Study of Correlation Between Planter Arch Index and BMI in Children

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Abstract: *Development of human lower limb and Foot structure make a triad that distinguished men from other mammalian. Particularly An arched foot is most distinctive feature of man. Pes planus (flat feet) means "a condition in which the longitudinal arch is broken down, the entire sole touching the ground" the aim of present study To calculate PI & establish association between BMI and flat foot. The study was conducted on 100 children of 5-11 age group having flat foot. Subjects were distributed in 3 age groups. PI was calculated by foot print method proposed by Engel and Staheli.[1] BMI of every child was calculated by using height and weight. SPAI (**Staheli`s planter arch index**) & Anthropometric measurements were carefully recorded in all subjects and on the basis of BMI percentile subjects are distributed into obese and non obese in all age groups. Observation shows correlation between BMI and planter arch index PI is significant for both the sides with correlation value 0.31 for right side and 0.49 for left side and p<0.05 for both the side. In this study it is shown that BMI was significantly associated with flat foot deformity. It is also concluded that obesity is may be associated with flat foot deformity and it can be an aggravating factor or it may be a causative factor.*
Keywords: *Pes planus, BMI, longitudinal arch, PI index, Footprints.*

I. Introduction

An arched foot is most distinctive feature of man. It distinguished it from other primates. Footprints of hominoids already demonstrated the existence of a plantar arch 3.7 million years ago, and, during human evolution, feet and not hands - experienced extraordinary changes.[2][3]Pes planus (flat foot) – for convention refers to loss the normal medial longitudinal arch.[4](Campbell`s operative orthopaedics, pes planus edi. 11nth vol-4 page 4587) Flat foot deformity or pes planus is the most common foot Pathology in patients of all ages.[5]. Many time it can be lead to the severe pain in lower limb malalignment of patella, hallux valgus (bunions), and rotation of the knee. High BMI some time may be a cause of flat foot. The assessment of plantar arch development, by the relationship between arch region width and heel region width obtained on a footprint, is proposed by Engel and Staheli [1] The present study is an attempt to create awareness about problems with flat foot deformity and what causes this problem and how easily it can be diagnosed by calculating PI by foot print method & To establish association between BMI and flat foot. This is very effective, easily applicable and comparatively cheaper then other diagnostic method likes x ray, CT scan or MRI scan.
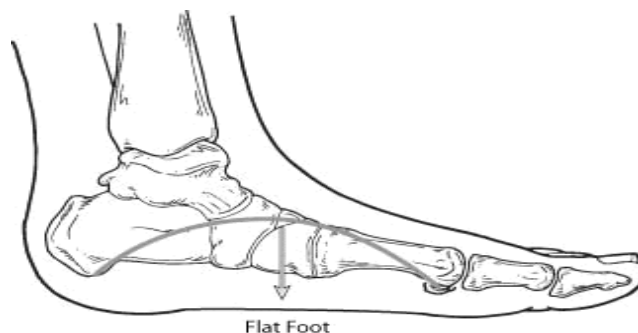
Flat Foot

II. Material and methods

Studies was conducted on 100 children of age group between 5-11 years. The 100 children were selected from the hospitals in mp attending the opds for the complaints of the foot & having apparent flat foot. Children with orthopedic surgeries or serious traumas on limbs, relevant clinical condition like palsy sequels, myelomeningocele, meningitis sequels & congenital anomalies of feet other then flat feet were excluded from stady. Subjects under study were categorized into three groups according to age and sex.

1) group i 5-7 years, 2)group ii 7-9 years, 3)group iii 9-11 years.

Detail history & written consent was obtained from the parents or the caregivers. Careful clinical examination was done under guidance of expert from orthopedic/physiotherapy department and signs were recorded. Foot print taken by ink method by using stamp ink ,roller ,plain paper, plastic platform, clips, ink dropper, measuring scale. After taking foot print Staheli`s planter arch index (SPAI) was calculated as a line drown tangent to the medial forefoot edge and at heel region. The mean point of this line is calculated. From this point a perpendicular line is drown crossing the footprint. At the heel perpendicular line is drown at maximum width of foot print thereby obtain theMeasurement of the support width of central region (A), and of the heel region (B) in millimeters.

Staheli`s planter arch index (SPAI) is obtained by dividing the A value with the B value. SPAI   A /B.
According to the pediatric orthopedic society :- A normal planter arch index is   the one comprises within 2standard deviations (SD) of the population average . Thus, PI values equal or above the sum of 2 SD with the average were considered as indicative of flat foot.
BMI of every child was calculated by using height and weight. BMI is defined as the individual's body weight divided by the square of his or her height[6].The formulae universally used in medicine (SI unit) produce a unit of measure of kg/m^2.

$$\text{BMI} = \frac{\text{mass (kg)}}{(\text{height(m)})^2}$$

BMI can also be determined using a BMI chart.[7] The BMI percentile allows comparison with children of the same sex and age.[8] Percentile 95th-100 considered as overweight.

III.   Results & Observations

Table No. 1 Distribution of study and control groups according to Age and sex.

Age Groups in years	Study group		Control group		Total no of subject
	Male	female	Male	Female	
Group I / 5 -7 years	10	5	8	8	31
Group II / 7-9 years	10	9	8	9	36
Group III/9-11 years	9	7	9	8	33
Total = 100	29	21	25	25	100

Subjects were distributed in 3 age groups. In age group I (5-7 years) total 31 subjects were included (18 males, 13 females).In age group II (7-9 years) total 36 subjects were included (18 males and 18 females). In age group III (9-11) total 33 subjects were included (18 males and 15 females). (Table no. 1)

Table No. 2 Distributions of study population into obese and non obese according to BMI percentile.

Age groups	Male		Female		
	Obese	Non obese	Obese	Non obese	Total
Group I / 5 -7 years	05	13	04	09	31
Group II / 7-9 years	06	12	04	14	36
Group III / 9-11 years	05	13	03	12	33
Total	16	38	11	35	100

SPAI (**Staheli`s planter arch index**) & Anthropometric measurements were carefully recorded in all subjects and on the basis of BMI percentile subjects are distributed into obese and non obese in all age groups
Average ,minimum, maximum and SD (standard deviation) values for planter arch (PI) index are calculated for right and left feet separately for cases and control groups.

Table No. 3 Average ,minimum, maximum and SD (standard deviation) values for planter arch (PI) index for right and left feet for cases.

PI	Right feet	Left feet
Average	1.30	1.30
SD	0.09	0.08
Minimum	1.18	1.17
Maximum	1.90	1.48

Observation shows that the Average PI value is 1.30 for both feet. SD for right is 0.09 and for left is 0.08. Minimum PI values are 1.18 and 1.17 for right and left feet. Maximum PI value for right and left foot is 1.90 and 1.48 respectively.

Table No. 4 Average ,minimum, maximum and SD (standard deviation) values for planter arch (PI) index for right and left feet for controls.

PI	Right feet	Left feet
Average	0.61	0.59
SD	0.20	0.20
Minimum	0.23	0.31
Maximum	0.86	0.85

Observations from above table shows that the Average PI value for right feet is 0.61 and for left feet is 0.59. SD is 0.20 both for right and left feet. Minimum PI value for right feet is 0.23 and for left is 0.31. Maximum PI value for right feet is 0.86 and for left feet it is 0.85.

Table No. 5 distribution of obese male subjects according to flat feet and normal feet.

Age groups	OBESE Male	FF	Normal foot
Group I / 5 -7 years	05	03	02
Group II / 7-9 years	06	04	02
Group III/ 9-11 years	05	03	02
Total	16	10	06

Observations shows that in obese male groups out of total number 62.5% are having flat feet and 37.5% of obese male are having normal feet.

Table No. 6 distribution of obese female subjects according to flexible flat feet, rigid flat feet and normal feet.

Age groups	OBESE GIRLS	FF	Normal feet
Group I / 5 -7 years	04	02	02
Group II / 7-9 years	04	02	02
Group III/ 9-11 years	03	02	01
Total	11	06	05

Observations shows that females having flat feet were 54.54% and not having flat feet were 45.46%.

Table 7 correlation between BMI and planter arch index value for case group.

	Correlation value	P value	Significant level
Rt. Feet	0.31	$P < 0.05^*$	Significant
Lt. feet	0.49	$P < 0.05^*$	Significant

*** very significant; * significant; Ns – not significant Observation shows that correlation between BMI and planter arch index PI is significant for both the sides with correlation value 0.31 for right side and 0.49 for left side and $p < 0.05$ for both the side.

IV. Discussion

In present study we calculate PI(planter index) by using Staheli`s planter arch index method and correlation of PI & BMI were calculated. One such study conducted by *A.M. Dowling et al*[9] entitled-Does obesity influences foot structure and planter pressure pattern in prepubescent children in 2001. Study was conducted on13obese and 13 non obese children. BMI, foot structure and planter pressure were collected they observed that foot discomfort associated structural changes and increased forefoot planter pressure in obese foot may hinder obese children from participation in physical activity and therefore warrants immediate further investigation. In another study *Eklem Hastalıkları et al* (2009). [10] observed the prevalence of flatfoot in Turkish male adolescents and Correlation of flatfoot with weight and height were also evaluated. They found that the - Prevalence of flatfoot was found to be 0.69%. Correlation of flat foot with weight or height was not significant. In one study *Chen et al* [11] studied 1024 subjects in 2009 for prevalence of flat foot in Taiwanese children. They observed incidence of flat foot 27% in normal wt, 31% in overweight, 56% in obese subjects.

V. Conclusion

In present study Observation shows that correlation between BMI and planter arch index PI is significant for both the sides with correlation value 0.31 for right side and 0.49 for left side and $p < 0.05$ for both the side. In this study it is shown that BMI was significantly associated with flat foot deformity it is clearly shown by correlation between BMI and planter arch index with correlation value for right and left side is 0.31 and 0.49 respectably which are Significant. From the analysis of the present study it is also concluded that obesity is may be associated with flat foot deformity and it can be an aggravating factor in the development of flat foot deformity or it may or may not be causative factor.

References

[1]. Engel GM, Staheli LT. The natural history of torsion and other factors influencing gait in childhood. Clin Orthop Relat Res. 1974; 99:12-7.

[2]. Hernandez AJ. Pé plano flácido e frouxidão ligamentar generalizada: estudo clínico em 125 crianças [dissertação]. São Paulo:Universidade de São Paulo; 1990.

[3]. Laitman JT, Jaffe WL. A review of the current concepts on the evolution of the human foot. Foot Ankle 1982; 2:284-90.

[4]. Campbell`s operative orthopaedics, pes planus edi. 11nth vol-4 page 4587

[5]. Lee MS, Vanore JV, Thomas JL, Catanzariti AR, Kogler G, Kravitz SR, Miller SJ, Gassen SC. Diagnosis and treatment of adult flat foot Journal of ankle surgery 2005;44(2)78-113.

[6]. Eknoyan, Garabed (January 2008). "Adolphe Quetelet (1796–1874)—the average man and indices of obesity". Nephrol. Dial. Transplant. 23 (1): 47–51. doi:10.1093/ndt/gfm517. PMID 17890752.

[7]. the Body Mass Index Table from the NIH's NHLBI.Beyond BMI: Why doctors won't stop using an outdated measure for obesity., by Jeremy Singer-Vine, Slate.com, July 20, 2009.

[8]. "Body Mass Index: BMI for Children and Teens". Center for Disease Control

[9]. A.M. Dowling Steele JR, Baur LA. Does obesity influences foot structure and planter pressure pattern in prepubescent children.[International journal of obesity 2001 25,845-852]

[10]. Eklem Hastalıkları ve Cerrahisi. Prevalence of flatfoot in Turkish male adolescents[Joint Diseases and Related Surgery Original Article 2009; 20 (2):90-92]

[11]. Chen JP, Chung MJ, Wang MJ: Flatfoot prevalence and foot dimensions of 5- to 13-year-old children in taiwan. Foot Ankle Int 2009, 30:326332.