Original Article

# Correlation between Foot Transverse Arch Index and Foot Posture Index in Identifying Foot Arches in Healthy Population

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**How to cite this article**: Pubali Das, S. Jeyakumar, Annie Thomas et. al. Correlation between Foot Transverse Arch Index and Foot Posture Index in Identifying Foot Arches in Healthy Population. Indian Journal of Physiotherapy and Occupational Therapy / Volume 18, Year 2024.

**Abstract**

**Background:** Medial longitudinal arch of foot plays a crucial role on maintaining ankle during weight bearing activities. In previous studies arch index derived from foot print shows a negative correlation with the navicular height. There are no other studies have correlated mathematically derived foot print values with standing arch height measurements with an acceptable equation. This study correlates arch index and foot posture index to identify foot arches.

**Methods:** subjects with high arch have taken for the study**.** The study type is observational study was done on sample size n=60,foot arch index and foot posture index was evaluated with the samples.

**Findings:** a r- value of 0.333, there is a Negative correlation between Arch index and Foot posture index in low arched foot. There is no significant correlation, and the a r- value of 0.173, there is a low positive correlation between arch index and foot posture index in high arched foot.

**Interpretation:** Among high arched foot and low arched foot, Foot Posture Index and Arch Index is correlated, according to Pearson's correlation, only high arched foot shows low positive correlation between Foot Posture Index and Arch Index. Flatfoot shows negative correlation.

**Keywords: pes cavus,** Pes planus, foot arch index, foot posture index

## Introduction

The ankle and foot complex play a critical role in maintaining erect posture, as also in adaptation to supporting surfaces, in correcting postural sway in single limb stance, in shock absorption and in transition of ground reaction force. [(1)] The structure of foot is critical to affect the load absorbed by the bones in the foot and force transferred to proximal components of lower extremity when performing exercise with weight bearing on foot.[(1)] Medial longitudinal arch is the largest arch of the foot and most important crash of foot from a clinical point of view. The bony share, ligaments and muscular tones all play an important role in supporting arches. [(2)]

Based on the structure of medial longitudinal arch, three types of foot have been proposed (i) the normal foot (ii) high arched foot or supinated foot or pescavus (iii) low arched or pronated foot or pesplanus [(1-3)] Measurement of height of arch of foot deserves immense importance as far its clinical

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aspects are concerned and for this purpose since middle of part century several neither were used by pioneer researchers.[3]

Practically the height of medial longitudinal arch provides acceptable outlook of arch height. Some researchers have classified the foot arch type by only visual impression which was practised until last century.[4,5,6] Few of them carried on such a classification based on palpation of naviculartuberosity[7]. In late nineties researchers approached with the help of radiography in parallel with footprint. Radiological parameters like 'talar height', 'navicular height' and recently the 'normalized navicular height' obtained from standing weight bearing lateral view of x-ray foot were accepted to predict arch height [8-11].

Procurement of and processing the footprint being easier and cheaper, is more acceptable for patient than radiography is still important in establishing arch height [12-13]. Footprint obtained on a graph sheet by conventional ink is better than an electronic footprint obtained by a special software system[14]. The concept of arch index was first described by Cavanagah et al (1987).

A six item criterion reference took the Foot Posture Index which wasdeveloped in response to a requirement for a quick, easy and reliable method for measuring foot position in variety of clinical settings.[15 Razeghi and Batt [15]discuss the current measures (2002) available based on foot morphology and classify according to four categories : visual assessment, anthropometric values, footprint measures and radiographic appraisal to date, there are only two foot posture measures – the arch index[16] and the rear foot angle[17] for which normative data are available. The FPI is the only approach that captures information about standing foot posture in multiple foot segments without a requirement for complex measurement techniques.

## Materials and Methods:

The arches form is created similarly to a spring; it supports the weight of the body and cushions the shock caused by movement. The flexibility of the foot provided by the arches makes it easier to perform regular locomotor activities like walking and running. The energy-saving spring hypothesis of the foot's arch has emerged as a key concept in explanations of the mechanical behaviour and evolutionary history of the foot. The passive-elastic labour the arch performs that would otherwise be performed by active muscle accounts for the majority of the metabolic energy saved by the arch. The taller of the two horizontal arches is the medial arch. It consists of the first, second, and third metatarsals as well as the calcaneus, talus, navicular, and three cuneiforms. Its summit is located at the superior articular surface of the talus, and its two extremities, or piers, are the heads of the first, second, and third metatarsal bones anteriorly and the tuberosity on the plantar surface of the calcaneus posteriorly, on which it rests when upright.

The Tibialis posterior tendon, which is spread out in a fan-shaped insertion and prevents excessive tension of the ligament or such an amount of stretching as would permanently elongate it, supports the ligament inferiorly and strengthens it medially by blending with the deltoid ligament of the ankle joint. The plantar aponeurosis, the tiny muscles in the bottom of the foot, the tendons of the Tibialis anterior and posterior and Peronaeus longus, as well as the ligaments of all the associated articulations, all contribute to supporting the arch.

When upright, the lateral arch, which is the flatter of the two longitudinal arches, is on the floor. It is made up of the cuboid, the fourth and fifth metatarsals, and the calcaneus. Its peak is located at the talocalcaneal articulation, and its main joint is the calcaneocuboid, which has a unique locking mechanism and only permits a small range of motion. The two strongest ligaments, the long plantar and the plantar calcaneocuboid, as well as the Extensor tendons and the short muscles of the little toe, maintain the integrity of this arch, which is characterised by its solidity and slight elevation. The arches are complete at the posterior part of the metatarsus and the anterior part of the tarsus, but they exhibit more characteristics of half-domes in the middle of the tarsus, whose concavities are directed downward and medially, so that when the medial borders of the feet are positioned in apposition a complete tarsal dome is formed. The interosseous, plantar, and dorsal ligaments, the short muscles of the first and fifth toes (especially the transverse head

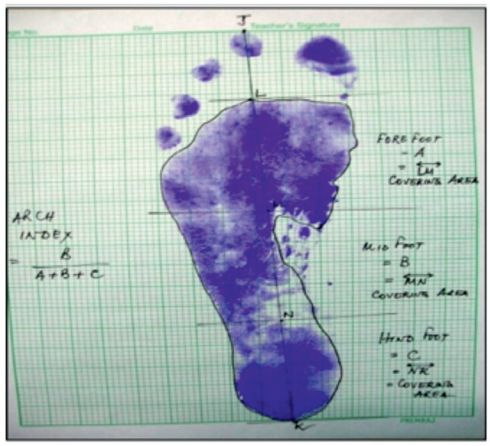
of the Adductor hallucis), and the Peroneous longus, whose tendon extends across between the piers of the arches, all work together to reinforce the transverse arches.

The FPI-6 is a quick, accurate diagnostic instrument that rates foot posture using predetermined criteria and a straightforward scale. It is used to determine how pronated, normal, or supinated a foot is. It is a measurement of standing foot posture and should not be used in lieu of a gait analysis when time and resources permit. However, compared to many of the static weightbearing and non-weightbearing goniometric measures presently used in clinic, it is a more reliable method. The FPI findings assist in choosing the best interventions to use with your patient, such as gait training, strengthening, stretching, or manual therapy. The Foot Posture Index findings aid in selecting the right orthotic for the patient.

The study done targeted with High arched and flat foot people with a Sample size n= 60. Convince sample method is used to select samples from the population. Study design was observational study with foot marking reading evaluation. Materials used are Foot posture index - Conventional ink and Graph sheet . The study Period is for one week. Patients with high arched foot and flat foot. Patients diagnosed with Hallux valgus, plantar fasciitis, Neuropathic foot, Hammer toe, Club foot are excluded from the study.

Arch index is obtained by conventional ink which was rubbed on the subject's right foot and he or she was instructed to stand still on the centimetre calibrated graph sheet with the ink rubbed whole feet. The standard imprint of 50% of body weight bearing right foot was taken.

Following description of literature, in the foot print the linear distance of the centre of the heel (say point K) and tip of second toe (axis of foot (say point J)) was measured. Next perpendicular kind warp drawn tangential to most anterior point of foot print, excluding the toes. Their point of intersection was marked (say point L). The kind LK was divided in three equal parts perpendicular to foot axis. The anterior, middle and posterior areas were marked as A,B,C respectively. Their areas were determined in square centimetre. Formula for arch index is Arch index = B÷[A+B+C] .




The subject was asked to stand still in a relaxed double limb support stance, arms by the sides and looking straight ahead. Prior to settling into the required stance, it was helpful for the subject to do spot marching. The subject was instructed not to try to look downwards during the assessment, as this would affect foot posture. The subject was required to stand for approximately 2 minutes for the test to be conducted. The tester had uninterrupted access to all aspects of the leg and foot.

The FPI consists of six validated, criterion-based observations of the rearfoot and forefoot of a subject standing in a relaxed position. The rearfoot is assessed via palpation of the head of the talus, observation of the curves above and below the lateral malleoli and the extent of the inversion/eversion of the calcaneus. The observations of the forefoot consist of assessing the bulge in the region of the talonavicular joint, the congruence of the medial longitudinal arch and the extent of abduction/adduction of the forefoot on the rearfoot . Each of the six parts of FPI-6 are evaluated on a scale from -2 to +2. Assessment of foot posture was carried out as stated below and the score was noted in the FPI-6 score sheet. All six items of FPI-6 were evaluated according to the procedure mentioned in The Foot Posture Index User Guide and Manual [22].

| | |
|---|---|
| 0 to +5 | - neutral foot |
| +6 to +9 | - slight foot pronation |
| +10 to +12 | - increased foot pronation |
| -1 to -4 | - slight foot supination |
| -5 to -12 | - increased foot supination |

**Table 1: Pearson Correlation Test**

| Variable | Mean | Std. deviation | N | R-value | Significance |
|---|---|---|---|---|---|
| Arch index (flat foot) | 0.3020 | 0.029 | 30 | -0.333 | 0.072 |
| Foot Posture Index.(flat foot) | 8.30 | 1.291 | 30 | | |

With a r- value of 0.333, there is a Negative correlation between Arch index and Foot posture index in low arched foot.. There is no significant correlation.

**Table 2: Pearson Correlation Test :**

| Variable | Mean | Std. Deviation | N | R-value | Significance |
|---|---|---|---|---|---|
| Arch Index(high arced foot) | .24013 | .142694 | 30 | 0.173 | 0.361 |
| Foot Posture Index(High arched foot) | -4.17 | 2.019 | 30 | | |

With a r- value of 0.173, there is a low positive correlation between arch index and foot posture index in high arched foot.

## Result and Discussion

In low arched foot there is no significant correlation between arch index and foot posture index and in high arched foot there is low positive correlation between arch index and foot posture index.

This study was performed to determine the correlation between Foot Posture Index and Arch Index in abnormal foot arches identification. The result shows that there is no statistical significant correlation between foot posture index and arch index in high arched foot.

Hylton B Menz says that foot posture can be reliably classified as high, normal, low using arch index tool.

Cavanagh and Rodgers defined each foot with cutoff scores. A score of or above 0.28 is indicative of flat foot. A score of or below 0.21 is indicative of high arched foot. Hylton B Menz said that there are some misclassifications although Cavanagh and Rodgers correlated arch index foot categories with arch index scores obtained. There wap a tendency for examiner to categorise participants as having higher arches than AI scores indicated. Hylton says that the degree of contact is particularly indistinct in medial arch region, pm that the examiners might have assumed that slight contact area was no contact thereby offsetting AI classification towards a higher arch. This maw ad the reason for negative correlation between FPI and AI.

According to Thamilvaani Manaharan, Amir Feisal Merican a women need not necessarily have a pair Hylton foot arches between their right and left feet. This conclusion will imply to males too. Thus, in our study only right foot arch index and foot posture index was taken. This may be the reason for negative correlation between FPI and AI in finding abnormal foot arches.

In this study both flexible flat foot, flexible flat foot with shortened achilles tendon and rigid flat foot were examined for foot posture index and arch index scores. However, in flexible flat foot the arch is further lowered in weight bearing position for both foot posture index and arch index. Powers et al 1995 says that FPI is strongly affected by the shape of the soft tissue and provides limited information about bony structures of medial longitudinal arch. This will also add the reason for negative or low positive correlation for FPI and AI.

## Conclusion

Among high arched foot and low arched foot, Foot Posture Index and Arch Index is correlated, according to Pearson's correlation, only high arched foot shows low positive correlation between Foot Posture Index and Arch Index. Flatfoot shows negative correlation.

## References


1. MuellerMJ. The ankle and foot complex. IN:Levangie PK, Norkin CC. Joint structure and Function, a comprehensive analysis. 4thed.Philadelphia: F. A. Davis company; 2005. P. 437-77.
2. Cubucku.S., Alimoglu.M.K., Balci.N., &Beyazova.M.(2005). Planar arch type and strength profile of the majority ankle muscle groups : a morphmetric-isokinetic study. Isokinetics and Exercis Science.13.217-222.
3. Snell, R. S. (2004). Clinical Anatomy (7thed.). Philadelphia:Lippincott Williams & Wilkins.
4. Giladi M. Milgrom C. Stein M. Ey al. The low arch. A protective factor in stress fracturOrthop Rev. 1985; 14:709-712.
5. Dahle LK, Mueller M, Delitto A, Diamond JE. Visual assessment of foot type and Relationship of foot type to lower extermity injury. J Orthop Sports Phys Ther. 1991;14:70-74.
6. Somers DL, Hanson JA, Kedzierski CM, et al. The influence of experience on the Relability of goniometric and visual measurement of forefoot position. J OrthopSportsPhysTher. 1997; 25:192-202.
7. Hawes MR, Nachbauer W, Sovak D, Nigg BM. Footprint parameters as a measure ofArch height. Foot Ankle Int. 1992; 13:22-26.
8. Harris R. Beath T. Army Foot Survey, Nat Res Counc Canada. Ottawa 1947; 1:1-26.
9. Steel MW, Johnson KA, Dewitz MA, Illstrup DM: Radiographic measurement of normal Adult foot: Foot Ankle 1980; 1:151-8.
10. Williams DS. Mc clay IS. Measurements Used to characterize the Foot and the Medial Longitudinal Arch: Reliability and Validity. Phys Ther. 2000: 80(9): 864-871.
11. Hames MR, Nachbeuer W, SovakD et al. Footprint parametersap a measure of arch height. Foot Ankle. 1992:Jan13(1):22-6.
12. Chu Woei Chyn, Shin Hwa Lee et al. The use of arch index to characterize arch height: a digital imaging processing approach. Biomedical Engineering 1995; 42(11):1088-93
13. Mc Crory JL, Young MJ, Boulton AJM, Cavanagah PR. Arch index as a predictor of arch height. Foot 1997;7:79-81.
14. Redmond AC, Crosbie J, Ouvrier RA: Development and validation of a novel saving system for scoring standing foot posture: The Foot Posted Index. Clin Biomech 2006, 21:89-98.
15. Razeghi M, Batt ME : Foot type classification : a critical review of current methods. Gait Posture 2002. 15:282-291.
16. Cavanagh PR, Rodgers MM: The arch index: a useful measure from footprints. J Biomech 1987. 20:547:551.
17. Sobel E, Levitz S, Caselli M, Brentnall Z, TranM : Natural history of the rearfoot angle: preliminary values in 150 children. Foot Ankle Int 1999, 20:119-125.
18. Mueller MJ, Host JV, Norton BJ: Navicular drop as a composite measure of excessive pronation. J AM Podriatr Med Assoc 1993. 83:198-202.
19. Shiang Shin, Tzyy, Yuang, Hwa lee.Evaluating different footprint parameters as predictor of arch height. Available as URL.:http//pubmed.com/ Engineering in Medicine and Biology magazine. IEEE.1998; 16: 62-66: (accessed on 27/7/2008).
20. Redmond AC:. The Foot Posture Index - Easy quantification of standing foot posture. Six item version FPI - 6 user manual.www.leeds.ac.uk/ medicine/FASTER /FPI.
21. Willams.D.S..& Mc Clay.D.S(2000) Measurements used to characteize the foot and medial longitudinal arch : reliablity and validity. Physical Therapy. 80:864-871.
22. Billis E, Katsakiori E, Kapodistrias C, Kapreli E. Assessment of foot posture: Correlation between different clinical techniques. Foot. 2007;17:65–72.
23. Mathieson I, Upton D, Prior TD. Examining the validity of selected measures of foot type: a preliminary study. J Am Podiatr Med Assoc. 2004;94:275–81.
24. Cobey JC, Sella E. Standardizing methods of measurement of foot shape by including the effects of subtalar rotation. Foot Ankle. 1981;2:30–6.
25. Hawes MR, Nachbauer W, Sovak D, et al. Footprint parameters as a measure of arch height. Foot Ankle. 1992;13:22–6.
26. Jarvis HL, Nester CJ, Jones RK, et al. Inter-assessor reliability of practice based biomechanical assessment of the foot and ankle. J Foot Ank Res. 2012;5:14.
27. Menz HB. Two feet, or one person? Problems associated with statistical analysis of paired data in foot and ankle medicine. Foot. 2004;14:2–5.
28. Redmond AC. The Foot Posture Index. FPI-6 User Guide and Manual. 2009. http://www.leeds.ac.uk/ medicine/FASTER/fpi.htm. Accessed 25 Apr 2013.