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Correlation Between Gender and Age and Flat Foot in Obese Children

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ABSTRACT

The purpose of this study was to detect the correlation between age and gender with flat foot deformity in obese children. One hundred fifty children ranged in age from 8-14 years participated in this study. They were selected according to body mass index to be obese children, then they were divided according to gender into two groups, group I and group II (75 boys and 75 girls), then each group divided according to age into equal three sub groups (from 8-10 years, from 10-12 years and from 12-14 years) each sub group included 25 children. Evaluation for each child was done using the Foot Posture Index-6 and foot print. The Foot Posture Index-6 was used to assess foot posture, while foot print was used to measure Stahili planter arch index. The results of the study showed that there were significant statistical differences in Foot Posture Index-6 score and arch index between group I (boys) and group II (girls), while there were no significant statistical differences in Foot Posture Index-6 score and arch index in the subgroups according to age. It was concluded that there was significant positive correlation between gender and incidence of flat foot, while there was no significant correlation between age and incidence of flat foot.

Key words: Flat foot, obese children, stahili planter arch index, foot posture index-6

INTRODUCTION

The foot has three arches; the medial longitudinal arch, the lateral longitudinal arch and the transverse arch. The medial longitudinal arch is the highest and most important of the three arches. It is composed of the calcaneus, talus, navicular, cuneiforms and the first three metatarsals. The lateral longitudinal arch is lower and flatter than the medial longitudinal arch. It is composed of the calcaneus, cuboid, the fourth and fifth metatarsals. The transverse arch is composed of the cuneiforms, the cuboid and the five metatarsal bases. The arches of the foot are maintained not only by the shapes of the bones as well as by ligaments. In addition, muscles and tendons play an important role in supporting the arches (George *et al.*, 2009).

Deformities of the lower extremities are very frequent in children and most of the time these conditions are physiological and do not need any treatment. Ninety percent of clinic visits for foot problems are due to flatfoot (FF) (Fabry, 2010).

The definition of flat foot is not standardized, nevertheless but the height of the medial longitudinal arch is the principal parameter to be observed and measured (Villarroya *et al.*, 2009).

Overweight and obese people must be most concerned with the arch of the foot and the additional stress load applies to the foot. As excessive amounts of weight are forced upon the feet, the muscles, tendons and ligaments that hold up the arch, do not become stronger. They become more stretched and weaker due to the extra weight that is forced upon these structures. In time, if these structures are not protected, they will allow the bones and joints of the feet to shift and collapse, causing the arch to become painful and even flat. This will lead to pain not only in the feet and ankles but also to pain in the shins, lower back knees and hips (Landsman and Weil, 2006).

Some parameters are considered as the predisposing factors of flatfoot, such as age, sex, body composition, ligamentous laxity, family history, types of footwear and age at which shoe wearing began (Abolarin *et al.*, 2011).

Males were twice more liable to have flat foot as females. Overweight and obese children were more likely to have flat foot with proper weight (Evans and Rome, 2011).

Although there are many methods currently being used to classify the medial longitudinal arch structures but the footprint is still the most popular approach to assess and analyze these arch. Staheli's arch index (planter arch index) was most commonly used for clinical diagnosis by using footprint. Staheli has characterized the width of the foot in the area of the arch and the heel and the ratio between these widths was called the Staheli's Arch Index (AI). The plantar arch index establishes a relationship between central and posterior regions of the footprint (ranged between 0.3-0.9), it is calculated as follows: A line is drawn 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 drawn crossing the footprint. The same procedure is repeated for heel tangency point. We thereby, obtain the measurement of the support width of the central region to the foot (A) and of the heel region (B) in millimeters (Fig. 1). The plantar arch index (PI) is obtained by dividing the A value by B value ($AI = A/B$) (Hernandez *et al.*, 2007).

A number of observational assessment scales have been developed to address the issue of the poor reliability of foot measures. Most recently the Foot Posture Index-6 (FPI-6) has been developed for which normative values have now been collected (Evans *et al.*, 2009).

The FPI-6 is a novel method of rating foot posture using set criteria and a simple scale. It is a measure of standing foot posture and so is not a replacement for gait assessment where time and facilities exist. It is however, a more valid approach than many of the static weight bearing and non-weight bearing goniometric measures currently used in clinic (Redmond *et al.*, 2006).

The FPI-6 is an assessment tool that is thought to reduce many of the reliability concerns surrounding more traditional measures of the foot. The FPI-6 has been refined from an eight

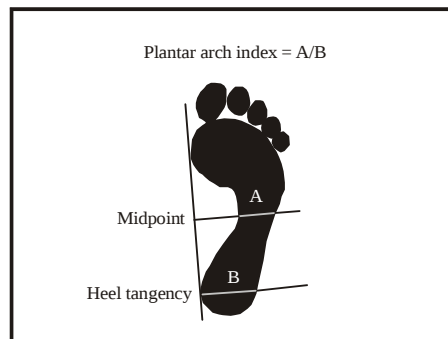


Fig. 1: Staheli's plantar arch index (Hernandez *et al.*, 2007)

point scale to a six point scale and permits assessment across the three planes of the foot (Morrison and Ferrari, 2009). The foot posture index is a technique to quantify foot posture in the transverse, sagittal and frontal planes. Based on scoring 6 index items rated from -2 to +2. The following are items which are assessed by FPI-6 (Anthony, 2005):

- Talar head palpation
- Supra and infra curvature at the lateral malleoli
- Calcaneal frontal plane position
- Bulging in the region of the talo navicular joint
- Height and congruence of medial longitudinal arch
- Abduction/adduction of the forefoot on the rearfoot

Each of the component tests or observations are simply graded 0 for neutral, with score of -2 for clear sign of supination and +2 for clear sign of pronation (Redmond *et al.*, 2006).

MATERIALS AND METHODS

This study included 150 children. This sample was selected from primary and secondary schools in Cairo and Giza, Egypt. 150 children ranged in age from 8-14 years participated in this study. They were selected according to Body Mass Index (BMI) to be obese children, then they were divided according to gender into two groups, group I and group II (75 boys and 75 girls), then each group divided according to age into equal three sub groups (from 8-10 years, from 10-12 years and from 12-14 years), each sub group included 25 children.

Sampling method: Stratified random sample with equal proportion to age and gender groups. Children were selected from primary and secondary schools in Cairo and Giza, Egypt (after permission and approval). We selected subjects to be obese according to body mass index (met the inclusive criteria) and divided them into subgroups according to age and gender, in each time 3 subgroups were formed according to age (we started by selection of boys then girls later on), each subgroup contained 5 children with selected criteria then randomly 2-3 children were selected from each subgroups, these procedures were repeated till 150 children were selected, duration of study was 25 weeks.

Prior to data collection ethical approval was granted from the parents. Details of the study were sent to parents with the appointment information and on attendance, parents gave informed consent form for participation. The selection of the samples and assessment were conducted in the children's school.

Each child in the three groups was assessed individually by foot print (Staheli's arch index) and FPI-6.

The collected data were statistically analyzed using ANOVA test. The results revealed that: Flat foot not affected by age but flat foot were more in boys than girls.

RESULTS

Correlation coefficient values among age

Correlation coefficient among different boys age: Table 1 shows that:

- There was no significant ($p>0.05$) correlation of weight ($r = 0.35$) among different boys age
- There was no significant ($p>0.05$) correlation of BMI ($r = 0.41$) among different boys age
- There was no significant ($p>0.05$) correlation of Rt. FPI ($r = 0.07$) among different boys age

- There was no significant ($p>0.05$) correlation of Lt. FPI ($r = 0.07$) among different boys age
- There was no significant ($p>0.05$) correlation of Rt. AI ($r = 0.48$) among different boys age
- There was no significant ($p>0.05$) correlation of Lt. AI ($r = 0.48$) among different boys age

Correlation coefficient among different girls age: Table 1 shows that:

- There was no significant ($p>0.05$) correlation of weight ($r = 0.38$) among different girls age
- There was no significant ($p>0.05$) correlation of BMI ($r = 0.51$) among different girls
- There was no significant ($p>0.05$) correlation of Rt. FPI ($r = 0.05$) among different girls age
- There was no significant ($p>0.05$) correlation of Lt. FPI ($r = 0.10$) among different girls age
- There was no significant ($p>0.05$) correlation of Rt. AI ($r = 0.05$) among different girls age
- There was no significant ($p>0.05$) correlation of Lt. AI ($r = 0.06$) among different girls age

Correlation coefficient values between boys and girls

Correlation coefficient values between boys and girls at 8-10 year: Correlation coefficients between boys and girls of weight, BMI, Rt. FPI, Lt. FPI, Rt. AI and Lt. AI at 8-10 years as shown

Table 1: Correlation coefficient values among age

Gender and variables	Age (years)	Correlation coefficients (r)	Probability (p-value)	Significance (p<0.05)
Boys				
Weight	8-10	0.35	0.20	NS
	10-12			
	12-14			
BMI	8-10	0.41	0.27	NS
	10-12			
	12-14			
Rt. FPI	8-10	0.07	0.461	NS
	10-12			
	12-14			
Lt. FPI	8-10	0.07	0.440	NS
	10-12			
	12-14			
Rt. AI	8-10	0.48	0.044	NS
	10-12			
	12-14			
Lt. AI	8-10	0.48	0.052	NS
	10-12			
	12-14			
Girls				
Weight	8-10	0.38	0.06	NS
	10-12			
	12-14			
BMI	8-10	0.51	0.42	NS
	10-12			
	12-14			
Rt. FPI	8-10	0.05	0.546	NS
	10-12			
	12-14			
Lt. FPI	8-10	0.10	0.304	NS
	10-12			
	12-14			
Rt. AI	8-10	0.05	0.597	NS
	10-12			
	12-14			
Lt. AI	8-10	0.06	0.521	NS
	10-12			
	12-14			

r: Correlation coefficient, P: Probability, NS: Non-significant, Rt.: Right, Lt.: Left, FPI: Foot positive index, AI: Arch index and BMI: Body mass index

Table 2: Correlation coefficient values between boys and girls

Age and variables	Correlation coefficients (r)	Probability (p-value)	Significance (p<0.05)
8-10 years			
Weight	0.64	0.023	S
BMI	0.70	0.024	S
Rt. FPI	0.62	0.002	S
Lt. FPI	0.60	0.009	S
Rt. AI	0.57	0.007	S
Lt. AI	0.79	0.025	S
10-12 years			
Weight	0.06	0.47	NS
BMI	0.15	0.81	NS
Rt. FPI	0.71	0.032	S
Lt. FPI	0.74	0.043	S
Rt. AI	0.69	0.014	S
Lt. AI	0.66	0.024	S
12-14 years			
Weight	0.71	0.019	S
BMI	0.76	0.032	S
Rt. FPI	0.66	0.025	S
Lt. FPI	0.71	0.013	S
Rt. AI	0.78	0.001	S
Lt. AI	0.77	0.014	S

r: Correlation coefficient, P: Probability, S: Significant, NS: Non-significant, Rt.: Right, Lt.: Left, FPI: Foot positive index, AI: Arch index and BMI: Body mass index

in Table 2. The results indicated that there was significant ($p<0.05$) positive correlation for weight, BMI, Rt. FPI (boy mean = 6.36 ± 2.27 , girl mean = 3.64 ± 2.64), Lt. FPI (boy mean = 6.48 ± 2.35 , girl mean = 3.72 ± 2.69), Rt. AI (boy mean = 0.95 ± 0.30 , girl mean = 0.78 ± 0.31) and Lt. AI (boy mean = 0.95 ± 0.30 , girl mean = 0.78 ± 0.31) at 8-10 years.

Correlation coefficient values between boys and girls at 10-12 years: Correlation coefficients between boys and girls of weight, BMI, Rt. FPI, Lt. FPI, Rt. AI and Lt. AI at 10-12 years as shown in Table 2. The results indicated that there were significant ($p<0.05$) positive correlation for Rt. FPI (boy mean = 6.12 ± 2.73 , girl mean = 4.04 ± 3.48), Lt. FPI (boy mean = 6.12 ± 2.64 , girl mean = 4.24 ± 3.10), Rt. AI (boy mean = 1.04 ± 0.38 , girl mean = 0.74 ± 0.29) and Lt. AI (boy mean = 1.04 ± 0.38 , girl mean = 0.74 ± 0.30) but no significant difference in weight and BMI at 10-12 years.

Correlation coefficient values between boys and girls at 12-14 years: Correlation coefficients between boys and girls of weight, BMI, Rt. FPI, Lt. FPI, Rt. AI and Lt. AI at 12-14 years as shown in Table 2. The results indicated that there was significant ($p<0.05$) positive correlation for weight, BMI, Rt. FPI (boy mean = 6.08 ± 2.78 , girl mean = 3.52 ± 3.15), Lt. FPI (boy mean = 6.24 ± 2.74 , girl mean = 3.64 ± 3.24), Rt. AI (boy mean = 1.03 ± 0.37 , girl mean = 0.74 ± 0.34) and Lt. AI (boy mean = 1.02 ± 0.33 , girl mean = 0.74 ± 0.35) at 12-14 years.

DISCUSSION

The current study showed that flat foot not affected by age but flat foot were more in boys than girls.

The age of children representing the sample, was ranged from 8-14 years old with mean value of 11.06 ± 0.62 years old. This choice depends on the fact that the medial longitudinal arch well developed between 5 and 6 years old and children younger than that may not develop the medial longitudinal arch (Urry and Wearing, 2001).

This also comes in agreement with Whitaker *et al.* (2000), who reported that the feet of children below the age of 5 years develop fatter pad. And also comes in agreement with Karen *et al.* (2009), who reported that the medial longitudinal arch is well developed at age between 5 and 6 years.

The choice of using the foot print in the assessment of flat foot in children in this study comes in agreement with Chen *et al.* (2006), who considered footprint one of the most popular methods of assessing MLA. On the base of this technique, we can measure the MLA by using different sorts of indexes like Clark's angle (footprint angle), Chippaux-Simirak index, Stahili arch index and Sztriter-Godunow index.

Also, Buerk and Albert (2001) said that footprint analysis can be used for qualification, classification and monitoring of flat feet.

In this study FPI-6 was used to assess foot posture which comes in agreement with Redmond *et al.* (2006), who confirmed that the foot posture index was developed in response to a requirement for a quick, easy and reliable method for measuring foot position in a variety of clinical settings.

Also, Morrison and Ferrari (2009) show that FPI-6 has almost perfect inter-rater reliability when used on the pediatric foot. He suggested that the FPI-6 may be of value in clinical practice and for use in podiatric research.

Age and flat foot: There was no significant correlation between age and flat foot for both sexes. This result comes in agreement with Garcia-Rodriguez *et al.* (1999) who said that the critical age for developing the arch is 6 years of age, so, if the prevalence of this pathology is studied in children younger than 6 years of age, the diagnosis will be overestimated.

In addition Arizmendi *et al.* (2004) reported that flat foot prevalence varies considerably with age, finding that 6 years of age is the age limit for the disappearance of flat foot.

Also, Pfeiffer *et al.* (2006) said that, its most remarkable development occurs between the ages of 2 and 6 years.

In addition Chen *et al.* (2006) reported that as the age of the children increases, prevalence of the flatfoot decreases due to its benign nature of spontaneous correction.

This result can be explained as the following: Mickle *et al.* (2006) reported that, high incidence of flat foot results from a fat pad of the plantar side of the foot. This pad diminishes after reaching the age of 4-5 years.

Also, this phenomenon has been explained by several factors as ligamentous laxity, overweight and the fatty tissue in the medial longitudinal arch which in the group older than 6 years of age may explain the decreased prevalence by the diminished fatty tissue package and the definite conformation of the foot arch (Vergara-Amador *et al.*, 2012).

Sex and flat foot: There was a significant positive correlation between gender and flat foot for all age, flat foot was more in boys than girls. It is reported by the previous study that the boys had a significant greater tendency for flat foot than the girls, the prevalence of flat foot in boys was 52% and in girls the prevalence was 36%. They said that the overweight boys have the highest risk for flat foot.

Also, according to Chang *et al.* (2010) the incidence percentages of flat foot in a total sample of 1,222 among Taiwanese school aged children were 67% for males and 49% for females.

Also, Umar and Paul (2010) indicated that all the measured anthropometric foot parameters in their study showed that male subjects process higher tendency to develop flat foot than their female counter parts. They reported that a flat foot incidence of 13% in males and 12% in females out of 200 Yoruba school students.

On the other hand, Eluwa *et al.* (2009) reported a flat foot incidence more in female than males. The prevalence of flat foot was determined among the people of Akwa Ibom state of Southern Nigeria. The overall prevalence of flat foot was 13.4% with a prevalence of 5.8% among males and 7.6% among females.

Also, Reihaneh *et al.* (2013) confirmed that prevalence of flat foot in girls is slightly more than boys: 75.2% of girls and 72.6% of boys showed flat feet but without any significant statistical difference.

Also, it is reported that sex does not influence the prevalence of at foot in this study.

Our result in this study can be explained as the following: The normal human foot demonstrates great individual variation in breadth, length and general in males and females (Snell, 2000).

In addition, Wunderlich and Cavanagh (2001) analyzed gender differences in foot shape in large samples. In their study they found out that men have long and broader feet than women. They demonstrated that female and male feet differ in number of shape characteristics, particularly at the arch, the lateral side of the foot, the first toe and ball of the foot. Females had a wider forefoot, shorter metatarsals and shorter arch length compared to males. The study showed that females had a 20-25% lower volume and surface area in the subtalar, talonavicular and ankle joints and up to 16% thinner cartilage also women's arches are higher which means they need more support.

Literature on sexual dimorphism in shape differences among human feet have focused on osteological difference between women and men. Linear measurement in size and shape differences between both sexes foot bones showed that male bones were larger than female bones. Also, measurement of articular surface suggested that females bones have the potential for more movement to occur in the direction of adduction (Jill *et al.*, 2004).

CONCLUSION

From the obtained results of this study supported by the relevant literature, it can be concluded that the prevalence of flat foot is not influenced by age but influenced by gender. There was no significant correlation between age and incidence of flat foot in obese children, while, here was significant correlation between gender and incidence of flat foot in obese children. There was a greater prevalence of flat foot among obese males compared with females.

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