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CORRELATION OF FOOT POSTURE AND ANKLE INJURY INCIDENCE IN INDIAN FENCERS

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ABSTRACT

***Background**: Fencing is an intermittent, high-intensity sport with frequent lower-limb loading and an elevated incidence of ankle injuries. Foot alignment (pronation/supination) may alter load distribution and predispose athletes to ankle pathology.*
***Objective**: To examine the relationship between static foot posture, quantified by the Foot Posture Index (FPI-6), and ankle injury incidence in Indian competitive fencers.*
***Methodology**: Observational study of 40 competitive fencers (age 18–25) recruited from a fencing academy in Pune (purposive sampling). Baseline FPI was measured for left and right feet according to standard procedures; athletes were followed monthly for four months to record ankle injuries. Statistical analysis included descriptive statistics and Pearson correlation between mean FPI and injury incidence.*
***Results**: Sample: 16 males, 24 females. Overall mean FPI = 1.36 (SD 2.75), indicating a mild pronation tendency. Categorical distribution (feet): neutral 45% (n=36), pronated 47.5% (n=38), supinated 7.5% (n=6). During follow-up 11 athletes (27.5%) sustained injuries; most injuries occurred in the 18–21 age group. Pearson's r between mean FPI and ankle injury incidence = 0.36 (t = 2.37, p = 0.023), indicating a moderate positive association.*
***Conclusion**: Pronated foot posture was moderately associated with increased ankle injury risk in this cohort. Baseline FPI screening and targeted interventions (proprioception, intrinsic foot/calf strengthening, orthotic consideration) are recommended for injury prevention.*

KEYWORDS: *Foot Posture Index, Ankle Injury, Fencing, Pronation, Injury Prevention.*

INTRODUCTION

Fencing is one of the oldest combat sports, evolving from ancient sword-fighting practices used for military training and personal defence into a regulated competitive discipline. Over time, particularly during the Renaissance period, fencing shifted from the use of heavy combat weapons to lighter foils, emphasizing speed, precision, and tactical control. The sport gained international recognition with its inclusion in the first modern Olympic Games in 1896 for men and later in 1924 for women, and has since continued to modernize through standardized rules, protective equipment, and electronic scoring systems that enhance safety while preserving technical demands.[1,2]

Contemporary fencing is an intermittent, high-intensity sport involving brief, repeated bouts of explosive activity interspersed with short recovery periods. Movements such as lunges, retreats, and rapid changes of direction require high levels of neuromuscular coordination, balance, and force production. These unique physiological and mechanical demands place substantial stress on the neuromusculoskeletal system, particularly the lower limbs, making fencers susceptible to musculoskeletal injuries.[1]

Among lower-limb joints, the ankle is particularly vulnerable due to its role in both shock absorption and propulsion. The fencing lunge—the primary offensive movement—requires rapid extension of the trailing leg and controlled landing of the lead leg. Biomechanical studies have demonstrated that landing forces during these actions may approach three times the athlete's body weight, depending on movement velocity and technical execution.[3,4] Repeated exposure to such forces during training and competition can exceed tissue tolerance, leading to acute sprains or overuse injuries.

Fencing biomechanics are inherently asymmetrical, with athletes consistently maintaining a stance in which one leg leads while the other trails. This asymmetry produces side-dominant loading patterns and may contribute to muscular imbalances and altered lower-limb mechanics over time.[1] Additionally, fencing is typically performed on hard, minimally cushioned surfaces to facilitate rapid footwork, which increases the transmission of ground reaction forces through the ankle–foot complex.[5] Plantar pressure analyses have shown uneven load distribution across the foot during fencing actions, highlighting the complex mechanical demands placed on the ankle and foot.[6]

Foot posture is a key determinant of how mechanical loads are distributed and attenuated within the lower limb. It describes the alignment of the foot relative to the ground and is commonly classified as neutral, pronated, or supinated. Deviations from neutral alignment can alter shock absorption, joint stability, and lower-limb kinematics. Pronated foot posture may compromise medial arch support and ankle stability, whereas supinated posture may reduce shock absorption and increase lateral ankle stress.[7,8] Evidence from sports such as running, basketball, football, and indoor sports indicates a clear association between abnormal foot posture and increased ankle injury risk.[9-12]

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Despite these biomechanical considerations, limited research has investigated the relationship between foot posture and injury incidence in fencing-specific populations. While fencing biomechanics are increasingly studied, most research prioritizes performance-related outcomes rather than injury prevention.[4,6,16] Given the sport's asymmetric loading patterns, minimal footwear cushioning, and high proprioceptive demands, examining the role of foot posture in ankle injury risk is warranted. Understanding this relationship may help identify at-risk athletes and inform targeted injury-prevention strategies in competitive fencing.

OBJECTIVE

To examine the correlation between different foot posture and the risk of ankle injury in Indian fencers with the help of foot posture index

METHODOLOGY

An observational study design was adopted to examine the relationship between foot posture and ankle injury incidence among competitive Indian fencers. The study was conducted at the Balewadi Fencing Academy, Pune, over a period of six months. A total of 40 fencers (male and female) aged between 18 and 25 years, competing at district level and above, were recruited using purposive sampling. Athletes were included if they had no history of ankle injury and were actively training and competing at the time of recruitment. Exclusion criteria included a history of ankle surgery, any acute or known ankle injury, congenital or structural foot deformities, neurological conditions such as vertigo or sensory loss, and a history of foot, ankle, or lower-limb fracture within the previous 12 months.

Ethical approval was obtained from the Institutional Ethical Committee prior to commencement of the study. All participants were informed about the purpose and procedure of the research, and written informed consent was obtained. Baseline foot posture assessment was performed using the Foot Posture Index (FPI-6), which has demonstrated good to excellent reliability and clinical validity for assessing static foot alignment and identifying abnormal foot posture associated with musculoskeletal injuries.[7–9] The FPI evaluates six criteria—talar head palpation, curvature of the medial longitudinal arch, forefoot–rearfoot alignment, rearfoot position, prominence of the first metatarsal head, and toe position—each scored from −2 to +2. Participants were assessed barefoot while standing on a flat, non-slippery surface, and total FPI scores were used to classify feet as neutral, pronated, or supinated.[7,8]

Following baseline assessment, ankle injury incidence was monitored prospectively over a four-month period through monthly follow-up via telephone calls and in-person communication when required. Any injury affecting the ankle region that resulted in pain, functional limitation, or restriction from training or competition was recorded, in line with previously reported fencing injury surveillance methods.[17,18] The baseline FPI score and injury data were subsequently analysed to determine the relationship between foot posture and ankle injury occurrence during the observation period.

SAMPLING DESIGN

A purposive sampling technique was employed to recruit participants for this study. Competitive fencing athletes aged 18 to 25 years, actively training and competing at district level and above, were selected from the Balewadi Fencing Academy, Pune. This sampling approach was chosen to ensure the inclusion of athletes who were regularly exposed to the sport-specific physical demands and injury risks associated with fencing. A total sample size of 40 athletes was included based on availability and eligibility during the study period. All participants met the predefined inclusion and exclusion criteria, ensuring a relatively homogeneous sample in terms of age, competitive level, and training background. Although purposive sampling limits the generalisability of findings, it was considered appropriate for this observational study, as it allowed focused investigation of the relationship between foot posture and ankle injury incidence within a specific competitive fencing population.

STATISTICAL DESIGN

Data collected from the baseline Foot Posture Index (FPI) assessment and prospective injury surveillance were organized and analysed using descriptive and inferential statistical methods. Descriptive statistics were used to summarize participant characteristics, foot posture distribution, and injury incidence, and were expressed as frequencies, percentages, means, and standard deviations. To examine the relationship between foot posture and ankle injury incidence, Pearson's correlation coefficient was applied using the mean FPI score and injury occurrence during the observation period. The level of statistical significance was set at $p < 0.05$. All statistical analyses were performed using standard statistical software, and the results were presented in the form of tables and graphical representations to facilitate interpretation.

RESULTS

A total of 40 competitive fencers, comprising 16 males and 24 females (Graph 1), were assessed for baseline foot posture using the Foot Posture Index (FPI) prior to the start of the study. The overall mean FPI score was 1.36 (SD = 2.75), which reflects a general tendency toward mild pronation within the cohort. When classified categorically, 45% of feet were found to be neutral (n = 36), 47.5% were pronated (n = 38), and 7.5% were supinated (n = 6) (Graph 4). At the individual level, 70% of athletes presented with at least one pronated foot, while 25% demonstrated bilateral pronation.

During the 4-month observation period, monthly injury surveillance identified 11 athletes (27.5%) who sustained injuries. The majority of these cases were reported in the younger subgroup of 18–21 years (n = 7) (Graph 3).

Correlation analysis demonstrated a significant positive association between mean FPI scores and the incidence of ankle injuries. The Pearson's correlation coefficient was r = 0.36, with a corresponding t-value of 2.37 and a two-tailed p-value of 0.023.(Graph 5) This indicates that athletes with more pronated foot postures were more likely to sustain ankle injuries during the study period. Although the effect size reflects a moderate correlation, the statistical significance suggests that

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foot posture can be considered a meaningful predictor of ankle injury risk within this cohort of fencers.

DISCUSSION

The present study examined the relationship between foot posture and ankle injury incidence among competitive Indian fencers aged 18–25 years. The findings revealed a moderate and statistically significant positive association between pronated foot posture and ankle injuries, indicating that athletes with higher Foot Posture Index (FPI) scores were more likely to sustain ankle-related injuries during the observation period. This supports the hypothesis that foot posture is a meaningful biomechanical contributor to injury risk in fencing.

One of the most notable findings was the high prevalence of pronated foot posture, with nearly half of all feet classified as pronated and 70% of athletes demonstrating at least one pronated foot. Given the repetitive nature of fencing-specific movements such as lunges, push-offs, and rapid directional changes, excessive pronation may alter load distribution across the ankle and lower limb, increasing stress on passive stabilizing structures. This altered biomechanics may reduce ankle stability during high-impact landings and sudden changes in direction, predisposing athletes to both acute sprains and overuse injuries.

The ankle emerged as the most frequently injured joint in this cohort, which is consistent with previous fencing-related injury literature. Sudden directional changes, asymmetrical stance, and high ground reaction forces during lunges place substantial demands on the ankle joint, particularly on the lead leg during landing and the trailing leg during propulsion. The observed association between pronated foot posture and ankle injury incidence aligns with findings from other sports such as basketball, football, and running, where abnormal foot alignment has been linked to increased ankle injury risk.

Age-related trends were also evident, with the majority of injuries occurring in the younger age group (18–21 years). This may be attributed to incomplete physical maturation, higher training loads during early competitive years, and limited exposure to structured strength and conditioning or injury-prevention programs. These findings highlight the importance of early screening and preventive interventions, particularly for younger athletes entering competitive fencing.

Although ankle injuries were most common, injuries involving the knee, hip, groin, and hamstring were also reported. This reinforces the concept that fencing places demands on the entire lower-limb kinetic chain. Abnormal foot posture may contribute to proximal compensations, emphasizing the need for injury-prevention strategies that address not only ankle stability but also hip strength, neuromuscular control, and movement symmetry.

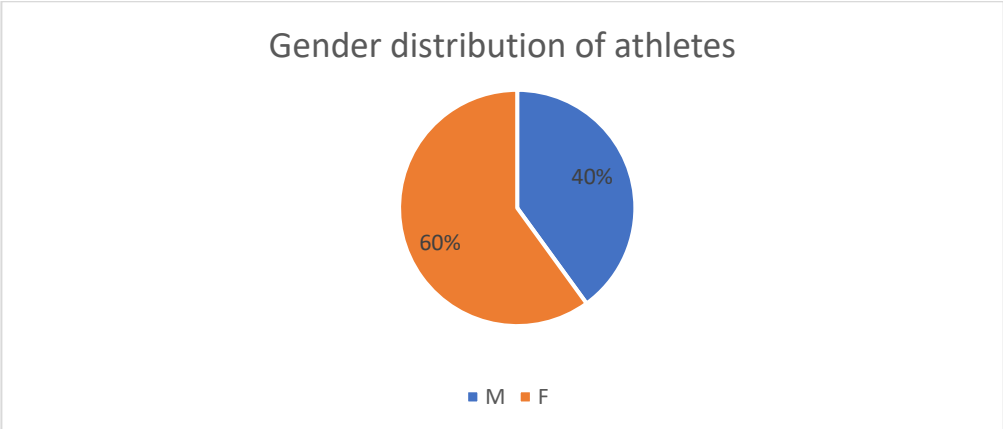
Clinically, the results suggest that preseason foot posture screening using the FPI can serve as a practical and low-cost tool for identifying athletes at increased risk of ankle injuries. Preventive strategies should include proprioceptive training, balance exercises, intrinsic foot and calf strengthening, and appropriate footwear or orthotic considerations for athletes with marked pronation. Addressing limb dominance and asymmetrical loading patterns through unilateral training may further reduce injury risk and enhance long-term athlete performance.

CONCLUSION

This study demonstrated a significant positive association between pronated foot posture and ankle injury incidence in Indian fencers. With nearly half of the athletes showing pronation and over a quarter reporting injuries during the 4-month monitoring period, foot posture emerges as an important modifiable risk factor. These findings support the use of baseline foot posture screening and targeted preventive strategies to reduce injury risk and enhance athlete performance.

Gender	No. of Athletes
Male	16
Female	24

Table 1: Gender Distribution



Graph 1 Represents the Gender Distribution amongst 40 Athletes.

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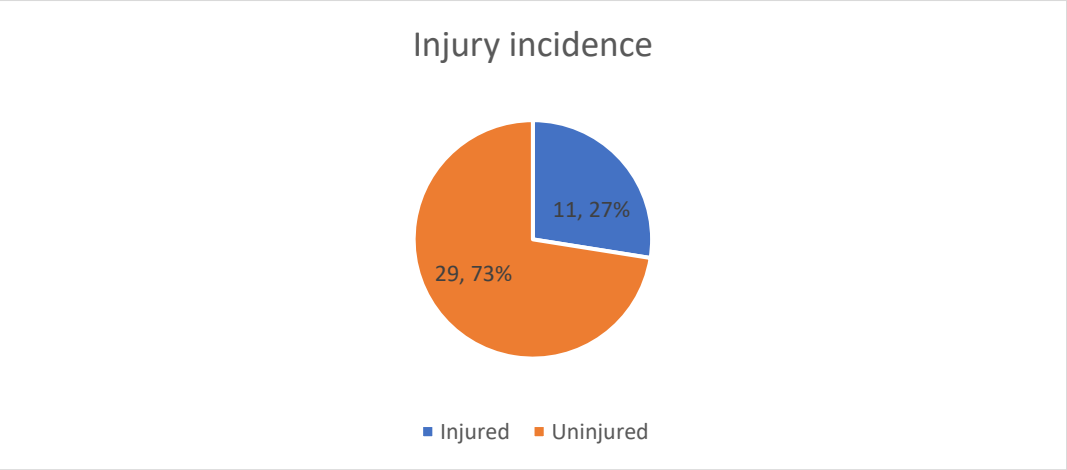
Gender	No. of Athletes
Injured	11
Uninjured	29

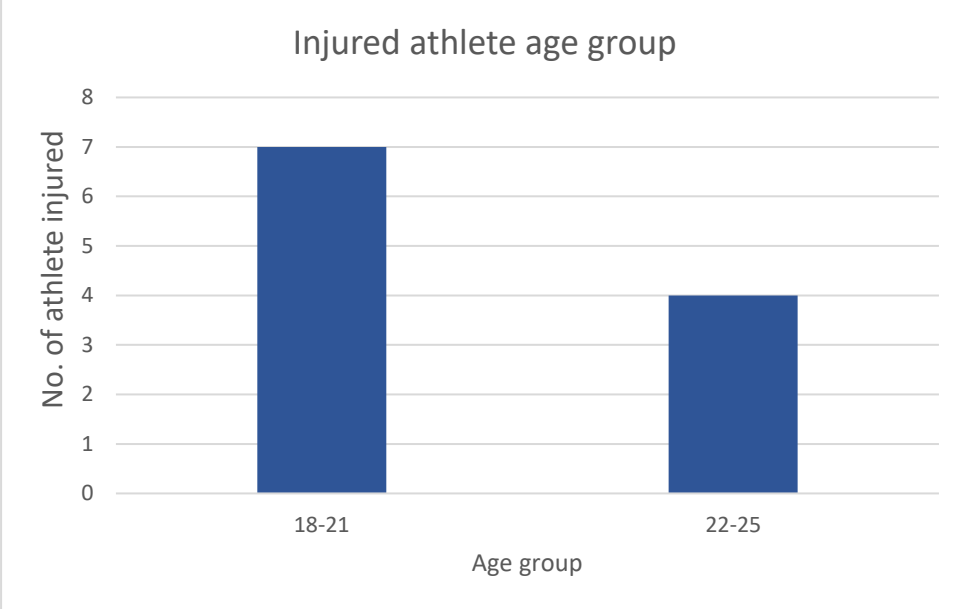
Table 2 : Injury Incidence



Graph 2 Represents the Athletes Suffering from Injurie

Age Group	No. of Injured Athletes
18-21	11
22-55	29

Table 3 – Age Group of Injured Athlete



Graph 3 Represents the Athletes Injured in the particular age group.

Category	FPI (R)	FPI (L)
Neutral	25	23
Pronated	10	12
Supinated	5	5

Table 4 – Left and right Foot posture category amongst 40 fencers

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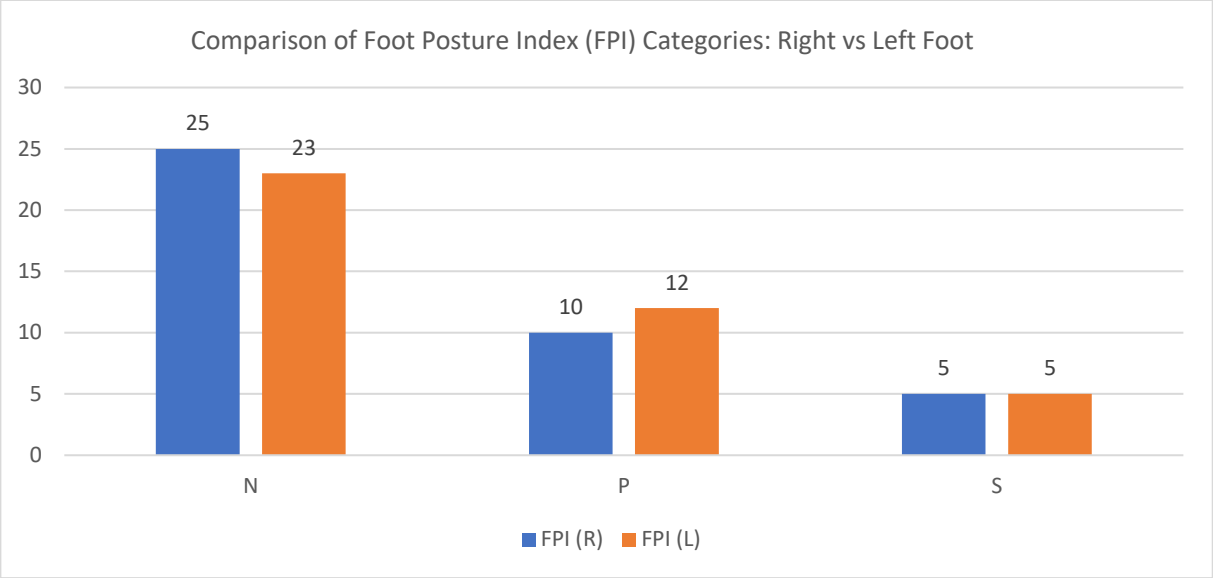
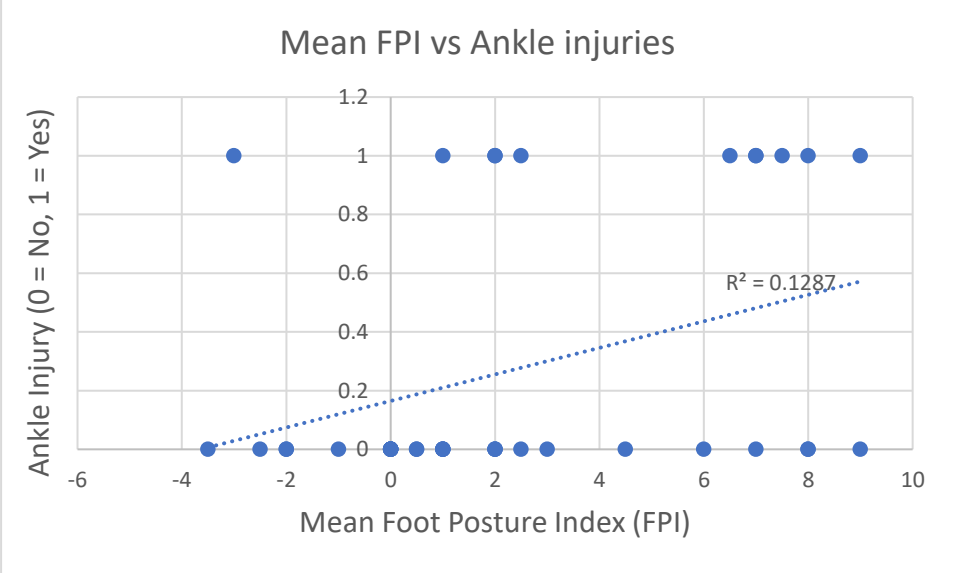


Graph 4 represents foot posture amongst 40 athletes. (N- Normal , P= Pronated , S= Supinated)



Graph 5 represents the correlation between Mean Foot Posture Index (FPI) and the Ankle injuries. (r=0.36)