INTERNATIONAL JOURNAL OF RESEARCH CULTURE SOCIETY
Monthly Peer-Reviewed, Refereed, Indexed Journal
Volume - 7, Issue - 5, May - 2023

ISSN(O): 2456-6683
[Impact Factor: 6.834]
Publication Date:31/05/2023

IJRCS

DOIs:10.2017/IJRCS/202305010 --:-- Research Paper / Article / Review

Assessment of Foot Postural Deviations in Kathak Dancers

[1]Dr. Srushti Patil, [2]Dr. Apoorva Dighe, [3]Dr. Shweta Satish Devare Phadke, [4]Dr. Pranati Tilak
[1]Bachelor of Physiotherapy, TMV's Lokmanya Tilak College of Physiotherapy, Kharghar (affiliated to MUHS).
[2]Assistant Professor, TMV's Lokmanya Tilak College of Physiotherapy, Kharghar.
[3]Professor and Principal, TMV's Lokmanya Tilak College of Physiotherapy, Kharghar.
[4]Campus Director, Kharghar Campus, Tilak Maharashtra Vidyapeeth, Pune, Maharashtra, India.

ABSTRACT: Background: *Kathak is considered to be one of the eight Indian Classical dance form having main characteristics that includes rhythmical tapping of the feet (tatkars), rapid spins (chakkars), facial expressions and different fine hand poses (mudras). With increase in level of Kathak education, prolonged repetitive stress (variations in tapping of the feet) is imposed upon the feet which may lead to changes in the foot posture / foot alignment leading to various musculoskeletal injuries. The need of this study is to assess for the foot posture deviations in Kathak dancers.* ***Methods:*** *30 Kathak dancers (15 male and 15 female dancers) were taken for this study from a dancing school in Mumbai (considering the inclusion criteria). The foot was assessed using Foot Posture Index and Static rearfoot and forefoot angles.* ***Results:*** *From the total study population, maximum population suggested foot pronation for both the feet (about 50% for left and 67% for right), for rearfoot values about 56% showed valgus in right foot and 66% showed no deviations in left foot. For forefoot alignment, maximum population showed forefoot varus (86% for left and 90% for right). Females suggested more foot in pronation as compared to males.****Conclusion:*** *It can be concluded from this study that foot posture deviations are seen in Kathak dancers (lowering of medial longitudinal arch, rearfoot valgus and forefoot varus). It can also be concluded that female dancers are more prone to foot pronation than male Kathak dancers.*

Key Words: *Kathak dancers, rhythmical tapping, foot posture deviations, foot posture index, rearfoot and forefoot angles.*

1. INTRODUCTION:

Kathak is considered to be one of the eight Indian classical dance form. The word 'Kathak' itself describes that it is the art of storytelling i.e. portraying various characters and conveying to the audience in an entertaining manner (combination of art, music and drama). It is a very complex yet lively dance form, where the kathak dancers make use of ankle bells (ghungroos) for rhythm. The main characteristics of Kathak include intricate footwork (tatkars), chakkars (different forms of rotations), complex and fine hand poses (mudras) and facial expressions.[1]

Initial stance or starting position of Kathak dancers is with dancers standing with feet placed in 'V' with about four finger distance space between the hindfeet.[2] Forefeet are placed away from the normal foot axis i.e., forefeet are turned out. This results in excessive strain placed on the midfoot and hindfoot which leads to improper weight distribution and hyper pronation of feet especially the hindfeet are pronated in weight bearing position. But due to repetitive stress imposed for prolonged practice session, over a course of duration, the forefeet tends to deviate from its normal alignment.[3,4] As Kathak dancers perform rapid, rhythmical stamping with the help of ankle bells, there is improper weight bearing on the feet, giving rise to various ankle musculoskeletal injuries. Also, due to repetitive stresses placed on the feet over a period of the time, results in ankle and foot injuries. Maximum reported injuries by Kathak dancers consist of ankle and feet. These repetitive tapping for years can lead to collapse of medial longitudinal arch due to impact of ground reaction force and imbalance that occurs with it.With changes in the medial longitudinal arch, the talus bone deviates from the normal leading to rearfoot misalignment.[8,9,10] Along with this, these injuries or trauma gets aggravated when a dancer performs rapid spins or jumps during the performance where most of the time dancers land on one foot that further leads to improper weight distribution and improper muscle activation.

Furthermore, the ankle bells made up of metallic bells or mainly brass are tied around the ankles bilaterally, approximately consists of about 100 to 150 ghungroos per leg (the number of ghungroos increases with levels) which may put additional stress on the tissues surrounding the ankle and feet. Combined effect of tapping for prolonged duration with ankle bells may affect structural alignment of the ankle and feet joints.[8,10] Over time, the feet undergoes various biomechanical changes and tissues are strained due to weights of ankle bells and stamping because of which

muscles must work harder to carry out movements during performance.[9,10] In today's era, where high demands and stakes are placed on the artists around the globe practicing any art form and the competitive nature among them has lead even the Kathak dancers to strive hard to gain perfection in their art, which can lead vigorous and prolong practice sessions contributing to the changes occurring in the foot posture. Due to various ankle and foot injuries caused in Kathak dancers, the assessment of foot and ankle is considered to be an important as foot and ankle injuries may lead to activation of various compensatory mechanisms in the lower extremities and spine.[10] As in the previous study, only foot posture was assessed in the Kathak dancers, the need for this study to assess the foot posture deviations using FPI-6 and rearfoot, forefoot angles, along with the comparison of these foot posture deviations among male and female Kathak dancers.The foot posture index (fpi-6) is a diagnostic outcome measure usually used to measure the degree to which a foot can be indicated as pronated, supinated or neutral. The rearfoot angle is the angle formed by a line bisecting the Achilles tendon and a line passing through the posterior aspect of the heel of the foot. It is used to measure whether rearfoot is in varus, valgus or in normal alignment. For forefoot angle measurement, the patient is in a prone . The subtalar joint should be in neutral. The examiner stabilizes the subtalar joint and places the goniometer such that the stationary arm is perpendicular to the line drawn from the base of the calcaneus and the movable arm on an imaginary line which is parallel to the metatarsal heads.[15,16,17]

2. MATERIALS AND METHOD:

The present study is of cross sectional study design with convenience sampling. A total study population of 30 Kathak dancers (15 male and 15 female dancers) were included in the study. Study setup was in Sanskriti Nritya Kalamandir, Mumbai. The criteria put forth for assessing the dancers included age group between 18- 30 years, both male and female dancers, dancing experience of more than or 3 years or passed 3 levels and dancers with normal BMI (according to Asian Criteria). The exclusion criteria included Kathak dancers pursuing other extra- curricular activities along with Kathak dancing. Kathak dancers who have undergone any lower limb or spinal surgeries. Kathak dancers suffering from any trauma to the spine or lower limb in past two weeks. Kathak dancers suffering from any congenital deformities, neurological, musculoskeletal deformities. The outcome measures used were Foot Posture Index (FPI), static forefoot and rearfoot angles.

3. PROCEDURE:

This study was ethically approved by the ethical committee of TMV's Lokmanya Tilak College of Physiotherapy, Kharghar. Demographic details were noted and informed written consent of the Kathak dancers were obtained and participants BMI was noted.

Foot posture index-6: The six diagnostic criteria in FPI-6 are: (1) Palpation of talar head (2) observation of supra and infra lateral malleolar curve (3) Alignment of calcaneus in frontal plane (4) Prominence in and around the talonavicular joint region (5) Medial longitudinal arch congruity (6) Forefoot varus or valgus on rearfoot. Scores are divided as -2, -1, 0, 1, 2.[13,14] The final score will be a whole number between -12 to 12. The score between -5 to -12 is suggestive of highly supinated foot, between -4 to -1 as supination of foot, between 0 to +5 is normal, score of +6 to +9 is suggestive of foot pronation and scores between +10 to +12 as highly pronated foot.[(15,16)]The participants were asked to be in standing position and were assessed and observed according to the FPI-6 criterion. The observations were noted and scored.

Rearfoot angle: Before, measuring the angle the participants were taken in prone, with the tested leg extended and placed such as the foot and ankle are outside the plinth.[(17] In this position, following points were palpated: base of calcaneus, Achilles tendon insertion, point marked at the center of Achilles tendon attachment at the height of medial malleoli, center of the calf muscle approximately 15cm from the previous point.[(18)] A line was drawn so as all the point on Achilles tendon attachment is covered. Another line was drawn from the base of the calcaneus which bisects the above line to form an angle. Then the participants were asked to stand in a relaxed stance phase with the stationary arm of the goniometer is placed on the line drawn from the base of the calcaneus while the movable arm is placed on the line drawn through the Achilles tendon attachment points, with fulcrum placed near the point of intersection.[(19)] Normal values i.e., the rearfoot is in neutral when the angle is about 4º of valgus and varus. The rearfoot is said to be in varus when the angle is < 4º and in valgus when the angle is > 5º. The readings were noted and interpreted.

Forefoot angle: The participants was taken in prone with the ankle placed out of the table. Initially, the subtalar joint was taken in neutral position. Then with the help of goniometer(stationary arm perpendicular to the line from base of calcaneus and movable arm is parallel to an imaginary line from the metatarsal heads), the forefoot angle was measured. The forefoot is considered neutral when observation noted is oº. The positive readings suggest of forefoot varus whereas the negative readings suggest of forefeet valgus.

The readings were noted and interpreted. All the three measurement scores and interpretation were correlated and final conclusion was inferred. After the final interpretation, the results were compared between male and female Kathak dancers and readings were noted.

Figure 1: shows rearfoot angle assessment in a Kathak dancer.

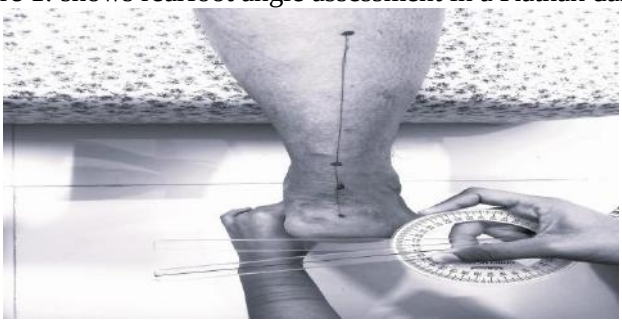

Figure 2: shows forefoot angle assessment in a Kathak dancer.

4. STATISTICAL ANALYSIS:

The present study was conducted on 30 Kathak dancers (15 males and 15 females). Mean and standard deviations were calculated for demographics details. Percentage of the collected data and Coefficient of Correlation was calculated for analysis.

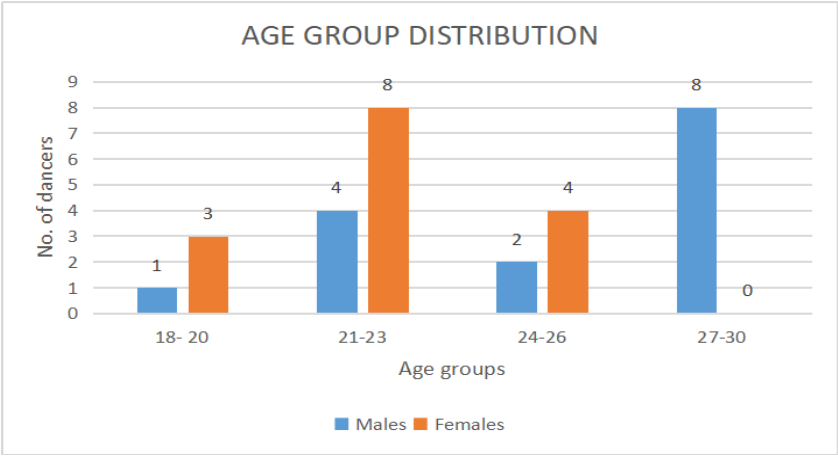

Figure 3: depicts the age and gender distribution in Kathak dancers who volunteered for the study.

AGE GROUP DISTRIBUTION				
GENDER	18- 20 yrs	21- 23 yrs	24- 26 yrs	27- 30 yrs
Males	1	4	2	8
Females	3	8	4	0

Table 1: shows age group distribution in the study population.

ISSN(O): 2456-6683
[Impact Factor: 6.834]
Publication Date:31/05/2023

The observations from Foot Posture Index states that from the total study population about 10% of the Kathak dancers showed foot pronation for both the feet. About 50% of the total population showed the chances of the left foot being in pronation. 67% showed suggestions of foot in pronation in their right foot. Around 40% showed no deviations in left foot and 23% showed no deviations in their right foot.

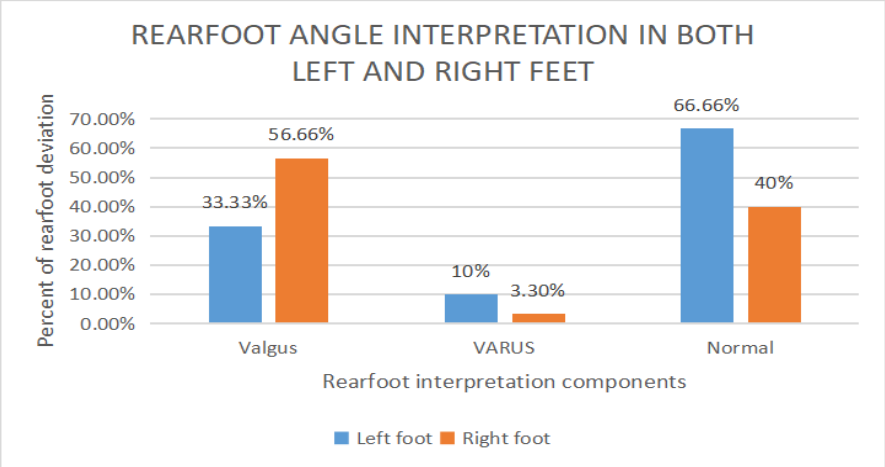

Figure 4: shows rearfoot angle interpretation in left and right feet for total population.

The observations from this study states that about 33.33% of Kathak dancers showed rearfoot valgus in left foot and 56.66% showed rearfoot valgus in right foot. About 66.66% showed no deviations in rearfoot in left foot and 40% in rearfoot in right foot. Rearfoot varus was noted in about 10% and 3.33% Kathak dancers in left and right foot respectively.

FOREFOOT ANGLE INTERPRETATION IN BOTH LEFT AND RIGHT FEET FOR TOTAL SAMPLE POPULATION (N=30)		
	LEFT FOOT	RIGHT FOOT
FOREFOOT VARUS	86.66%	90%
NORMAL	13.33%	10%
VALGUS	0	0

Table 2: shows forefoot angle interpretation in both left and right feet for total study population.

FOOT POSTURE INDEX IN MALE AND FEMALE KATHAK DANCERS				
	FEMALES		MALES	
	Left foot	Right foot	Left foot	Right foot
Foot Pronation	6.66%	6.66%	13.33%	13.33%
Suggests foot pronation	73.30%	93.33%	40%	40%
Normal	26.66%	0	46.66%	46.66%
Suggests foot supination	0	0	0	0
Foot supination	0	0	0	0

Table 4: shows foot posture index interpretation in female and male Kathak dancers for both the feet.

ISSN(O): 2456-6683
[Impact Factor: 6.834]
Publication Date:31/05/2023

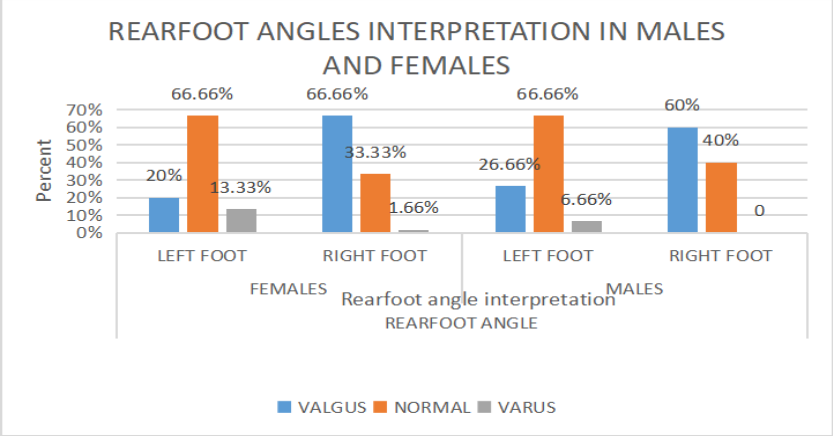

Figure 5: describes the percentage of rearfoot angle variations in male and female Kathak Dancers in both left and right foot.

The graph to the right shows rearfoot angle interpretation and comparison in male and female Kathak dancer. In females dancers, about 20% showed rearfoot valgus in left foot and 66.66% showed valgus in right foot. There were no changes in rearfoot angle in about 66.66% and 33.33% for left and right foot respectively. Rearfoot varus was seen to about 13.33% and 1.66% in left and right foot. In male dancers, rearfoot valgus was seen in about 26.66% and 60% for left and right foot respectively, 66.66% showed no changes in left foot and 40% showed no changes in right foot. Rearfoot varus was seen in 6.66% for left foot.

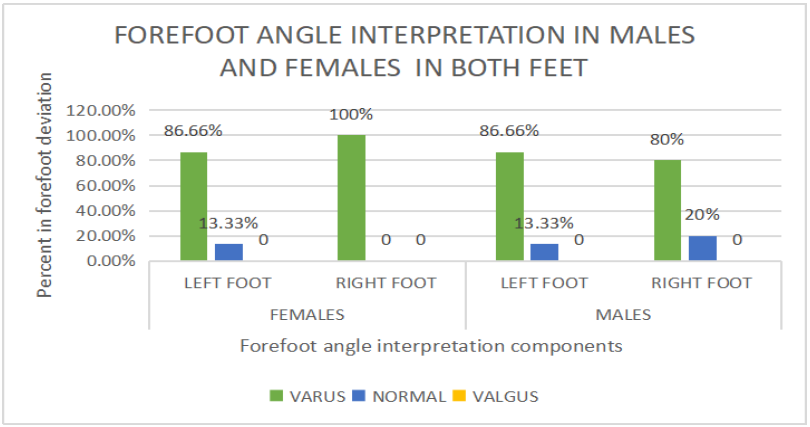

Figure 6: describes variations in forefoot angles of male and female Kathak Dancers for both left and right foot.

The graph on the left shows the forefoot angle interpretation in both feet of male and female Kathak dancers. About 86.66% dancers , both male and female dancers showed forefoot varus in left foot. 13.33% of female and male dancers showed no forefoot deviations in left foot. In right foot female dancers showed 100% forefoot varus and about 80% male dancers showed forefoot varus in right foot. 20% male dancers showed no forefoot angle deviations.

5. DISCUSSION:

Kathak dance is one of the eight classical dance forms which requires extensive footwork, rapid spins and facial expressions, which are used to express various emotions, actions or depict a story. The rhythm of the dancers is generated through the rhythmical and repetitive tapping of the ghungroo tied feet.[1] Due to increase in the hours and days of practice as well as increase in the syllabus with years, the dancer's feet undergo various musculoskeletal changes. The current study was conducted to assess the foot posture changes occurring in the Kathak dancers (both males and females) between the age group of 18 to 30 years. The postural deviations in foot were assessed using Foot Posture Index (FPI-6), static rearfoot and forefoot angles. The starting position of Kathak dancers is with dancers standing with feet placed in 'V' with about four finger distance space between the hind feet i.e. the heels of the foot are almost in touch to form an angle.[2] Forefeet are placed in turned out i.e. forefeet in abduction. This can lead to imposing excessive strain on the midfoot and hindfoot which leads to improper weight distribution and hyper pronation of feet especially the hindfeet are pronated in weight bearing position. Due to which supination occurs at the transverse tarsal joint to maintain the

alignment of the forefeet. But due to repetitive stress imposed for prolonged practice sessions, the forefeet tends to deviate from its normal alignment.[3] With prolonged duration the dancers tend to stand with deviated feet even in normal standing position. As this stresses continue for prolonged duration, inadequate supination at transverse tarsal joint results in the medial forefeet i.e. the first and second rays are dorsiflexed due to the ground reaction force which increases its impact during tapping on the floor. The lateral forefeet i.e. the fourth and the fifth rays are responsible for the plantarflexion of the tarsometatarsal joint so as to keep the whole of the forefeet in contact with the ground. Thus, the forefeet goes in abduction and inversion aka forefoot varus.[3,4,5] As talus is considered to bear the whole of the body weight, lowering or flattening of the medial longitudinal arch can lead to misalignment of the talus i.e. deviate from its anatomical position. In the rearfoot, eversion and adduction occurs, as the subtalar joint axis reduces causing rearfoot valgus which further leads to excessive foot pronation.[8,10]

The collapse of medial longitudinal arch as tapping makes primarily use of tibialis posterior, flexor hallucis longus and flexor digitorum longus. Tibialis posterior acts as a dynamic stabilizer of the medial longitudinal arch (by elevation of medial longitudinal arch stabilizing midtarsal bones making hindfoot and midfoot rigid), aids in plantarflexion and inversion.[5,6] The flexor hallucis longus supports the medial longitudinal arch, flex great toe, stabilize the metatarsal head and supinate the subtalar joint. Due to dysfunction of tibialis posterior, the surrounding ligaments and joint capsules become lax leading to flat feet. Also, foot overpronation can occur due to dysfunction of tibialis posterior which results in improper eccentric contraction of the muscle.[6] The flexor hallucis longus tendon is at a risk of friction and compression at various tendon insertion sites. At the plantar midfoot, the flexor hallucis longus tendon is passed over by the flexor digitorum longus tendon (aka knot of Henry). At this site, the tendon sheaths of both the muscles communicate. Thus, microtears or any microtrauma at the location or inflammation leads to dysfunction of both the muscles.[7] From a study conducted in 2021 by Yamazaki et al. published in Journal of Foot and Ankle Research, there is general joint laxity and increase in plantar fascia elasticity during ovulation (i.e. during higher estrogen levels) in females. [21] Considering this, it can be hypothesized that due to increased joint and ankle laxity in females combined with the microtrauma to the musculature, altered biomechanics of the starting posture or stance and prolonged practice sessions (rapid and rhythmical tapping), the incidence of foot pronation is seen more in females than in males. In future studies, dominance and relation between menstrual cycles and ankle and foot should be considered to fully assess the prevalence and affinity of foot pronation in both the sexes.

6. CLINICAL IMPLICATIONS:

From this study it is stated that there are foot posture deviations present in Kathak dancers i.e. foot pronation with flattening of medial longitudinal arch, forefoot abduction and rearfoot valgus. This may lead to many musculoskeletal injuries occurring in and around the ankle joint and foot. Also, the years of practice and negligence in treating these changes may later on lead to compensatory changes in the lower limb and lumbar spine, further increasing the risk of musculoskeletal injuries and pain. An early intervention is necessary to avoid further complications and injuries and in prevention of the same. A proper education regarding the foot posture changes, their complications and treatment is important. Strengthening of lower limb musculature is considered to be pivotal in maintenance of Foot posture.

7. CONCLUSION:

From this study conducted on both male and female Kathak dancers, it can be concluded that Kathak dancers show significant changes in their foot posture. Due to increase in frequency of their practice sessions with increase in their training levels (i.e rhythmical tapping variations), it is seen that Kathak dancers show depression in medial longitudinal arch, forefoot abduction and rearfoot valgus leading to foot pronation. The study also showed that female Kathak dancers are more prone to foot pronation than the male Kathak dancers. However, the study lacks to provide accurate comparisons due to small sample size, Kathak gharanas not taken into consideration and lack of noting down of the number of years gap taken in between their Kathak education.

8. ACKNOWLEDGEMENT:

It is my genuine pleasure to express my deep sense of gratitude to my guide, Dr. Apoorva Dighe(PT). Her dedication and keen interest and above all her overwhelming attitude to help her students has been solely and mainly responsible for completion of my research work. Her timely advice and scientific approach has helped me to a great extent to accomplish this task. I owe my sincere and deep sense of gratitude to my dance Guru, Sangeet Acharya, Dr. Rupali Desai for always helping her disciples in need and her timely advice in my research work. I also owe a special thanks to all the members from the Dance community for providing me with their sincere cooperation in carrying out my research work.

REFERENCES

1. Morelli, S. (2010). Intergenerational adaptation in north indian kathak dance. *Anthropological notebooks*, *16*(3).
2. Walker, M. (2009). Kathak log ya kathak nrtya: The search for a dance called kathak. *Indian Musicological Society. Journal of the Indian Musicological Society*, *40*, 168.
3. Levangie, P. K., & Norkin, C. C. (2011). *Joint structure and function: a comprehensive analysis*. FA Davis.
4. Donatelli, R. (1987). Abnormal biomechanics of the foot and ankle. *Journal of Orthopaedic & Sports Physical Therapy*, *9*(1), 11-16.
5. Kohls-Gatzoulis, J., Angel, J. C., Singh, D., Haddad, F., Livingstone, J., & Berry, G. (2004). Tibialis posterior dysfunction: a common and treatable cause of adult acquired flatfoot. *Bmj*, *329*(7478), 1328-1333.
6. Bubra, P. S., Keighley, G., Rateesh, S., & Carmody, D. (2015). Posterior tibial tendon dysfunction: an overlooked cause of foot deformity. *Journal of family medicine and primary care*, *4*(1), 26.
7. Newman, D. P., Holkup, K. C., Jacobs, A. N., & Gallo, A. C. (2021). Recalcitrant Flexor Hallucis Longus Dysfunction: A Case Study Demonstrating the Successful Application of an Adaptable Rehabilitation Program With a Two-Year Follow-Up. *Cureus*, *13*(4).
8. Sabharwal, R., & Singh, S. (2017). Prevalence of ankle instabilities and disabilities among female Kathak dancers. *Physiotherapy-The Journal of Indian Association of Physiotherapists*, *11*(2), 45.
9. Chandan, S., Tamaria, S., Gaur, D., Chadha, C., & Sharma, P. Cross-Sectional Study of Foot Posture Index, Navicular Drop and Arch Index in Kathak Dancers.
10. Sabharwal, R., & Singh, S. (2017). Foot postural deviations in female Kathak dancers. *International journal of physiotherapy*, *4*(1), 38-43.
11. Masal, S., & Borkar, P. (2021). Epidemiology of musculoskeletal injuries in Indian classical dancers: A systematic review. *International Journal of Physical Education, Sports and Health*, *8*(3), 310-319.
12. Neal, B. S., Griffiths, I. B., Dowling, G. J., Murley, G. S., Munteanu, S. E., Franettovich Smith, M. M., ... & Barton, C. J. (2014). Foot posture as a risk factor for lower limb overuse injury: a systematic review and meta-analysis. *Journal of foot and ankle research*, *7*, 1-13.
13. Kuo, Y. L., & Liu, Y. S. F. (2017). The foot posture index between elite athletic and sedentary college students. *Kinesiology*, *49*(2), 202-207.
14. Vijayakumar K, Senthil y Kumar. Morphometric Analysis of Ankle and Foot in Classical Bharatanatyam Dancers Using Foot Posture Index (FPI) And Plantar Scan Images (PSI). IOSR Journal of Dental and Medical Sciences. 2016;15(5):20-5.
15. Buchanan, K. R., & Davis, I. (2005). The relationship between forefoot, midfoot, and rearfoot static alignment in pain-free individuals. *Journal of Orthopaedic & Sports Physical Therapy*, *35*(9), 559-566.
16. Garbalosa, J. C., McClure, M. H., Catlin, P. A., & Wooden, M. (1994). The frontal plane relationship of the forefoot to the rearfoot in an asymptomatic population. *Journal of Orthopaedic & Sports Physical Therapy*, *20*(4), 200-206.
17. Hunt, A. E., Fahey, A. J., & Smith, R. M. (2000). Static measures of calcaneal deviation and arch angle as predictors of rearfoot motion during walking. *Australian Journal of Physiotherapy*, *46*(1), 9-16.
18. McPoil, T. G., & Cornwall, M. W. (1996). Relationship between three static angles of the rearfoot and the pattern of rearfoot motion during walking. *Journal of Orthopaedic & Sports Physical Therapy*, *23*(6), 370-375.
19. Evans, A. M., Copper, A. W., Scharfbillig, R. W., Scutter, S. D., & Williams, M. T. (2003). Reliability of the foot posture index and traditional measures of foot position. *Journal of the American Podiatric Medical Association*, *93*(3), 203-213.
20. Behling, A. V., & Nigg, B. M. (2020). Relationships between the foot posture Index and static as well as dynamic rear foot and arch variables. *Journal of biomechanics*, *98*, 109448.
21. Yamazaki, T., Maruyama, S., Sato, Y., Suzuki, Y., Shimizu, S., Kaneko, F., ... & Edama, M. (2021). A preliminary study exploring the change in ankle joint laxity and general joint laxity during the menstrual cycle in cis women. *Journal of Foot and Ankle Research*, *14*(1), 1-8.