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Prevalence of foot posture deviations in professional dancers of South Gujarat- A cross sectional study

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Abstract
Background: Dance is an art that combines athleticism with artistry. Dancers are clearly athletes in the degree to which they require sophisticated physical capacities to perform at a high level. The foot and ankle provide a base of support that aids in postural stability and flexibility. The high demand placed on the feet of these dancers leads to injuries over a period than spontaneous. Hence, assessing foot posture is essential to detect any deviations occurring.
Methods: A cross sectional study was conducted in Various Dance Academics of South Gujarat. The subjects were included into the study based on inclusion and exclusion criteria. Outcome measures of the study were Navicular Drop Test and FPI-6**.**
Results: The prevalence of foot posture deviations in dancers was examined using the Navicular Drop Test and FPI-6, revealing significant findings. According to the Navicular Drop Test, 30% of dancers showed deviations, with higher rates among age group of 18-23 (36%) and with BMI 18.5-24.9 (32%). Experience-wise, dancers with 11-15 years of experience unveiled the highest prevalence that was 50%. Females had a higher prevalence (33%) compared to males (25%). Concerning dominance, 30% of dancers had deviations in their right foot and 25% in their left foot. In terms of dance form, Bharatnatyam dancers had the highest prevalence (39%) following (26%) in Freestyle and Kathak and (22%) in Contemporary dancers. Meanwhile, the FPI-6 analysis showed a 51% prevalence of pronation and 13% of supination. Pronation was more common in younger dancers and those with higher BMI, longer experience, and among females. Hip-Hop dancers exhibited the highest pronation rates (74%). However, supination was mainly observed in adult dancers and Kathak dance form.
Conclusion: This study indicates high prevalence of foot posture deviations according to FPI-6 and moderate prevalence according to Navicular Drop Test.

Keywords: Professional dancers, foot posture deviations, pronation, supination

Introduction

Dance is an art that combines athleticism with artistry [1]. Dance is a conscious effort to create visual designs in space by continuously moving the body through a series of poses and pattern training. The movement must also be in symmetric and should follow a particular rhythm [2]. Dancers are clearly athletes in the degree to which they require sophisticated physical capacities to perform at a high level [3].

Globally there is a unit completely different sorts of dances like the Line Dance, Salsa Dance, Ballet Dance, Break Dance, B-Boying, Kathak Dance, Yanko Dance, Tap Dance, Hip Hop Dance [4].

Anatomy Of Foot

The bones of the ankle and foot consist of the distal tibia and fibula, seven tarsals, five metatarsals, and 14 phalanges. The foot is divided into three segments: the hindfoot, midfoot, and forefoot [5].

Arches Of Foot

1. **Longitudinal**

a. **Medial:** This arch is considerably higher, more mobile, and resilient than the lateral.

b. **Lateral:** This arch is characteristically low, has limited mobility, and is built to transmit Weight and thrust to the ground. This contrasts with the medial longitudinal arch which acts as a shock absorber [5].

2. **Transverse**

a. **Anterior:** It plays a crucial role in modulating the elasticity and rigidity of the foot, acting as a stiff spring lever that stores energy for propulsion during movement [6].

b. **Posterior:** The posterior transverse arch of the foot provides stability to the midfoot and forefoot by traversing from a higher medial to a lower lateral side, contributing to foot biomechanics and modulating the rigidity of the foot [7].

The lower leg, ankle, and foot form the terminal portion of the lower extremity kinetic chain. The foot and ankle provide a base of support that aids in postural stability and flexibility [9].

The foot in the human body serves various essential functions, including

- enabling locomotion
- bearing the weight of the body
- absorbing shocks while walking
- Maintaining balance [10].

The feet play crucial role in dancing, serving functions of support, balance, and propulsion. Dancer's feet are complex structure that must cope with high forces while maintaining stability [11].
In any form of dance, great strain is placed on the lower extremity and the strong but sensitive foot. A large percentage of injuries to dancers involve the foot and ankle.[12] Therefore excessive strain like loading the foot with continuous foot tapping movements during dancing over the hard surface produces a high level of compressive

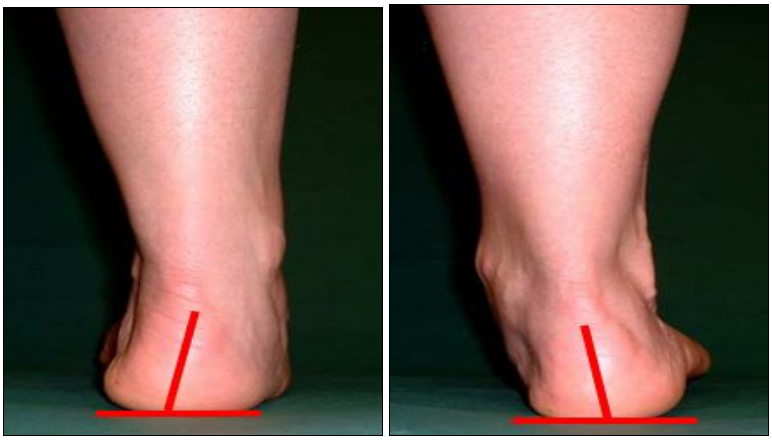
force over the heel, tarsal and metatarsal joint complex may alter the integrity of the structure of the foot arch thus leading to flatness of foot [13]. The high demand placed on the feet of these dancers leads to injuries over a period of time than spontaneous [14].

Foot Posture Deviations refer to variations from the ideal alignment of the foot, often characterized by the contour of the medial longitudinal arch. These deviations can include

- pronated (flat foot)
- supinated (high-arched foot)
- other abnormal foot postures [15].

Pronation causes medial longitudinal arch to flatten, which might lead to compensating forefoot varus [16].

Supination of foot is linked to stiffness and poor shock absorption because it locks the sub talar joint to keep the body balanced and conserve energy, and create a hard lever to push off during the gait last stride [16].



[A] **[B]**

Fig 1: [A] Pronated Foot [B] Supinated Foot [18]

Poor foot posture and misalignment have been reported to result in increased musculoskeletal injuries, which include low back pain, ankle/foot injuries due to overuse, patellofemoral pain syndrome, and medial stress syndrome. Therefore, the primary aspect of an appropriate clinical response involves early assessment and evaluation of the foot posture [19].

Dance injuries are generally classified into two types, acute traumatic injuries and overuse injuries resulting from repetitive microtrauma [20].

The etiological factors of lower extremity injuries in dancers are muscle weakness, improper footwear, high impact torsion during jumping movements and some environmental factors.[13] Such as performing on hard up sprung floor surfaces the demand for an exaggerated turn out from hips, use of thin-soled soles on bare foot [21].

Many studies document injury patterns, with the lower leg, foot, and ankle making up roughly 40% and knee and hip each about 20%. Prevalence of foot and ankle pain within same year was 84% in Ballet Dancers, 79% in Chinese Dance and 70% in Contemporary Dancers [22]. Due to intensive practicing and training for hours together over the hard surface leads to Patho mechanical changes in the foot arch structure [13].

Different foot postures are assessed with alteration in foot functions, kinetics, and the subsequent occurrence of injury [9]. Meanwhile, there is an evident lack of studies that have prospectively examined factors associated with injury occurrence in youth dancers involved in different dance styles [23].

The Foot Posture Index (FPI-6) is a clinical assessment tool used to classify foot posture [4]. It is a quick and reliable diagnostic tool that quantifies the degree to which a foot is pronated, neutral, or supinated [24]. The Navicular Drop Test is a measure to evaluate the function of medial longitudinal arch, which is important for examination of patient with overuse injuries.[9]

Assessing various foot postures is crucial for understanding injury risks in youth dancers, yet there is a notable lack of prospective studies in this area. The Foot Posture Index (FPI-6) and Navicular Drop Test offer efficient ways to classify foot posture and evaluate medial longitudinal arch function, aiding in injury prevention in dancers

Methodology

- **Study Setting**
- Various Dance Academics of South Gujarat.
- **Study Design**

Cross–sectional study.

- **Study Sample Size**

150 Professional Dancers.

- **Study Sample Design**

Convenient Sampling.

- **Study Population**

Professional Dancers of South Gujarat.

- **Study Duration**

The study was undertaken for a total of 6 months.

Material Used

- A Pen and pencil
- Assessment form
- FPI datasheet
- Weight machine
- Measurement tape
- Marker
- Scale
- Paper
- Step stool
- Ball

Selection Criteria

- **Inclusion Criteria**
- Age between 18-35 years [28]
- Minimum dancing experience of 1years [28]
- Both males and females [9]
- Normal BMI – 18.5 to 24.9 kg\m^{2}and over weight – 25.0 to 29.9 kg\m^2[9]
- 5 to 6 Hours of practice/week [9]
- Willing to Participate [9]

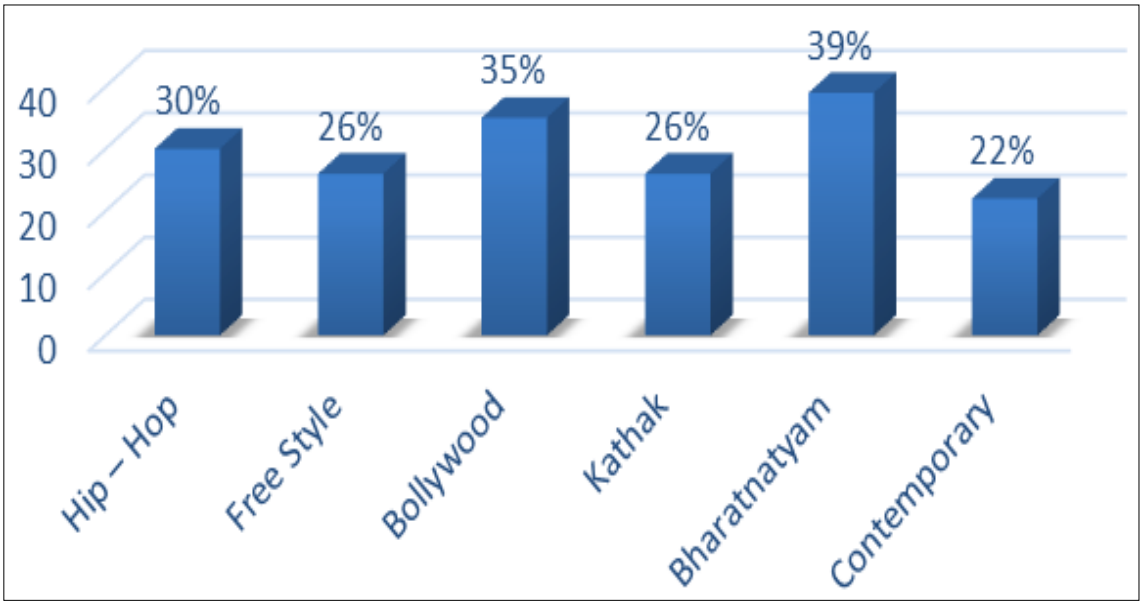
- **Exclusion Criteria**
- Any previous history of Trauma of lower limb, spine, and abdomen [9]
- Any previous history of Surgery of lower limb, spine, and abdomen [9]
- Subjects with neurological dysfunction or dermatological conditions [9]
- Uncooperative / Unreliable subjects [9]

Result

Table 1: Prevalence Of Navicular Drop Test In Professional Dancers According To Different Dance Forms

Dance Form	Total DancERS	Navicular Drop Test Positive	Prevalence
Hip – Hop	23	7	30%
Free Style	23	6	26%
Bollywood	23	8	35%
Kathak	23	6	26%
Bharatnatyam	23	9	39%
Contemporary	23	5	22%

Table 12: is showing the prevalence of Navicular Drop Test Positive among professional dancers across six dance forms. There were 23 subjects in each Dance Forms.



Graph 2: Prevalence Of Navicular Drop Test In Professional Dancers According To Different Dance Forms

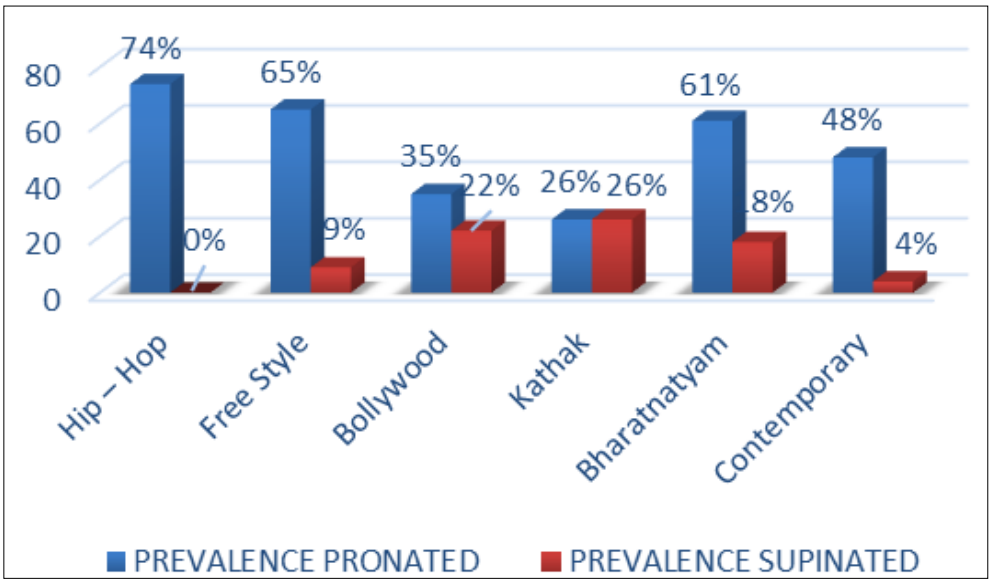
Graph 11: is showing that Bharatnatyam is showing more prevalence and Contemporary is showing less prevalence of Navicular Drop Test

Table 2: Prevalence Of Fpi In Professional Dancers According To Different Dance Forms

Dance form	Total Dancers	Fpi Positive		Prevalence	
		Pronated	Supinated	Pronated	Supinated
Hip – Hop	23	17	0	74%	0%
Free Style	23	15	2	65%	9%
Bollywood	23	8	5	35%	22%
Kathak	23	6	6	26%	26%
Bharatnatyam	23	14	4	61%	18%
Contemporary	23	11	1	48%	4%

Table 13: is showing the prevalence of Foot Posture Index among professional dancers across six dance forms. There were 23 subjects in each Dance Forms.

Graph 12: is showing that Hip Hop is showing more prevalence of pronated foot and Kathak is showing more prevalence of supinated foot.

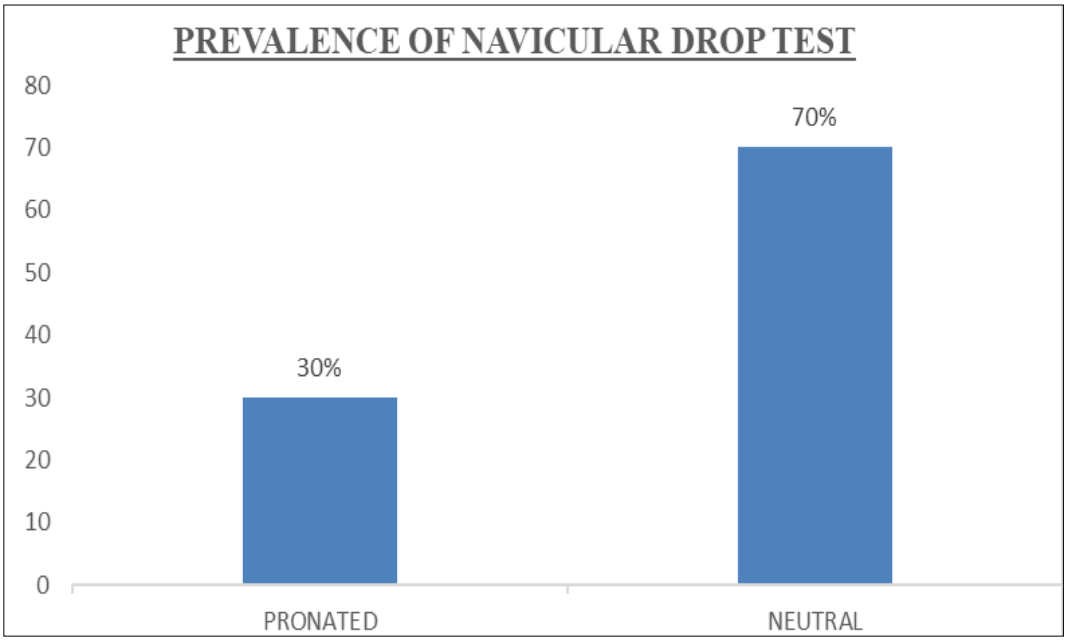


Graph 3: Prevalence Of Fpi In Professional Dancers According To Different Dance Forms

Table 3: Prevalence Of Pronated And Neutral Foot According To Navicular Drop Test

Navicular Drop Test				
Total Dancers	**Pronated**	**Neutral**	**Prevalence**	
			Pronated	**Neutral**
138	41	97	30%	70%

Table 14: is showing Prevalence of Pronated and Neutral foot according to Navicular Drop Test. Out of 138 sample 41 had Pronated foot and 97 had Neutral foot.



Graph 4: Prevalence Of Neutral And Pronated Foot According To Navicular Drop Test

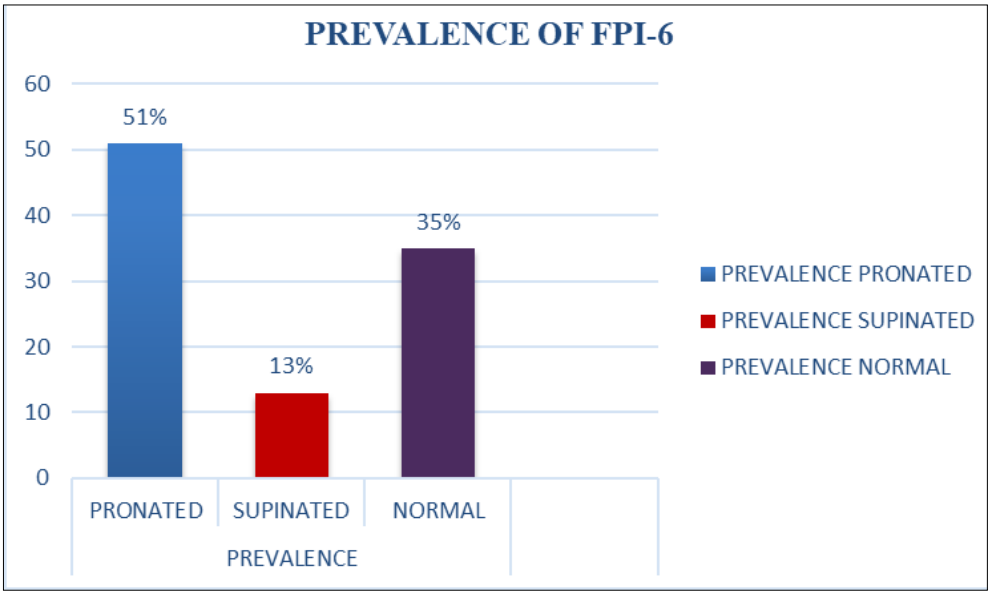
Graph 13: is showing more prevalence of neutral foot and less prevalence of pronated foot

Table 4: Prevalence Of Fpi-6 In Professional Dance

	FPI Positive			**Prevalence**		
Total Dancers	Pronated	Supinated	Normal	Pronated	Supinated	Normal
138	71	18	49	51%	13%	35%

Table 15 is showing Prevalence of Normal, Pronated and Supinated foot according to FPI-6. Out of 138 samples, 71 Dancers had pronated foot, 18 had supinated and 49 had normal foot.

Graph 14: is showing more prevalence of pronated foot and less prevalence of supinated foot



Graph 5: Prevalence Of Normal, Pronated And Supinated Foot According To Fpi-6

Discussion

The present study aimed to find out the Prevalence of Foot Posture Deviation in Professional Dancers of South Gujarat Region. Subject were included based on inclusion and exclusion criteria.

The study has included various Dance academies of South Gujarat such as Kala Gunjan Classical Dance Classes, King Empire Dance Company, The Direction, Dance Space, Naad Nrutam, 3dx.

The Demographic characteristic of the subjects wasName, Age, BMI, gender, Academy name, contact number, leg dominance, work experience, Previous medical/surgical history, Aadhar card number etc. The Navicular Drop Test and Foot Posture Index (FPI-6) were used to find out prevalence of Foot Posture Deviations in Professional Dancers respectively.

The main intention of the study was to check prevalence of Foot Posture Deviations in Professional Dancers of South Gujarat region.

In any forms of dance, excessive strain like leading the foot with continuous foot tapping movements over hard surface produces high level of compressive force over the heel, tarsal and metatarsal joint complex. Excessive loads and forces over the feet of Dancers can gradually lead to deviations of Foot Posture.

Navicular Drop Test is used to find out the pronation and flat feet among population but here in this study only pronation was considered. Foot Posture Index (FPI-6) is one of the gold standard methods to classify foot into pronated, supinated, or normal foot. This study screened 150 Professional Dancers, in which 12 professional dancers were excluded according to exclusion criteria.

In this study, after screening, a prevalence of 30% pronated and 70% neutral was found according to the Navicular Drop Test, which contradicts the findings of Shweta Chandan *et al*.'s (2018) research. They examined 100 young Kathak dancers using the Foot Posture Index, Navicular drop, and Arch index, with results showing 3% supinated, 48% normal, and 49% pronated. This variance may be attributed to their focus on a single dance form regardless of participants' training periods and experiences [12].

According to the FPI-6, the prevalence was 51% pronated, 13% supinated, and 35% normal, aligning with findings from research conducted by Shweta Chandan *et al*. (2018), where results indicated 3% supinated, 7% normal, and 25% pronated, with 65% exhibiting excessive pronation in their feet [12].

In this study, the prevalence of Foot Posture Deviations is notably higher in the age groups of 18-23 years (36%) according to the Navicular Drop Test. Additionally, the prevalence of Foot Posture Deviations according to FPI-6 in the age group of 24-29 years is 58%. In a study conducted by Tajeshree Bhoir *et al*. (2014) to determine the prevalence of foot posture deviations among 18-25 years old in normal individuals, a higher prevalence was observed among the 19-22 years age range (age 19: 3.75%, age 22: 3.75%) [32].

As per the Body Mass Index (BMI), the incidence of pronated foot stands at 60% according to the Foot Posture Index-6 (FPI-6) and 30% according to the Navicular Drop Test within the 25-29.9 BMI cohort, as evidenced by research conducted by Sami S. Alabdulwahab *et al*. (2016), which explored the impact of BMI on foot posture and core stability among 39 non-athletic male university students [33].

The higher prevalence of foot posture deviations observed in dancers with 11-15 years of experience signifies the impact of prolonged dance training on foot health and biomechanics. This finding suggests that as dancers accumulate more years of experience, they may develop foot posture deviations due to the repetitive and demanding nature of dance movements. Prolonged dance practice can lead to muscular imbalances, altered foot mechanics, and increased stress on the feet and ankles, contributing to the development of deviations such as pronation or supination.

According to the Navicular Drop Test, males exhibit a higher prevalence of pronation, a finding corroborated by research conducted by Naohiro Shibuya *et al*. (2010) which identified male gender as a significant factor associated with flatfoot deformity [34].

The research findings done by Dhairav Shah *et al*. (2022) in150 volunteers of Surat city reveal a notable prevalence of pronation in the right foot based on dominance which likely supports this study. This asymmetry in foot posture deviations based on dominance suggests a potential link

between the demands of dance movements and the development of pronation in the dominant foot. Understanding and addressing these asymmetries in foot posture deviations are crucial for injury prevention and performance optimization in professional dancers [35].

According to the Navicular Drop Test, Bharatnatyam exhibits a 39% prevalence of pronation, while according to the FPI-6, it shows 61% pronated and 18% supinated. These findings indicate a considerably higher prevalence of Foot Posture Deviation in Bharatnatyam, a conclusion supported by research conducted by Dr. Shekhar Modak *et al*. (2023) which demonstrated a total FPI score of 6.5 according to FPI-6, suggesting a high prevalence of foot posture deviation. The higher prevalence of foot posture deviation in Bharatnatyam could be attributed to repetitive tapping steps, the maintenance of dance positions, and altered alignment and biomechanics of the lower limb [16].

These findings tell the importance of understanding foot posture Deviations in dancers across different parameters such as age, experience, gender and dance form providing valuable insights for injury prevention strategies and tailored interventions to optimize foot health in dance community.

Conclusion

The prevalence of Foot Posture Deviations using Navicular Drop Test and FPI-6 was done with 138 Professional Dancers from various academies of South Gujarat Region concludes that there is a high prevalence of Foot Posture Deviations according to FPI-6 and there is a moderate prevalence based on Navicular Drop Test.

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