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Original Research Article

Can long standing affect arches of foot: A cross-sectional study between bus conductors and bank employees

Nagaraj Mallashetty[1,*], Veeresh Itagi[1], Gururaj Pattar[1]

[1] *Dept. of Anatomy, SS Institute of Medical Sciences and Research Centre, Davangere, Karnataka, India*

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ABSTRACT

Introduction: Arches of foot are curvatures found on the plantar surface of the human foot. The presence of these arches is a distinct feature of human feet. They are formed because of the wedge shape of bones and are supported and maintained by the intrinsic and extrinsic muscles, along with the ligaments in the sole of the foot. They are present right from the time of birth. These arches play a major role in bearing the weight of the body. They also act as shock absorbers, especially while jumping, and they provide protection to the soft tissue of the sole against pressure.

Objectives: The objective of present study is to know the effects of long-standing hours on height of arch of foot, by comparing arch index and arch angles of bus conductors, who stand for long hours with that of bank employees who relatively sit for long hours in their duty time. To compare the Stahelis plantar arch index between bus conductors and bank employees. To compare arch angle between bus conductors and bank employees.

Materials and methods: Materials required for taking foot prints include ink pad, graph Sheet. Materials required for calculating stahelis arch index and arch index are measuring scale, protractor, ink pad, ink bottle, graph paper and compass. The subjects to be studied are 50 bus conductors and 50 bank employees within the age group of 35-55 years, who have been in service for a minimum period of 10 years.

Measuring of plantar arch index is done by Stahelis arch index and arch angle by using footprints. A plantar graph of the weightbearing surface of the feet was taken on graph papers with ink pad with the subject standing erect with feet on the ground without any support.

Results: The mean arch index of the right feet of bus conductors and bank employees are .68 and .54 respectively, which is higher for bus conductors than bank employees. The mean arch index of the left feet of bus conductors and bank employees are .69 and .54 respectively, which is more for bus conductors than bank employees The mean arch angle of right feet of bus conductors and bank employees are 42.44 and 49.02 respectively, which is lesser for bus conductors than bankemployees, The mean arch angle of the left foot of bus conductors and bank employees are 43.52 and 48.12 respectively, which is lower for bus conductors than bank employees, by applying Mann whitney U " P" value is found to be less than 0.05. The mean arch index is higher in bus conductors and arch angle is higher in bank employees.

Conclusion: From the present study it is shown that long standing hours can be associated with increase in arch index and decrease in the arch angle of foot, suggesting decrease in the arch height of foot probably due to prolonged stress of standing on architecture of arches of foot.

1. Introduction

The human foot is described as an architectural marvel of the nature. Human foot is a unique feature of man, which

* *Corresponding author*.
E-mail address: nagarajsmalashetti@gmail.com (N. Mallashetty).

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differentiates him from other primates. The foot performs mainly two major functions:

1. It acts as an elastic platform to bear the body weight during standing position.
2. It acts as a lever to push the body forward during walking, running and jumping.

There is a very complex in the nature of human feet architecture, having various constituents working to give the balance, mobility, and support to the erect posture of human body.[1] To accomplish first function, the foot is designed in the form of elastic arches. To fulfill the second function, the foot is so constructed that it is a transformable in a lever.

The arches of foot are classified into two main types, 1.longitudinal arches and 2.transverse arches. Arches of foot are able to sustain of the body weight by distributing it proportionately. Concave nature of these arches prevents damage to the underlying blood vessels and nerves from compressive pressure. When the foot is placed on the ground the arches flatten, but when they are lifted above the ground they regain their basic concave shape. Thus it acts like spring which helps in jumping and running.[2] The arches are present since birth, but they are invisible in infants because of more amount of fat in the soles.

Feet act as foundation to the human bodies and help in performing most necessary functions of day today life. One foot contains 26 bones, held together by ligaments and tendons aponeurosis.

Some activities like prolonged longstanding, the foot can modify structurally over time, resulting a change in shape of the foot. Leading to several foot deformities.

1.1. High arched foot (Pes cavus)

In a usual walking foot, the gait cycle starts with arch of foot in a flat position, allowing the foot to be free enough to adjust to the uneven surface. But when the leg is placed right angle to the ground, the concavity begins to rise to allow the foot to lock and support the body weight as it moves forward.

In high arched foot (Pes cavus), the concavity fails to flatten with weight bearing[3] and the foot remains locked and is not malleable and strikes the ground as the individual starts walking.

1.2. Flat foot (Pes planus)

In Pes planus, foot is a flat and it is one among the most common structural deformities of the foot, in this, the medial longitudinal arch is collapsed.[4] This deformity may be present since birth or acquired when the ligaments and tendons are unable to support the foot architecture.[5]

The height of foot arches is most significant as per the mechanics of structure is concerned. As per studies, no correlation has been found between arch height and performance of activities like jumping, running, weight bearing, balancing, but there is a relation between arch height to the occurrence of fracture of femor, tibia and metatarsal metatarsals.[6]

2. Aims and Objectives

The objective of the study is to know the effects of long standing hours on height of arch of foot, by comparing plantar arch index and arch angles of bus conductors, who stand for long hours with that of bank employees who relatively sit for long hours in their duty time.

To compare the Stahelis plantar arch index between bus conductors and bank employees.

To compare arch angle between bus conductors and bank employees.

3. Materials and Methods

Materials necessary for taking foot prints are ink pad, graph sheet.

Instruments used for calculating Staheli's plantar arch index and foot arch angle are measuring scale, ink pad, ink bottle, graph paper protractor and compass.

The subjects for the study include 50 bus conductors and 50 bank employees within the age group of 35-55 years who have been in service for a minimum period of 10 years.

3.1. Exclusion criteria

1. Foot deformity
2. History of pes clavus and pes planus
3. Existing neurological problem

Measurement of Stahelis arch index and plantar arch angle were performed by taking foot prints of the subjects. A plantar graph of weight bearing surface of the foot was taken on graph papers by applying ink uniformly over the foot with the subject standing erect and foot on the ground without any support.

The boundaries of the complete footprint without toes were outlined and significant geometrical points on the ground were marked.

Calculation of Staheli's plantar arch index.

A straight line was drawn by joining the medial most points of heel and front of the foot at the metatarsal part of the foot print.

A horizontal line, perpendicular to the above straight line was drawn from its midpoint across the footprint. The width of this perpendicular was taken as "A"

One more perpendicular line was drawn in the heel region from its most medial point. The breadth of this perpendicular was taken as "B"

The ratio of A / B is calculated as plantar arch index[7]

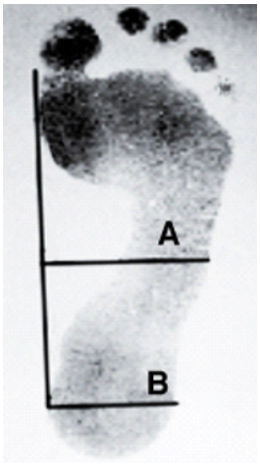

Fig. 1: Plantar Arch Index = A/B

3.2. Arch Angle

For measurement of the plantar arch angle, a straight first line segment was drawn by taking medial most points of heel and metatarsal region as in the calculation of arch index. A second line segment was drawn from the distal point of first line segment to the point where the slopes of this arch meet as shown in diagram.

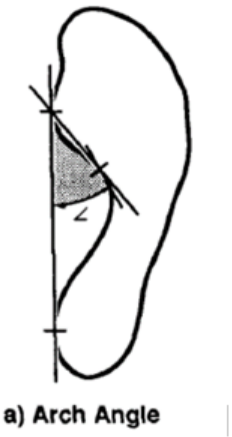

Fig. 2:

3.3. Statistical analysis

Stahelis arch index and arch angle of bus conductors and bank employees were compared by applying Mann Whitney U Test and comparing "p" value.

4. Observation and Result

After applying man Whitney U test, the P-value is 0.000052 which is less than 0.05 suggesting significant value

Fig. 3: Samples footprints of bus conductors

Fig. 4: Samples footprints of bank employees

Table 1: Comparisonbetween right leg arch index of bus conductors and bank employees

Study sample	Mean Arch Index	Standard Deviation	U-Value	P-Value
Bus Conductors	.684	.094	104	0.000052
Bank Employees	.54	.11		

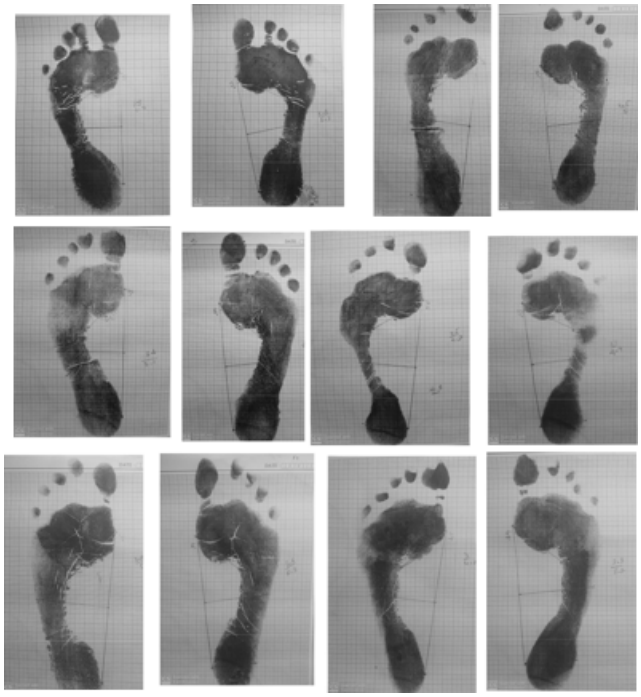

Fig. 5:

indicating increase in arch index of bus conductors.Table 1

Table 2: Comparisonbetween left leg arch index of bus conductors and bank employees

Study Sample	Mean Arch Index	Standard Deviation	U-Value	P- Value
Bus Conductors	0.69	0.114	112.5	0.000104
Bank Employees	0.54	0.118		

After applying man Whitney U test, the P-value is 0.000104 which is less than 0.05 suggesting significant value indicating increase in arch index of bus conductors.Table 2

Table 3: Comparisonbetween right leg arch angle of bus conductors and bank employee

Study Sample	Mean Arch Angle	Standard Deviation	U-Value	P-Value
Bus Conductors	42.44	6.65	122	0.000219
Bank Employees	49.04	6.54		

After applying man Whitney U test, the P-value is 0.000104 which is less than 0.05 suggesting significant value indicating decrease in arch angle of bus.Table 3

Table 4: Comparison between left leg arch angle of bus conductors and bank employees

Study Sample	Mean Arch Angle	Standard Deviation	U-Value	P-Value
Bus Conductors	43.52	4.57	178.5	0.0093
Bank Employees	48.12	6.93		

After applying man Whitney U test, the P-value is 0.0093 which is less than 0.05 suggesting significant value indicating decrease in arch angle of bus conductors.Table 4

5. Results

The mean of arch indices of the right feet of bus conductors and bank employees are .68 and .54 respectively, which is higher for bus conductors compared to the bank employees ,by applying Mann Whitney U test " P" value is found less than 0.05, which is a significant increase in arch index of bus conductors. The mean arch index of left feet of bus conductors and bank employees are .69 and .54 respectively, which is higher for bus conductors than bank employees ,by applying MW U TEST " P" value is found to be less than 0.05, which shows significant increase in arch index of bus conductors .

The calculated mean of plantar arch angles of the right feet of bus conductors and bank employees were 42.44 and 49.02 respectively, which is lower for bus conductors compared to bank employees, by applying Mann whitney U," P" value is found to be less than 0.05 , which shows the significant decrease in the arch angle of bus conductors.

The calculated mean of arch angles of left feet of bus conductors and bank employees were 43.52 and 48.12 respectively , which is lower for bus conductors than bank employees, by applying MWU test, " P" value is found to be <0.05 , which is a significant decrease in the arch angle of bus conductors .

The mean arch index is higher in bus conductors and the arch angle is high in bank employees. Thus by comparing bank employees and bus conductors, it is found that bus conductors have got higher arch index and lower arch angle due to continuous stress on architecture of arches of foot because of long standing.

6. Discussion

In present study footprints of bus conductors and bank employees are compared with stahelis plantar arch index and plantararch angle.

Singrolay. R, et al,[7] in 2015 compared 'Radiological Methods of Foot Parameters' with that of Staheli's Arch Index' using simple footprint method.

They studied on 100 children aged between 5 to 11 years. Their results revealed that similarity between

the plantar arch index and Talo-first metatarsal (TMF) radiological angle was significant with P value less than 0.05 for both feet with value of correlation 0.33 for right foot and 0.49for left foot.

By their study it was found that Staheli's plantar arch index as measured by simple foot print method is just as effective as other radiological methods as a diagnostic tool for determining flat foot.

Considering this in the present study Stahelis Plantar Arch Index is used as a parameter to compare the Arch index of Bus Conductors and Bank Employees.

The mean plantar arch index of the right feet of bus conductors and bank employees are .68 and .54 respectively, which shows higher values for bus conductors than bank employees. The mean plantar arch index of the left feet of bus conductors and bank employees are .69 and .54 correspondingly, showing higher values for bus conductors than bank employees. The mean plantar arch angle of the right foot of bus conductors and bank employees are 42.44 and 49.02 correspondingly, showing lesser values for bus conductors than bank employees. The mean of plantar arch angle of left feet of bus conductors and bank employees are 43.52 and 48.12 correspondingly, showing lesser values for bus conductors than bank employees. The mean arch index is higher in bus conductors and plantar arch angle is high in bank employees. Thus by comparing bank employees and bus conductors, it is found that bus conductors got higher arch index and lower arch angle due to stress on architecture of arches of foot because of long standing.

Plantar arch index value above 1.15, should be considered as suggestive of pes planus. Arch angle less than 31^0 has the tendency to flatness. In present study though no sample showed features of flat foot, but arch index and arch angle values showed significant difference.

Therefore the present study confirms that prolonged standing definitely stresses on Arches of foot, by increasing the arch index and decreasing the arch angle tending towards flat foot.

No similar studies were found**,** but other studies done on arches of foot are:

Chen et al.[8] conducted study on1024 subjects in 2009 to know the prevalence of pes planus in Taiwanese children. They found the incidence of pes planus was more in obese persons (56%) as compared to normal weight (27%) and overweight, (31%).

Eklem Hastalıkları et al in 2009,[9] studied the prevalence of pes planus in male adolescents of Türkiye. They observed the prevalence 0.69% pes planus. Correlation of flat foot as compared to weight and height were not statistically significant.

A.M. Dowling et al[10] in 2001 studied the influence of obesity on structure of foot and plantar pressure pattern in preadolescent children which was carried on 13 obese and 13 no obese children. Body mass index, foot pattern and plantar pressure were compared. It was found that foot discomfort was associated with change in the structure of foot. More forefoot plantar pressure which is seen in the obese foot may hinder obese children in the performance of physical activity.

Shanmukha V V et al,[11] in 2019 studied Staheli Arch Index in the Tribal children of Jharkhand State. Cross sectional study performed on 360 male and female children of less than 15 years age. Mean SAI value was .63 for right foot and .61 for left foot. A decrease in SAI values from 3to 4 years to 14 to 15 years age for both feet was observed. This study concluded that the SAI value goes on decreasing with increasing age.

From above studies, it is observed that increase in the BMI and age is associated with decrease in arch angle and increase in arch index moving towards flat foot. In the present study similar results were observed on study samples of bus conductors whoa stand for long hours that is increase in arch index and decrease in arch angle compared to bank employees.

7. Conclusion

From the present study it is observed that long standing hours can be associated with increase in arch index and decrease in the arch angle of foot, suggesting decrease in the arch height of foot probably due to prolonged stress of standing on architecture of arches of foot.

8. Conflict of Interest

There are no conflicts of interest in this article.

9. Source of Funding

None.

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Author biography

Nagaraj Mallashetty, Associate Professor

Veeresh Itagi, Associate Professor

Gururaj Pattar, Medical Student

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