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RESEARCH ARTICLE

CORRELATION OF BODY MASS INDEX WITH NAVICULAR HEIGHT IN YOUNGS

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ABSTRACT

Background: Flat foot or pes planus is one of the main postural deformities. The arch provides an elastic springy, connection between fore foot and hind foot. The varying lifestyles and food habits has created an ongoing epidemic of obesity in children and adults, and it has highlighted the importance body fat for short term and long term health. The foot print of an obese person looks like a flatfoot print due to the accumulation of fat under the medial longitudinal arch. This gives an impression of pes planus irrespective of navicular position. Thus this study aims to find out whether the navicular bone actually drops according to the BMI.
Methodology: The study was done on college a student aging from 18-22, navicular height, Arch index and BMI was calculated by measuring height and weight and the navicular height was measured using measuring scale in standing position.
Result: Out of 132 participants including male and female were found to have flat foot. The mean age, BMI, navicular height left & right were 18.86±1.08, 20.84±3.37, 4.24±0.7, 4.38±0.7 respectively. We found BMI is having negative correlation with navicular height.
Conclusion: This study reveals that navicular height drops as BMI increases.

INTRODUCTION

Flat foot or pes planus is one of the main postural deformities. The arch provides an elastic springy, connection between fore foot and hind foot. The varying lifestyles and food habits has created an ongoing epidemic of obesity in children and adults, and it has highlighted the importance body fat for short term and long term health. Weight bearing or loading on children legs plantar arch begins to develop and it keep budding throughout the early decades of their life. 21 to 57 percentages of children before school age have a tendency to develop flexible flat foot. Flexible flat foot prevalence diminishes with increase in age, but once rigid flat foot develops, changing to foot biomechanical abnormalities leading to pain, influence the act of physical activity and gait (Lin *et al.,* 2001). A rigid flat foot is an eternally fixed deformity on flat position of foot irrespective with weight bearing or not. The medial longitudinal arch permits the foot to distribute weight and shock absorption during erect postures (Huang *et al.,* 1993). Foot acts as a key stone in maintaining stable platform for static and dynamic functional activities.

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However, it is contradictory when dealing with the rigid flat foot can forecast flexible flat foot conduct. There are enough literature supports for both static and dynamic foot arch measurements. Human foot is the part mainly affected by anatomical variations in the entire human body, and one of the most important characteristics presenting the highest level of variability is the medial longitudinal arch, and navicular height. And an arch index provides a quantitative measurement of the plantar arch, which can be compared to other measurements (Hernandez *et al.,* 2007). Obesity is an issue that is becoming increasingly prominent in almost every developed and developing nation. We are all aware that obesity has negative effects on our bodies, but most of this focus is directed at issues such as heart disease and diabetes. The reality is that obesity affects the entire body, and its effects on our feet are largely overlooked (Krul *et al.,* 2009). The first and perhaps most obvious effect that obesity will have on our feet is that it places a far greater amount of weight on them when we stand or move about. This results not only in placing immediate physical stress on the skin and bones in our feet, but also physically alters them over time (Steele *et al.,* 2015). Fallen arches are a common side-effect of obesity, and can lead to long term pain, as well as a number of other problems. This is a result of both the extra weight that is being placed on the feet, as well as the fact that obesity wears down shoes at a much faster rate than usual. Similarly, obesity will often result in pronation, which is itself often a result of fallen arches. Pronation is a condition where people stand or walk not with their feet flat on the ground, but slightly on the side. This pushes the heels outwards and our ankles closer together (Lin *et al.,* 1999). Need of the study: The foot print of an obese person looks like a flatfoot print due to the accumulation of fat under the medial longitudinal arch. This gives an impression of pes planus irrespective of navicular position. Thus this study aims to find out whether the navicular bone actually drops according to the BMI.

MATERIALS AND METHODS

Methodology: This study constituted 132 college students aging from 18 to 22 years of old. Before commencing the study Institutional ethical committee clearance and individual consents were taken to avoid the unethical practice. Students with foot injuries and allergy to dyes/ink were excluded from the study. Each students Body mass index (BMI), right and left navicular height, and occurrence of flat foot were measured.

BMI Calculation: Body Mass Index or Quetelet Index is a value obtained from mass of the body (in kg) by height of an individual (in m^2). BMI categorizes an individual as underweight, Normal weight, Overweight and obese. BMI values greater than 30 kg/m^2 considered as obese individuals (Mauch *et al.,* 2008).

Navicular Height and Arch Index Measurement: The subject was standing on one leg on an elevated platform with the other leg supported on a stool. The width and length of both feet were measured. The foot width was measured between the first and fifth metatarsal heads. The foot length was measured from the most posterior point of the calcaneus to the end of the longest toe. The navicular height (NH) was obtained from the lowest palpable medial projection of the navicular to the supporting surface (Huang *et al.,* 1993). All the measurements were performed by the same experienced physical therapist. A set of data, including 132 feet with the navicular height measured twice by the same physical therapist, was used to evaluate the intra-observer reliability.

The plantar arch index establishes a relationship between central and posterior regions of the footprint, and 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 (Queen *et al.,* 2007). 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 (Figure 2). The plantar arch index (PI) is obtained by dividing the A value by B value (PI = A/B). The diagnosis of flatfoot was based on an inked plantar impression technique (footprint) and the calculation of 'Arch Index' was consistent with the method introduced by Cavanagh and Rodgers. A footprint was rejected and repeated if apparent foot displacement occurred on the paper sheet during recording.

Statistical Analysis: Was done by using SPSS ver 21.0. Descriptive analysis and average calculation of the standard deviation and mean was analyzed.

Pearson Correlation between right and left navicular height with BMI also done to identify the relationship between BMI vs Navicular height.

RESULTS AND DISCUSSION

The total number of participants in this study was 132 college students. Among them 30 subjects were males and 102 subjects were females. The mean and standard deviation of age group of the subjects were 18.86 ± 1.08. And the BMI mean value were 20.84 ± 3.37 (Table 2). We also found that there is not much difference in the values of navicular height between right and left. Navicular height average was 4.24 ± 0.7 and 4.38 ± 0.7 in left and right respectively. The arch index also calculated to find out the occurrence of flat foot among the 132 subjects. Arch index mean value was 0.68 ± 0.8 and 0.72 ± 0.8 in left and right respectively. (Table 2) Arch index value 1 or more than 1 implies flat foot. Table 3 shows the correlation values between navicular height and BMI. Pearson correlation test was used to find out the relationship between these two parameters. The correlation shows negative values on left and right navicular height. BMI is having negative correlation with navicular height, which shows that arch gets flatten as the body weight increases. People with more body weight will have reduced navicular height. It is due to the elasticity of non contractile structures of the foot which supports the arch and gets more deformed as body weight increases.

Figure 1. Navicular Height Measurement

Figure 2. Arch Index Measurement

Table 1. BMI Categories by WHO

Category	BMI (Kg/m^2)
Underweight	< 18.5
Normal Weight	18.5 – 24.9
Over Weight	25 – 29.9
Obese	30

Table 2. Descriptive statistics of the variables

	Mean ± SD
Age	18.86 ± 1.08
BMI (Kg/m^2)	20.84 ± 3.37
Navicular Height – Left (cm)	4.24 ± 0.7
Navicular Height – Right (cm)	4.38 ± 0.7
Arch Index – Left	0.68 ± 0.8
Arch Index – Right	0.72 ± 0.8

Table 3. Pearson correlation between navicular height and BMI

	Navicular Height (Left)	Navicular Height (Right)
BMI (kg/m^2)	-0.132	-0.95

Obesity is a problem that affects essentially the entire body, but its effects on the feet are often ignored, despite them being so painful and potentially life-altering. Fallen arches and pronation will lead to a wide number of other problems very quickly. Swelling of the ligament that connects the heel to the toes is the most common side effect of obesity on feet, resulting in sharp pain throughout the foot. This, as well as the extra weight associated with obesity, soon results in pain extending up the leg, particularly in the shin. Ultimately, the knees, hips, and back are affected, which results in severe and chronic pain throughout most of the body. These factors altogether affect how we walk, sit, sleep, and generally hold ourselves, which will usually result in further pain and complications. The combination of the extra weight, pain, and exhaustion makes it far less likely that people will exercise, which then exacerbates all of the aforementioned issues. Obese people are also more susceptible to ankle sprains, which will further decrease the amount of exercise a person does.

The traditional clinical measurements of arch height typically describe the vertical height of some bony landmarks of the foot with respect to the horizontal surface. However, this measurement only considers the height of the foot arch and the variations of the bone make it difficult for clinicians to accurately identify the landmarks, raising concerns about reliability. Staheli et al. stated that the arch increased significantly from ages two to six, (Staheli *et al.,* 1987) while Henning found the foot arch matured at the age of six (Hennig *et al.,* 1994). And a rapid progression of the medial longitudinal arch occurring between two and six years old was reported by Volpon in 1994. However, Gould et al. postulated that while arch development was faster during the first two years after starting to walk, it continued until five years of age (Gould *et al.,* 1989). Navicular height is an index which only represents the height of the medial longitudinal arch and. Therefore, it not really reflects the completed characteristics of the arch. Basmajian et al. concluded that the support of the medial longitudinal arch is ligamentous, and that the muscle is used only as a dynamic stabilizer (Basmajian and Stecko, 1963). However, there are few studies that investigate the biomechanical properties of the ligaments at different ages in growing youngs, and this could be a topic for future research. The incidence of flat foot increased with greater values of BMI. People with higher BMI were more prone to have symptomatic flat foot. Persons with overweight and obesity had reduced dorsiflexion range, more pronated heel and flatter plantar arch. It is acknowledged that fractional corrections of flatfoot occur in pre-pubertal ages. Several developmental factors like BMI and the lower limb configuration persuade the normal growth of the foot structure. Associated misalignments of the lower limb can influence the normal maturity of the foot and adapt the gentle nature of the flexible flat foot to a pathologic situation. The investigation of the correlating factors of flat foot helps to establish the causal factors affecting the foot structure in youngs. This research entail that youngs with rigid flat foot who have higher BMI are at higher threat of malformation development in the later on ages. BMI increment is not an issue that can be dealt with using a single-pronged approach, but if a person is serious about tackling their weight issues and looking after their body, taking care of the feet is an absolute necessity. Wearing comfortable shoes that provide arch support and prevent pronation is the most effective way to begin, but ultimately, weight loss is the only real solution. This result recommends that healthcare professionals should consider pain and foot deformity into relation in their experimental assessments, particularly for youngs with overweight and obesity that have compacted dorsiflexion range and pronated heels. Early interventions in those can be valuable to avoid the exacerbation of surplus weight and foot issues in those young.

Conclusion

This study concludes that navicular height drops as BMI increases and navicular drop not directly indicating the occurrence of flat foot. Due to the elasticity of non contractile structures of the foot which supports the arch and gets more deformed as body weight increases.

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REFERENCES

Basmajian, JV. and Stecko, G. 1963. The role of muscles in arch support of the foot. *J Bone Joint Surg Am.,* 1184–1190.

Cavanagh, PR. and Rodgers, MM. 1987. The arch index: a useful measure from footprints. *J Biomech.,* 20:547–551. 29.

Chen, CH., Huang, MH., Chen, TW., Weng, MC., Lee, CL., Wang, GJ. 2006. The correlation between selected measurements from footprint and radiograph of flatfoot. *Arch Phys Med Rehabil.,* 87:235-40.

Gould, N., Moreland, M., Alvarez, R., Trevino, S., Fenwick, J.1989. Development of the child's arch. *Foot Ankle,* 9:241–245.

Hennig, EM., Staats, A. and Rosenbaum, D. 1994 Plantar pressure distribution patterns of young school children in comparison to adults. *Foot Ankle Int.,* 15:35–40.

Hennig, EM., Staats, A. and Rosenbaum, D. 1994. Plantar pressure distribution patterns of young school children in comparison to adults. *Foot Ankle Int.,* 15:35–40.

Hernandez, AJ., Kimura, LK., Laraya, MHF. and Favaro, E. 2007. Calculation of staheli's plantar arch index and prevalence of flat feet: a study with 100 children aged 5-9 years. *Acta Ortop Bras*., [serial on the Internet].; 15(2):68-71.

Huang, CK., Kitaoka, HB., An, KN. and Chao, EY. 1993 Biomechanical evaluation of longitudinal arch stability. *Foot Ankle*, 14:353–357.

Huang, CK., Kitaoka, HB., An, KN. And Chao, EY. 1993. Biomechanical evaluation of longitudinal arch stability. *Foot Ankle,* 14:353–357.

Jelen, K., Tetkova, Z., Halounova, L., Pavelka, K., Koudelka, T. and Ruzicka. P. 2005. Shape characteristics of the foot arch: dynamics in the pregnancy period. *Neuro Endocrinol Lett.,* 26:752–756. 30.

Krul, M., van der Wouden, JC., Schellevis, FG., van Suijlekom-Smit, LW. and Koes, BW. 2009. Musculoskeletal problems in overweight and obese children. *Ann Fam Med.,* 7: 352–356.

Lin, CJ., Lai, KA., Kuan, TS. and Chou, YL. 2001. Correlating factors and clinical significance of flexible flatfoot in preschool children. *J Pediatr Orthop.,* 21:378–382.

Lin, CJ., Lin, SC., Huang, W., Ho, CS. and Chou, YL. 1999. Physiological knock-knee in preschool children: prevalence, correlating factors, gait analysis, and clinical significance. *J Pediatr Orthop.,* 19: 650–654.

Mauch, M., Grau, S., Krauss, I., Maiwald, C. and Horstmann T. 2008. Foot morphology of normal, underweight and overweight children. *Int J Obes.,* 32: 1068–1075.

Onodera, AN., Sacco, IC., Morioka, EH. et al. 2008. What is the best method for child longitudinal plantar arch assessment and when does arch maturation occur? *Foot (Edinb)* 18: 142–149.

Queen, RM., Mall, NA., Hardaker, WM., Nunley, JA. 2007. 2nd: Describing the medial longitudinal arch using footprint indices and a clinical grading system. *Foot Ankle Int.,* 28:456–462.

Staheli, LT., Chew, DE. and Corbett, M. 1987. The longitudinal arch. a survey of eight hundred and eighty-two feet in normal children and adults. *J Bone Joint Surg Am.,* 69:426–428.

Steele, JR., Riddiford-Harland, DL. and Mickle, KJ. 2015. Excessive Weight Bearing Compromises Foot Structure and Function Across the Lifespan, *The Mechanobiology of Obesity and Related Diseases*, Springer: New York, pp. 149–179.

Volpon, JB. 1994. Footprint analysis during the growth period. *J Pediatr Orthop.,* 14:83–85. 33.

Volpon, JB. 1994. Footprint analysis during the growth period. *J Pediatr Orthop.,* 14:83-5. 28.

Wearing, SC., Hills, AP., Byrne, NM., Hennig, EM. and McDonald, M. 2004. The arch index: a measure of flat or fat feet? *Foot Ankle Int.,* 25: 575–581. 42.

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