

# Cross-Sectional Study of Foot Posture Index, Navicular Drop and Arch Index in Kathak Dancers

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## ABSTRACT

**Background:** Foot posture has long been considered to contribute to the development of lower limb musculoskeletal conditions as it may alter the mechanical alignment and dynamic function of the lower limb. The foot and ankle provides a base of support that aids in postural stability and flexibility. During stance, the foot must be able to adapt to the ground surface, aid in shock absorption and transition to a rigid level to propel the body forward during push-off. The foot and ankle of a dancer are particularly vulnerable to injury. The need of the study is to see whether there is deviation in the foot posture of Kathak dancers. The foot posture index is a clinical diagnostic tool with which we quantify the static posture of the foot.

**Aim:** To study the foot posture in kathak dancers.

**Methodology:** 100 healthy young kathak dancers fulfilling the inclusion criteria were selected from various dancing schools in Delhi. The foot posture was assessed using the foot posture index, navicular drop and arch index.

**Result:** 3 % of the population had supinated foot, 7% of the population had normal foot, 25% of the population had pronated foot and 65% of the population had excessive pronated foot. 3% of the population had supinated foot, 48% of the population had normal foot and 49% of the population had pronated foot. 5% of the population had cavus foot, 17% of the population had normal foot and 78% of the population had planus foot.

**Conclusion:** It can be concluded from the present study that there is deviation in the foot posture of kathak dancers.

**Key words:** kathak dancers, foot posture, foot posture index, navicular drop, arch index.

## INTRODUCTION

Kathak, is a classical dance form from north India characterized by fast, rhythmically sophisticated footwork, quick turns, delicate hand positions and storytelling. <sup>[1]</sup> Kathak dancers are barefoot but because they wear ankle bells and their technique emphasizes stamping and sharp rhythmic shifts, kathak can produce quite a clatter. <sup>[2]</sup> The lower leg, ankle and foot form the terminal portion of lower extremity kinetic chain. The foot and ankle provides a

base of support that aids in postural stability and flexibility. <sup>[3,4]</sup> Kathak dance is an art that combines athleticism with artistry. The demands placed on dancer's lower extremity leaves them at risk for musculoskeletal injuries. <sup>[3]</sup> In professional musical theatre dancers, foot and ankle injuries have been reported as comprising 23%-45% of all injuries. <sup>[3]</sup> The foot and ankle of a dancer are particularly vulnerable to injury and represents 34% to 62% of all injuries reported. <sup>[3]</sup> The lower extremity

chain bears responsibility for important daily function, the most essential being the weight bearing and ambulation. Many activities that require lower extremities to react to these forces by either pronating or supinating the hind foot. [5] The nature of dancer's feet causes the ankle to be forced into extreme plantar flexion. Hence, the kathak dancer is repetitively placing the ankle in an unstable position. [6]

In order to prevent abnormal weight bearing loads, proper biomechanics is crucial in a dancer. Primary and secondary kinetic chain dysfunctions are common in dancers. Rear foot and forefoot deformities, excessive ankle and great toe range of motion, pes cavus and planus all contribute injuries at the foot and ankle, continuing up through the kinetic chain. Most of these dysfunctions come into play when the dancer is turning or landing from a jump. Many jumps in dance require them to land on one foot. This often gives the dancer a disadvantage that often leads to injury. [7-9] The foot posture index (FPI) is a diagnostic clinical tool aimed at quantifying the degree to which a foot can be considered to be in a pronated, supinated or neutral position. It is intended to be a simple method of scoring the various features of foot posture into a single quantifiable result, which in turn gives an indication of overall foot postures. The foot posture index rates weight bearing posture according to a series of predefined criteria. [10]

There are many studies on musculoskeletal injuries performed on dancers of different dance forms like ballet, hip hop, jazz etc. [10]

Any variation in the foot posture of kathak dancers from neutral may predispose them to lower extremity injuries. Therefore, there is a need to assess the foot posture in order to understand the effect of dancing on the feet and to reduce their risk of sustaining lower extremity injuries. [10]

The foot posture index (FPI) is a diagnostic clinical tool aimed at quantifying the degree to which a foot can be considered to be in a pronated, supinated or neutral

position. The navicular drop test is a measure to evaluate the function of the medial longitudinal arch, which is important for examination of patients with overuse injuries. Arch index is the ratio of the middle third of the foot to the entire foot area excluding the toes. [10]

#### **HYPOTHESIS H1- Experimental**

**Hypothesis:** There is deviation in foot posture of kathak dancers. **Ho-Null**

**Hypothesis:** There is no deviation in foot posture of kathak dancers.

**STUDY DESIGN:** Cross sectional study

#### **NUMBER AND SOURCE OF**

**SUBJECTS:** 100 healthy young kathak dancers fulfilling the inclusion criteria will be taken from various dancing schools in Delhi.

**INCLUSION CRITERIA** 1.Both males and females. 2. Age: 18-25 years. [16,17] 3.Duration: 5 or more than 5 years of dancing. [17] 4. 5-6 hours of practice per week. [18] 5. Normal BMI- 18.5-24.9 Kg/m<sup>2</sup>. [19]

**EXCLUSION CRITERIA:** Any history or diagnosed case of: 1.Trauma of lower limb, spine and abdomen (last 3 months) [20] 2.Surgery of lower limb, spine and abdomen (last 3 months) [20] 3. Subjects with neurological dysfunction, musculoskeletal dysfunction, psychiatric or dermatological conditions. [5,11,21,22,23]

4. Subjects with menstrual dysfunctions. [15] 5. Activities other than kathak which may affect outcome of study. [14]

**OUTCOME MEASURE:** Foot posture index, navicular drop and arch index.

**PROCEDURE:** The purpose of study was explained to the subject and a verbal description of all procedures was given. Testing was performed only after informed consents taken from the subjects.

A demographic data of all subjects with duration of exposure per week was

obtained prior to the initiation of the study. Dominant leg was checked by asking the Subject to kick the ball placed in front of them. [5] The foot posture will then be assessed using foot posture index, arch index and navicular drop in the study group. Foot posture is considered to be an important component of musculoskeletal assessment in clinical practice and research. It defines normal and potentially 'abnormal' foot types. [12]

Foot posture index is a clinical diagnostic tool with which we quantify the static posture of the foot. It is a simple and rapid method and has demonstrated good reliability. [24] FPI consists of 6 validated, criterion based observations of the rear foot and forefoot of a subject standing in a relaxed position. The rear foot 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 observation of the forefoot consist of assessing the bulge in the region of the talo-navicular joint, the congruence of the medial longitudinal arch and the extent of abduction/adduction of forefoot on the rear foot. [25]

Navicular drop test is used to evaluate the function of the medial longitudinal arch, which is important for examination of patients with overuse injury. [13]

Arch index is the ratio of the area of the middle third of the foot to the entire foot area excluding the toes. [26]



Illustration 1.3- showing measurement of supra and infra lateral malleolar curvature



Illustration 1.4- showing measurement of calcaneus frontal plane position



Illustration 1.5- showing measurement of prominence in the region of the talo-navicular region



Illustration 1.2- Showing measurement of talar head palpation



Illustration 1.6- showing measurement of the medial longitudinal arch





Illustration 1.7- showing measurement of abduction/adduction of the forefoot on the rear foot



Illustration 1.8- showing measurement of navicular drop



Illustration 1.9(a)- showing measurement of arch index



Illustration 1.9(b)- showing measurement of arch index

A sample of hundred kathak dancers in age group eighteen years to twenty five years

was taken. Out of which, eighty were female and twenty were male kathak dancers. (Refer [Graph 4.1](#))

The mean age of the kathak dancers was 22.06 years and standard deviation was  $\pm 1.989$  years. The mean height of the kathak dancers was 1.608 meters and standard deviation was  $\pm 0.706$ . The mean weight of the kathak dancers was 57.95 kilograms and standard deviation was  $\pm 6.094$ . (Refer [Table 4.1](#))

Foot Posture Index: As per data analysis, the mean of the foot posture index of kathak dancers was 8.17 and the standard deviation was  $\pm 2.648$ . (Refer [Table 4.2](#))

3% of the subjects had supinated foot, whereas, 7% of the subjects had normal foot and 25% of the subjects had pronated foot followed by 65% of the subjects with excessive pronated foot. (Refer [Graph 4.2](#))

Navicular Drop: As per data analysis, the mean of the navicular drop of kathak dancers was 9.19mm and the standard deviation was  $\pm 1.785$ . (Refer [Table 4.2](#))

3% of the subjects had supinated foot, whereas, 48% of the subjects had normal foot followed by 49% of the subjects with pronated foot. (Refer [Graph 4.3](#))

Arch Index: As per data analysis, the mean of the arch index of kathak dancers was 0.2931 and the standard deviation was  $\pm 0.5509$ . (Refer [Table 4.2](#))

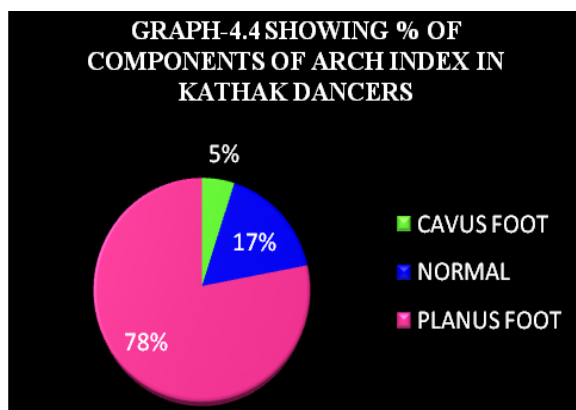
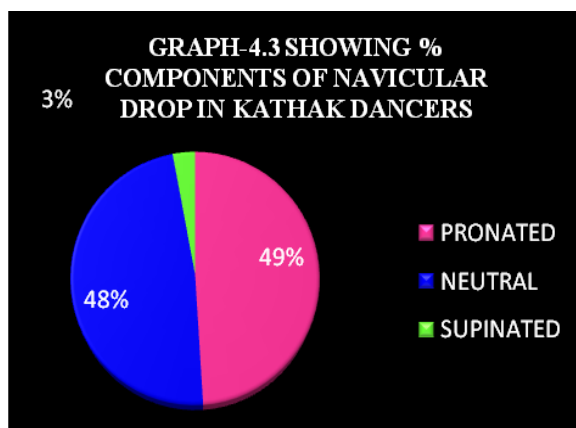
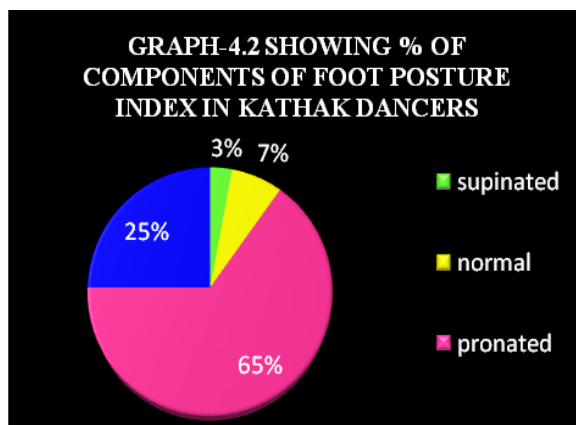
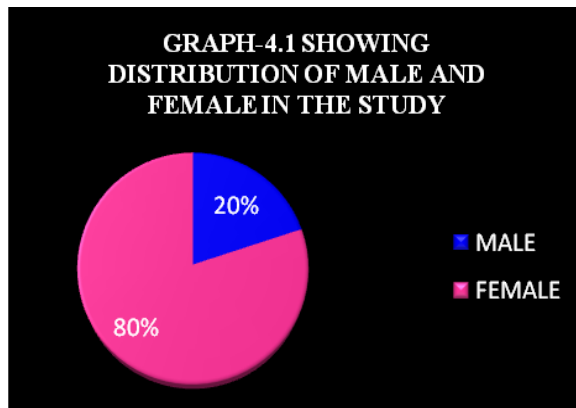
5% of the subjects had cavus foot, followed by 17% of the subjects had normal foot, whereas, 78% of the subjects had planus foot. (Refer [Graph 4.4](#))

TABLE NO. 4.1 Showing mean and standard deviation of age, height, weight and BMI

Subjects N=100	Age (years)	Height (m)	Weight (kgs)	BMI (kgs/m <sup>2</sup> )
Mean	22.06	1.608	57.95	22.47
Standard Deviation ( $\pm$ )	1.989	0.706	6.094	1.4719

TABLE NO. 4.2 Showing mean and standard deviation of FPI, ND and AI

	N	Min.	Max.	Mean	Standard Deviation ( $\pm$ )
FPI	100	-6	12	8.17	2.648
ND	100	2	13	9.19	1.785
AI	100	.1200	.4200	.293100	.0550976
Valid N (list wise)	100				



## DISCUSSION

Kathak, a classical dance form of northern India, is characterized by rhythmically sophisticated footwork, quick turns and storytelling. It includes complex and powerful footwork, multiple spins and complicated compositions of different body postures. [27]

This dance form requires different kinematic and kinetic characteristics while landing from different heights. Different pattern of control due to increased proprioceptive awareness has been hypothesized in various dance forms. [27]

Foot posture has long been considered to influence the mechanical alignment and dynamic function of the lower limb and may therefore be related to the development of lower limb musculoskeletal conditions. Some variations in the foot posture is associated with changes in lower limb motion and muscle activity, and is strongly influenced by some systemic conditions, such as neurological and rheumatologic diseases. Human foot posture is highly variable among healthy individuals and ranges from flat to high arched. Measurement of foot posture is widely considered to be an important component of musculoskeletal examination in clinical practice and research, as variation in foot posture have been found to influence lower limb gait kinematics, muscle activity balance and functional ability, and predisposition to overuse injury. Identification of the hip, knee and ankle joint centres enables the measurement of the lower limb mechanical axis (hip-knee-ankle) angle and mechanical axis deviation, both of which have been used in calculating the predicted amount of alignment correction. [28]

Excessive pronation is characterized by a flattening of the medial arch and a hypermobile midfoot but may also place greater demands on the neuromuscular system to stabilize the foot and maintain upright stance. [6] The result of this study shows that there is deviation in the foot posture of kathak dancers in relation to the

foot posture index, navicular drop and arch index. 65% of the subjects have excessive pronated foot posture as measured by foot posture index, 49% of the subjects shown to have pronated foot as measured by navicular drop and 78% of the subjects were shown to have planus foot as measure by arch index. [29,34]

R.J. Walls stated in his study that overuse injuries of the foot and ankle have been frequently reported in athletes and professional dancers and leads to pronated foot. [25] V. Anbarasi also concluded from his study that dancers have flat foot and muscle tightness problem. Therefore, our study collaborates with the available studies that dancers are at risk of pronated foot which may lead to musculoskeletal disorders during his/her dancing carrier. The nature of dancer's feet causes the ankle to be forced into extreme plantar flexion. Hence, the kathak dancer is repetitively placing the ankle in an unstable position [6] which may indicate towards predisposition of foot, knee and back related problems. [30]

There are a myriad of patients involved in different dancing activities, placing themselves at risk of musculoskeletal injuries. The artistic body movements displayed in dance place specific demands on the body in terms of endurance and aerobic capacity, muscle strength, overall flexibility, joint stability, somatosensory integration, and neuromuscular coordination. [31]

Different foot postures are associated with alteration in foot functions, kinetics and the subsequent occurrence of injury. However, the entire lower extremity is known to be an interrelated functional and mechanical unit, and alterations at one aspect of the lower extremity (e.g., the foot) can have significant impact on distant areas such as the knee. Lower extremity alignment has been proposed as a risk factor for acute and chronic lower extremity injuries, including patella femoral syndrome, anterior cruciate ligament injuries, medial tibial stress syndrome stress fractures, and plantar fasciitis. It has been

suggested that biomechanical changes resulting from abnormal alignment may influence joint loads, mechanical efficiency of muscles, and proprioceptive orientation and feedback from the hip and knee, resulting in altered neuromuscular function and control of lower extremities. [32,33]

The cause of this high prevalence of overuse injuries in dancers varies, but landing mechanics is likely a main contributor because of the repetitive requirement of the legs to absorb landing forces by eccentrically contracting muscles as joints flex.

### LIMITATION OF THE STUDY

1. The ratio of the male to the female is not equal. 2. Maximum hours and years of the practice were not defined. 3. Study was irrespective of the various gharanas of the kathak dance form.

### SCOPE FOR FUTURE RESEARCH

1. Comparison between the foot posture of the male and female kathak dancers. 2. Defining the maximum hours and years of the practice. 3. Study can be on different types of the gharanas of the kathak dance.

### CONCLUSION

It can be concluded from this study that kathak dancers have deviation in the foot posture i.e. pronated foot posture which may indicate towards predisposition of foot, knee and back related problems.

### CLINICAL RELEVANCE:

As per my study it can be concluded that the kathak dancers have pronated foot. So as to improve the quality of life and functional status of kathak dancers we should train them for the correct foot posture and exercises.

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