Study of correlation between arches of foot and lower back pain in Eastern India

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ABSTRACT

Background: Low back pain is one of the most common disorders of the musculoskeletal system, leading to impaired function and decreased quality of life in many patients. Foot arch alterations may lead to structural changes and/or affect its load distribution. It should be noted that even slight elevations of the foot's medial longitudinal arch above the norm may lead to changes in load and pressure distribution. Hence, it becomes important to find the relationship between low back pain and altered foot arch indices leading to improper body balance. **Aims and Objectives:** The aims and objectives of the study are to find any correlation between lower back pain and an altered foot arch index in the Eastern Indian population. **Materials and Methods:** A total of 60 subjects aged 20–40 years with varying degrees of low back pain were selected. Low back pain scores of the subjects were found using modified oswestry low back pain disability questionnaire. Footprints in standing position using ink were taken on graph paper and the foot arch indices were calculated. **Results:** 54.16% of the male and 36.11% of female participants had low arched feet, 20.83% of male and 52.78% of female participants had normal arched feet, and 25% of male and 11.11% of female participants had high arched feet with varying degrees of low back pain. 77.42% of the participants with minimal disability due to low back pain were having normal arched feet, 71.43% of the participants with moderate disability due to low back pain were having low arched feet, and 100% of the participants with severe disability due to low back pain were having either high or low arched feet. **Conclusion:** This study showed that people having either low or high arched feet are at an increased risk of developing acute or chronic low back pain at some stage in their lives. Knowledge of this risk factor might even help people to choose appropriate occupations in the future.

Key words: Low back pain; Foot arch; Foot arch index acute low back pain

INTRODUCTION

Low back pain is one of the most common disorders of the musculoskeletal system leading to impaired function and decreased quality of life. In addition, the disease also brings heavy economic costs to the patients and society.[1]

Low back pain is experienced in 60–80% of adults at some point in their lifetime. Estimated the annual worldwide low back pain incidence in adults was found to be 15% with a point prevalence of 30%.[2] Low back pain is manifested by pain, muscle tension, or stiffness between the lower costal margin and inferior gluteal folds which might or might not radiate to the lower extremities. Cause of low back pain can be divided into specific caused by a specific pathophysiological mechanism (herniated disc, infection, osteoporosis, etc.), or non-specific which is caused by an unknown reason.[3] Acute low back pain is a self-limited condition and usually resolves without medical treatment in <4 weeks. On the other hand, chronic low back pain is a persistent form of low back pain that is of moderate intensity, lasts for more than 3 months, and results in substantial limitations in activity.[4]

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The foot is a very important part of the bio-kinetic chain connecting the lower limb to the spine, through the pelvis. The longitudinal and transverse arches of the normal, healthy foot help in proper load distribution. It should be noted that even slight elevations of the foot's medial longitudinal arch above the normal may lead to changes in load and pressure distribution. It has been suggested that inappropriate tension in some parts of the body may be transmitted to distant parts of the musculoskeletal system causing overload and functional restrictions.[5]

Approximately 80% of the general population has alterations in the feet. Three types of foot arches have been described. They are low arch (flat feet; pes planus), normal arch (neutral foot), and high arch (pes cavus).[6-8]

Hence, it becomes important to find the relationship between low back pain and its probable cause due to an improper body balance because of an altered foot arch index. If any relation is found between the two, then the treatment of low back pain can be advanced to newer long-term methods by correcting the foot arch indices of the patients through various exercises.

Aims and objectives
Aim of the study is to find a correlation between lower back pain and an altered foot arch index in Eastern Indian population.

The objectives are:

• To measure and calculate the different types of foot arches among individuals of different age groups and sexes in Eastern India.
• To find out the low back pain score of the subjects using modified Oswestry low back pain disability questionnaire.
• To observe any association of altered foot foot arches with low back pain severity.
• To observe the gender difference in the presence of flat in different age groups.

MATERIALS AND METHODS

The approval was sought from the Institutional Ethics and Scientific Research Committee of Jagannath Gupta Institute of Medical Sciences and Hospital, Budge Budge under the letter number (JIMSH-IEC-17–2022). This cross-sectional observational study was conducted in Kolkata with 60 participants aged between 20 and 40 years with varying degrees of low back pain. Informed consent was obtained from the subjects before the study.
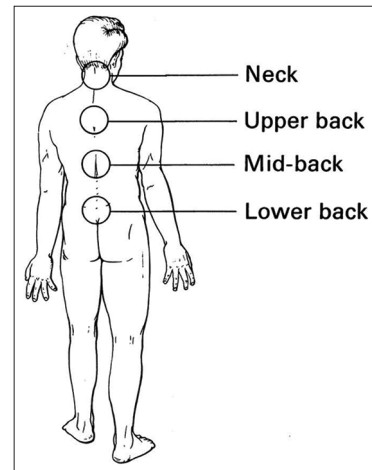
The study was conducted in two phases. In phase 1,

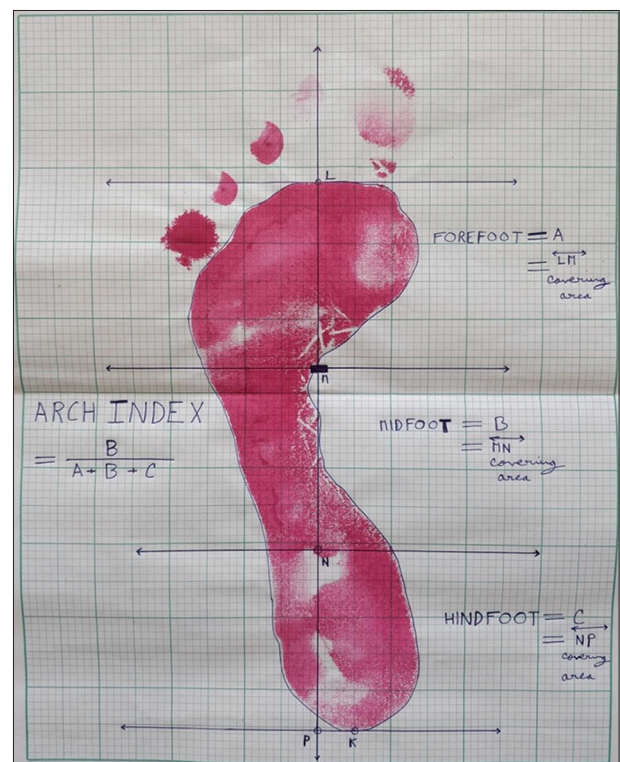**Figure 1:** Body chart used to determine the location of low back pain[11]

Figure 2: The photograph of the left footprint of a subject along with the markings for the foot arch index calculation. A – Forefoot, B – Midfoot, C – Hindfoot

consenting subjects with varying degrees of low back pain were administered the oswestry low back pain disability questionnaires.[9,10] This prevalidated questionnaire contains one optional and nine compulsory sections. This questionnaire helped to generate a score which was used to assess the respective low back pain intensities of the subjects (Figure 1).

In phase 2, the foot arch indices of all the subjects were measured and compared with the normal range. For

calculating the foot arch index, first, an impression of one foot coated with red or blue ink dye was taken on graph paper in standing position. The same procedure was repeated with the other feet (Figure 2).

Thereafter, the length of the foot excluding the toes was measured. This length was then divided into three regions: A – forefoot; B – midfoot; and C – hind foot. The arch index is then calculated by dividing the midfoot region (B) by the entire footprint area (i.e., arch index=B/[A+B+C]).

RESULTS

The study employed a total of 60 participants. Among them, 24 (40%) were males and 36 (60%) were females. The mean age of male participants was 28 years and that of female participants was 35 years. All of the participants had low back pain of varying intensities.

It was found that 41.66% of the male participants were financially comfortable and the rest were uncomfortable. Among the female participants, 44.44% of them were financially comfortable and the rest were uncomfortable. The body mass index (BMI) of each participant was calculated by dividing the weight (in kilogram) of the participant by a square of height (in metres) of the participant.

The BMI values thus obtained were categorized using the standard classification[11,12] as follows: Severely underweight – BMI <16.5 kg/m^2, underweight – BMI under 18.5 kg/m^2, normal weight – BMI ≥18.5–24.9 kg/m^2, overweight – BMI ≥25–29.9 kg/m^2, and obese – BMI ≥30 kg/m^2.

It was found that most of the females were having a normal BMI while most of the men were either overweight or underweight.

The categorization of foot arch types was done according to the following classification:[13] Arch indices ≥0.260 were considered low arched, arch indices between 0.210 and 0.260 were considered normal arched, and arch indices ≤0.210 were considered high arched. The range arch of low arched foot indices in male was between 0.263-0.407 in right foot and 0.275-0.423 in left foot while in female it was 0.264-0.398 in right foot and 0.260 - 0.349 in left foot (Table 1). A total of 43.3 % participant had low arch indices while 16.6% had normal and 40 % had high arch indices. (Table 2). The frequency distribution of the various foot arch types showed a higher frequency of low arches (54.1%) in male in comparison to females (36.1%) (Table 2 and Figure 3).

The scores generated for the low back pain intensities of the participants were according to their respective responses in the oswestry low back pain disability questionnaire.[9,10]

The grading of the low back pain intensities of the participants was done according to the classification given in the oswestry low back pain disability questionnaire[9,10] as follows: 0–20%: Minimal disability, 21–40%: Moderate disability, 41–60%: Severe disability, and 61–80%: Crippled.

It was found that 77.42% of the participants with minimal disability due to low back pain were having normal arched feet, 71.43% of the participants with moderate disability due to low back pain were having low arched feet, and 100% of the participants with severe disability due to low back pain were having either high or low arched feet (Table 3). The percentage distribution of the disability due to low back pain is shown in Fig 4 as minimal disability in 51.6%, moderate in 35% and 13.3% having severe disability.

DISCUSSION

The present study aimed at evaluating an association between foot arch indices and corresponding lower back pain in 60 patients of Eastern India in the age group of 20–40 years having non-traumatic low back pain.

Low back pain is a common complaint among individuals engaging in prolonged standing such as teachers and

Table 1: Comparison of the range of arch indices of both feet according to the type of foot arch		
Foot arch type	**Male**	**Female**
High arched foot		
Left	0.167–0.180	0.182–0.205
Right	0.130–0.203	0.143–0.156
Normal arched foot		
Left	0.217–0.250	0.222–0.250
Right	0.218–0.238	0.212–0.259
Low arched foot		
Left	0.263–0.407	0.264–0.398
Right	0.275–0.423	0–0.349
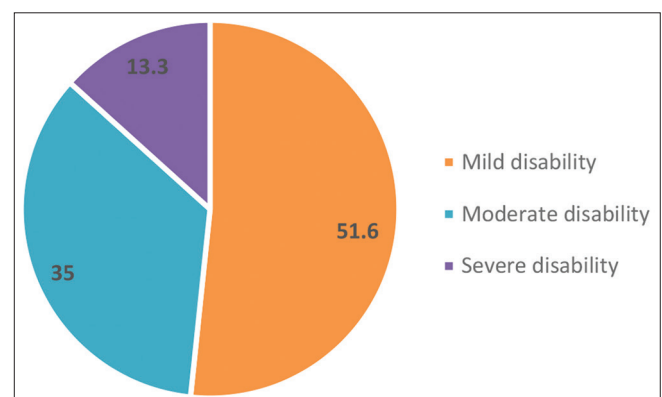
Figure 3: Percentage distribution of the subjects (%) with different degrees of low back pain intensity

students, due to the constant mechanical load placed on the entire lower extremity and spine.[14] In our study, 13.3% of subjects suffered from severe low back pain whereas 35% from moderate and 51.6% from mild low back pain (Figure 3).

Plantar arches along with the load distribution of the feet can be measured by various methods such as plantigraphy, a podoscope, or baropodometry. In podoscopy, the individual stands with both feet on the glass of the metal frame and the plantar areas are reflected in the mirror, whereby it is possible to analyze the plantar areas submitted to the individual's bodyweight, which makes the assessment very effective.[5] As this study was conducted in a low-and middle-income country where allocation of budget in any research work becomes a big problem, a simple method of measuring the foot index with only graph paper and ink was undertaken.

The present study found a significant association between deviated foot arch types with lower back pain (Table 3). Almutairi et al., stated that flat feet are associated with both acute low back pain and chronic low back pain.[15] These findings were similar to our study where 50% of the participants with low back pain were having low arched feet or pes planus.

Amoozadeh et al., stated that flatfoot can have a relation with the development of mechanical chronic low back pain,[16] again similar to our findings in Table 3 and Figure 4 which shows that as the foot arch indices are increasing (moving toward pes planus), the low back intensities are rising in the participants. A similar finding was found in the cohort study by Chou et al., where co-relation of flatfoot and spinal degeneration leading to low back pain was found.[17]

Borges et al., have stated in their study on the relationship between lumbar changes and modifications in the plantar arch in women with low back pain that a high arch was correlated with more intense algic syndrome.[18] This is in congruence with our results where 100% of the participants with high arched feet were found to be having either moderate or severe disability due to low back pain (Table 3).

On the contrary to our study, Marikkar et al., in their study conducted in Sri Lanka, found no significant association between foot arch types and gender among patients with chronic low back pain.[7] Similarly, no association of low back pain with altered foot arches was found in the studies of Menz et al.,[19] Ojukwu et al.[20] In our study, males with low arched feet had varying degrees of low back pain as shown in Table 2.

## Table 2: Frequency distribution of male and female participants of each foot arch category

Sex of subject	Type of foot arch			Total number of subject
	High arch	Normal arch	Low arch	
Male	6	5	13	24
Female	4	19	13	36
Total	10	24	26	60

Table 3: Comparison of various low back pain intensities with type of foot arch

Low back pain intensity	Type of foot arch			Total
	Normal arch	Low arch	High arch	
Minimal disability	24	7	0	31
Moderate disability	0	15	6	21
Severe disability	0	4	4	8
Total	24	26	10	60
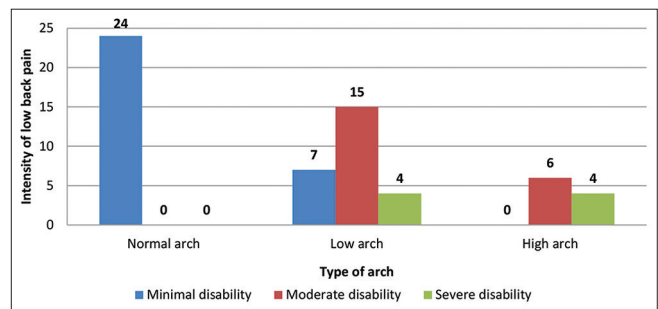
Figure 4: Comparison of various intensities of low back pain with type of foot arch
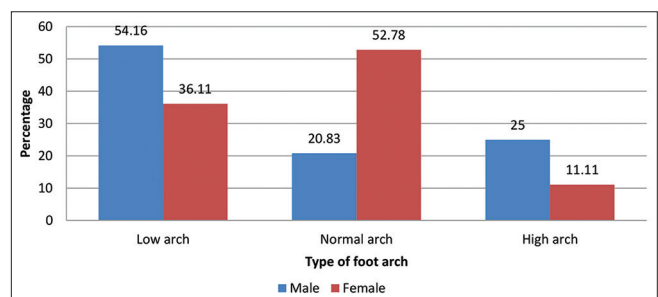
Figure 5: Percentage of different foot arch types among male and female subjects

Sex is another major confounder for both flat feet and low back pain.[15] Females generally differ from males in terms of body alignment, range of motion, and spinal joints. Women with flat feet have a greater static anterior pelvic tilt and dorsal inclination of the spine. Females also tend to have greater internal hip rotation and trunk extension compared with males, accounting for kinematic changes influenced by flat feet.[21,22] On the contrary, our study showed 54.16% of males and 36.11% having flat feet with varying degrees of low back pain (Figure 5).

Age is another major contributing factor to low back pain, along with the presence of flat feet. Subjects above 25 years of age who had flat feet have 7 times more chances to develop chronic low back pain compared to the same age category with normal feet arch.[15] Flat feet usually disappear by the age of six when the feet become less flexible and the arches develop.[22] The rates of flat feet are often higher in children due to ligament laxity, but this then declines with age.[23] Studies have noted that the highest incidence of low back pain is in the third decade of life and the overall increased prevalence increases until age 60–65 years.[4] Therefore, the age factor has contributed negatively to the prevalence of low back pain in combination with the presence of flat feet.[2] Regardless of any weight category, flat feet are significantly associated with acute and chronic low back pain.[15] Our study participants with varying degrees of low back pain and altered indices were between 20 and 40 years of age.

The nature of occupation also plays a significant role in developing both acute and chronic low back pain among subjects with flat feet. Some jobs require longer times of standing, lifting heavy objects, whereas others require operating on chairs behind desks. Subjects may or may not follow healthy ergonometric postures while sitting.[15,24] It has been reported that those subjects who are unsatisfied with their work situation and its physical demands were at a higher risk of developing low back pain.[25] In military forces, applicants with flat feet have been historically rejected due to the risk of developing foot and back pain.[19] The National Health Interview Survey confirmed that white-collar workers such as professional, managerial, or administrative staffs with flat feet were significantly more prone to low back pain. Accordingly, these participants need to be more vigilant about healthy body mechanics and postures during their working hours.[26]

This study encountered some limitations. The sample size was small, and our results might have differed with a larger study sample. In this study, the study participants included teachers, staff, and students. The participants belonged to varying socioeconomic classes with some of the participants managing their back pain using physiotherapy and medications. These participants were excluded from our study as the use of medications and other aids to relieve their pain might and alter the questionnaire scores leading to fallacies in data analysis. Only untreated non-traumatic low back pain patients were included in the study.

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CONCLUSION

Pes cavus or pes planus is deformities that accompany the individual since early childhood. This study showed that people having either low or high arched feet are at an increased risk of developing acute or chronic low back pain at some stage in their lives. Although medications and physiotherapy can relieve the symptoms of low back pain when they occur, knowledge of predisposition to these conditions from early life can help people to prepare accordingly and start wearing special shoes and using other methods of prophylaxis to minimize the condition as much as possible in the future. Knowledge of this risk factor might even help people to choose appropriate occupations in the future.

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SD- Definition of intellectual content, literature survey, prepared the first draft of the manuscript, implementation of the study protocol, data collection, data analysis, manuscript preparation, and submission of the article; **SM-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **AS-** Design of study, statistical analysis, and interpretation; **RC-** Review manuscript; **RD-** Review manuscript; **SD-** Literature survey and preparation of figures; **RC-** Coordination and manuscript revision; **AL-** Literature survey and preparation of tables and figures

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