one of the most common conditions observed in adult health practice. The objective of our study was to find out prevalence of flat foot in a population of 18 to 25 year old physiotherapy students and to find out correlation of BMI with arch index Methodology: A cross sectional study was conducted with sample of 80 physiotherapy students fitting in inclusion criteria.: Prevalence of flat foot in a population of 18 to 25 years old physiotherapy students was 11.25% for all subject affected with bilateral flat foot. According to the age, 18 years were having 2.5% of flat foot bilaterally, 19 years were having 3.75% flat foot bilaterally, 22 years were having 3.75 % flat foot bilaterally, 24 years were having 1.24% flat foot bilaterally.

Table No. 1- Distribution of arch index according to BMI.

Subject no	BMI		Arch index	
			RIGHT	LEFT
27	<18	Underweight	0.47	0.47
44	18-24.9	Normal	0.44	0.44
8	25-29.9	Overweight	0.53	0.53
1	30-34.9	Grade-I obesity	0.55	0.55

	NO. of subject with score >10mm	No. of subject with score <10mm
No. of subject	9	71
Percentage (%)	11%	89%

Measurements of Foot Arch in Standing, Level Walking, Vertical Jump and Sprint Start[15]

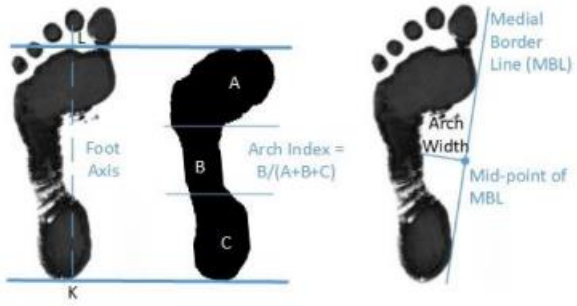
Foot arch is important for force transfer and shock absorption in impact sports. The purposes of this study were to measure the height of foot arch in static standing and dynamic activities, and to compare the difference of foot arch between level walking, vertical jump and sprint start. Twenty-three healthy subjects were recruited in this study. Significant differences between non-weight bearing condition and standing were found on arch height, arch angle and arch index. Arch height was gradually decreased in loading phase but suddenly increased in push-off phase during level walking, vertical jump and sprint start. Vertical jump and sprint start required significantly greater ranges of arch height change than level walking.

The presence of flatfoot and the degree of its severity according to Tachdjian's system of grading for flatfoot was assessed. The data showed that the overall prevalence of flat foot was 74% out of which 23% were mild, 34% were moderate and 17% were severe. The prevalence of flat foot in girl and boy students were 75.2% and 72.6% respectively, but this difference was not significant. Moreover, no significant relationship was observed between the prevalence of flat foot and age. Discussion: This study showed that flat foot is a common problem among primary school students and should be addressed by responsible organizations.[16]

Table 1: Distribution According to Grade

Grade	Grade 1		Grade 2		Grade 3		Grade 4		Grade 5	
Gender	No	%	No	%	No	%	No	%	No	%
Male	102	59.3	108	55.4	121	55.5	85	43.6	69	42
Female	70	40.6	87	44.6	97	44.5	110	56.4	96	58
total	172		195		218		195		165	

Flat foot represents a foot deformation where the arches on the inside of the feet are flattened allowing the entire soles of the feet to touch the floor when a person is standing. The flat feet pathology is normally detected by human experts based on the footprint images, but the lack of trained experts preludes the massive routine diagnostic of this pathology among the population. In present, there are the main two groups of approaches to capture and estimate arch-foot parameters: Vision Based Measurement (VBM) approaches and Foot Plantar Pressure (FPP) measurement and processing. The main characteristics of both approaches will be analyzed and compared in this paper.[17]



Agreement among raters was determined using the kappa statistic. For comparisons between clinical rating and diagnostic systems, receiver operating characteristic (ROC) curves and ordinal logistic regression were calculated. The combined kappa score for all three arch types (0.422, 32.8%) shows borderline moderate agreement between raters. Area under the curves (AUC) values of the ROC curves ranging from 0.48 to 0.68 show poor relationship between quantitative and qualitative arch height measurements.[18]

Calculation of staheli's plantar arch index and prevalence of flat feet: a study with 100 children aged 5-9 years[19]

The authors studied 100 normal children from the general population of both genders with ages ranging from 5 to 9 years old in order to evaluate the plantar arch index and the flat-feet prevalence. The flat-feet evaluation was obtained by means of the footprint and the plantar arch index (IP), which establishes the ratio between central and posterior regions of this footprint, determining a mean IP and a limit to the flat-foot. They conclude that the plantar arch index is easy to obtain from footprints and that there are no differences in terms of gender or age. The mean values of the plantar arch index within this age group are stable and range from 0.61 to 0.67, with plantar arch indexes greater than 1.15 being regarded as flat feet.[22]

Biomechanics of transverse axis of medial longitudinal arch of children's foot based on 3D scanning[20]

The feet of children with flat foot, normal foot and high arched foot were scanned with the Foot Secret 3D scanner in the sitting and standing positions. The scanning data were imported into CATIA v5 software for measurement, to obtain four parameters of transverse axis of medial longitudinal arch from transverse arch angle, external transverse arch angle, curvature and transverse arch crosssectional area. Result: There were statistically significant difference in transverse arch angle, external transverse arch angle and cross-sectional area between sitting and standing positions ($p < 0.05$). There were statistically significant differences in transverse arch angle, external transverse arch angle, curvature and transverse arch cross-sectional area among children with flat foot, normal foot and high arch foot ($p < 0.05$).

Our study was to find the prevalence of flat feet in 1st year MBBS students, age group between 17 to 25 years by navicular drop test.

CONCLUSION

In this study arch height measured during the sitting and standing position. Navicular drop test calculate and it was 5 % means out of 200 only 10 students have positive navicular drop test.

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