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Association between Foot Posture and Agility in Amateur Soccer Players

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ABSTRACT

Background: Agility is the ability to accelerate, decelerate and sprint with change in direction. The risk factors for injuries in soccer players are imbalance, decreased agility, and improper foot posture. Understanding the relationship between foot posture and agility can facilitate agility training and rehabilitation to improve their performance in the sport. **Objective:** To determine an association between foot posture and agility in amateur soccer players. **Methodology:** The cross sectional study recruited 78 age and gender-matched amateur soccer players. They were then allocated into pronated, supinated and neutral foot postures based on the foot posture index scores. Later the modified Illinois change of direction test (MICODT) was administered to all the players to test agility. With standing as the starting position of the test the players were made to run from the starting point to the finish point without any stop in between. The time to complete the test was noted. **Results:** Out of 78 subjects, 26 subjects had supinated feet 26 had pronated feet and 26 had normal feet. An association was found between foot posture and agility with a significance of $p<0.001$. Logistic regression analysis revealed that players with supinated a feet demonstrated 3.53 times greater influence on agility than players with normal feet ($p<0.05$). Players with pronated feet showed 0.54 times greater influence on agility than players with normal feet. **Conclusion:** A significant association between foot posture and agility was detected in amateur soccer players. Supinated feet influenced agility to a greater degree when compared to pronated and normal foot postures in amateur soccer players.

Key words: Foot Deformities, Physical Fitness, Rehabilitation, Postural Balance, Talipes Cavus, Kinanthropometry

INTRODUCTION

Soccer being one of the most popular sports worldwide is found to have approximately 200,000 professional and 240 million amateur players. As a sport the game includes vigorous activity with a relatively higher incidence of injury (Hachana et al., 2014).

Professional male soccer players were reported to have an overall incidence of 8.1 injuries for every 1000 hours of exposure (López-Valenciano et al., 2020). The incidence of match injury (36 injuries/1000 hours of exposure) was almost 10 times more than the incidence of training injury (3,7 injuries/1000 hours of exposure) (López-Valenciano et al., 2020). The game involves various movements like running, cutting, sprinting, and shooting. During a match, a soccer player changes his direction every 2 to 4 seconds, which is about 1800-2000 times in a game lasting 90 minutes (Hachana et al., 2014).

To be successful in soccer, a player requires high levels of physical, technical, psychological and tactical skills. The physical skills include aerobic, anaerobic power, flexibility, agility and muscle strength, (Lennemann LM et al., 2013; Joaquin Calatayud et al., 2017). Soccer players during their game alternate between high-intensity movements like sprinting, jumping, and direction changes and repeated bouts of low-intensity exercise like walking, jogging, or cruising. The ability to accelerate,decelerate and sprint alongside change of direction is commonly known as agility (Lennemann LM et al., 2013). Although many sports, including soccer, require agility as a necessary physical attribute for success, improving agility is one of the most crucial components of off-season strength and conditioning programs. (Fox et al., 1974;Harman et al & Hoolahan P.,1990)

Agility has been defined as “a rapid whole-body movement with change of velocity or direction in response to a stimulus”(Sheppard et al., 2006). According to this definition, agility is widely acknowledged to consist of components related to change of direction (COD) as well as perceptual and decision-making aspects.(Sheppard et al., 2006). In

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the past, agility had been viewed as a component of fitness that is influenced primarily by physical (eg: leg muscular strength, reactive strength and power, sprinting speed) and biomechanical (eg: running technique) factors (Lennemann LM et al., 2014;Cote et al.,2005). However there are various other factors like balance, vision, proprioception, cognitive perceptual, and neuromuscular control that could influence agility. Altmann S et al (2021) in their study highlighted the contribution of both physical (i.e., linear-sprint and change-of-direction performance) and perceptual-cognitive factors (i.e., perceptual-cognitive deficit) in relation to soccer-specific agility performance at an amateur level. Agility also involves a complex interaction of multiple intrinsic and extrinsic factors such as the activation of muscles, the rate of muscular activity and activated muscles synergies (Alonso et al., 2016; Kirkendall et al., 2010;Zouhal et al., 2019).

The foot plays an integral role in various sports including soccer by adapting to ground reaction forces, and facilitates various sporting movements, such as running, jumping, change of direction, shooting and landing from jumps (Miguel-Andrés 2021). An Athletes' plantar loads during sports activities can therefore be influenced by their foot type (Marencakova et al., 2018). The variations in foot posture has been found to influence the function of the lower limb thereby being a risk factor to injuries, through its connectivity and activation of the kinetic chain (Queen et al., 2009;Petersen et al., 2017).

With the overall incidence of injuries in soccer players being relatively high, Alonso et al (2016) and Fiorilli et al (2017), Neal et al (2014) in their studies stated that balance, agility and foot posture were the primary risk factors for lower limb injuries. They identified ankle sprains, tendon injuries, knee sprains, strains and fractures as the most common injuries in soccer players (Alonso et al., 2016; Fiorilli G et al., 2017). The foot was primarily found to be susceptible to overuse injuries when the structure of the sole was altered, particularly during raising or lowering of the arch and with exposure to physical activity (Levinger Pet al., 2010;Williams DS et al., 2001). Foot postures have been classified into three categories as: supinated, pronated, and neutral feet. The variations in foot postures during dynamic activities can alter the center of mass and base of support thereby contributing to changes in the dynamic balance (Cote KP et al., 2005). While changes in kinetics of foot like ground reaction force, center of pressure and center of mass makes an individual susceptible to balance disorder, an abnormality of flexible flat foot, could further lead to loss of balance and proprioception (Williams DS et al., 2001;Ghorbani M et al., 2023). Poor foot position sense is also thought to hinder accommodation between the support surface and plantar surface of the foot, thus requiring postural adjustments more proximally to maintain upright posture and balance (Cote et al., 2005). The reduced grasping ability of the toes may also contribute to loss of balance and falls in individuals with different types of foot postures (Fiorilli G et al., 2017;Donnell-Fink 2015).

With agility being one of the major components of fitness and performance, and foot posture being a risk factor for decreased balance and lower limb injuries among soccer players, this study aims to determine if an association exists between foot posture and agility.

A better understanding of this relation could aid trainers, coaches, and healthcare professionals design more customized training programs and injury prevention strategies. Additionally, targeted interventions can be used to treat any underlying foot problems and lower the chance of injury.

METHOD

Study Design

The participants for this cross-sectional study were recruited from a soccer arena at Hennur, Bengaluru. Permission was sought from the coach and director of the arena to recruit players for the study. The study was explained to the players and all those who were willing to participate were assessed for foot posture. The recruited player's foot posture was assessed using Foot Posture Index (FPI). The Modified Illinois Change of Direction Test (MICODT) (Figure 1) was then administered to all the players for testing agility and the best of three attempts of MICODT was measured and documented (Figure 2.)

Participants

The study was cleared from the ethical board of the Institute (MEU-PT/EC/02/2018). All the procedures were according to the latest Helinski declaration in human research. The purpose of the study was explained to the participants. A total of 78 participants were recruited through convenience sampling after obtaining an informed consent from the players prior to recruitment. Based on a study conducted by Karen P Cote et al (2005) on "Effects of pronated and supinated foot postures on static and dynamic postural stability" the sample size (n=78) was calculated using G power 3.1 software, considering an effect size of 0.4, alpha error of 0.05, power of 0.8 and, a 1:1:1 allocation ratio. The players were then categorized as supinated, pronated and, normal foot individuals (n=1:1:1) using the FPI (Table 1). The inclusion criteria

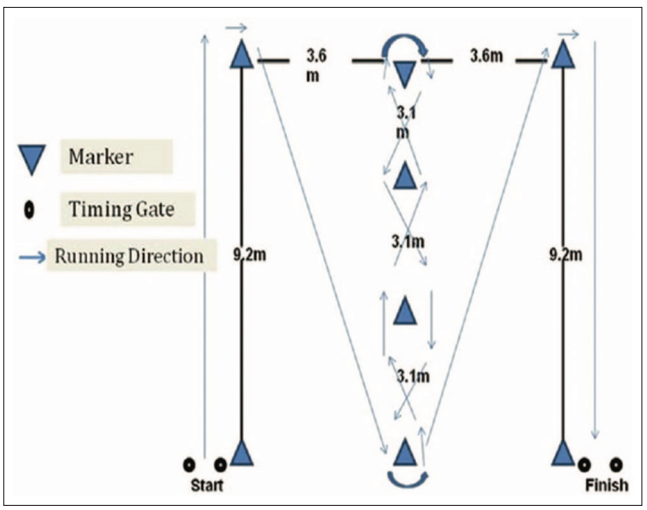

Figure 1. MICODT test

Table 1. Demographic and baseline data of soccer players

Foot Posture	Mean Age (in years)	Mean Height (in cms)	Mean BMI	Mean Years of Playing Soccer (years)	Mean Agility (seconds)
Supinated Feet	24.6	170	23.4	4	16.8
Normal Feet	23.9	173.9	23.8	4.2	17.09
Pronated Feet	24.2	171	24	5	17.37

n=78

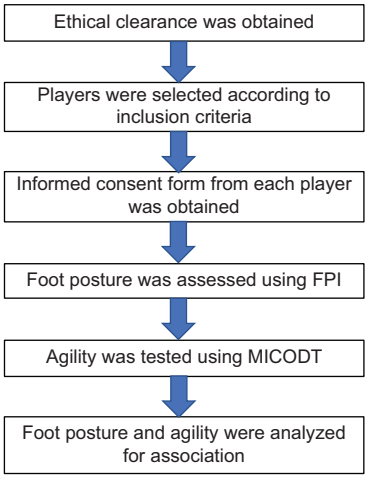

Figure 2. Procedure of data collection

included amateur players who have been playing football for more than one year and have bilaterally supinated, pronated, or neutral foot posture. Participants were matched on basis of gender (male) and age (18 – 30 years). The study excluded players with neurological impairments, congenital disorders, recent injuries (such as surgery within the last two to six months, a history of ankle sprains, dislocations, and semi-dislocations, as well as significant injuries that recently involved lower limb joints), and recreational players.The subjects were screened for lower extremity abnormalities prior to recruitment into tthe study.

Procedure and Material Used

For testing agility marking cones, measuring tape, stopwatch was used.

Testing for FPI

FPI, a valid and reliable clinical method was used to determine the foot posture (Redmont A.C.,2006). It provides information on rear foot, midfoot and forefoot segments. It aims at evaluating and categorizing the foot into pronated, supinated, or neutral position. The six clinical criteria employed in the FPI-6 are: Talar head palpation, Supra and infra lateral malleolar curvature, Calcaneal frontal plane position, prominence in the region of the talonavicular joint, Congruence of the medial longitudinal arch and abduction/adduction of the forefoot on the rear foot. Each item is scored as -2, -1,0, +1, +2 where negative score indicates an increase in supination of the foot and a positive score indicates an increase in pronation of the foot. Neutral foot posture is graded as zero. The total score varies from -12 to +12. All observations were made with the subject standing in a relaxed bilateral limb static standing position. This relaxed double limb standing position has been shown to approximate the position about which the foot functions during the gait cycle. Subjects were asked to march on the spot prior to the measurement and then stand in a relaxed position with the hands by the side and looking straight ahead. The FPI of each of the foot was scored individually and then summated.

Testing for Agility

All the players were then administered MICODT for testing agility (Figure 1). MICODT is a valid and reliable tool to evaluate agility in soccer players. It has an intra class correlation coefficient of 0.99 with a standard error of measurement for absolute reliability at <5% (Hachana et al., 2014).

With standing as the starting position, the players had to to run from the starting position to the finish point without any stop in between. The time taken for completion of the test was noted.The best time of three attempts of MICODT was measured and documented. Based on the timings obtained during the test, agility was categorised into good, average and bad with Good: <= 15 seconds, Average: 15-17 seconds and Bad: >= 17 seconds (Hachana et al., 2014).

Statistical Analysis

Statistical software namely SPSS v.16 was used for analysis and Microsoft Word and Excel were used to generate tables and graphs. Normality of data was checked using Shapiro- Wilk test, and the equality of variances was assessed using Leven test. As the data was not normally distributed Chi - Square test was used to determine the association between the variables and Spearman's correlation test was used to determine the correlation between foot posture and agility. As the data was categorical, the strength of the association between foot posture and agility in amateur soccer players was analyzed using logistic regression analysis. For all the analysis, the significance level was kept at 0.05.

RESULTS

The variables obtained are age, height, BMI, years of playing football, foot posture and agility. Foot posture was categorized into supinated, normal and pronated feet. Mean agility of players with supinated feet is 16.8 seconds, normal feet is 17.09 seconds and pronated feet is 17.37 seconds respectively (Table 1).

Chi square test was used to determine the association between foot posture and agility with foot posture as the

independent variable and agility as the dependent variable (Table 2). The results showed a significant association between foot posture and agility ($p<0.01$)

Logistic regression analysis was used to determine the odds of influence of pronated or supinated feet on agility. The results revealed. that players with supinated feet had 3.53 times greater influence on agility ($p<0.05$) than players with normal feet. (Table 3)

DISCUSSION

This study was undertaken to understand the association between foot posture and agility in amateur soccer players. Results of this study indicate that foot posture has an association with agility in amateur soccer players($p<0.05$). Agility is an important factor for successful performance in soccer (Calatayud et al., 2017). It is known that based on the type of foot posture there can be variations in the base of support and stability of the individual. In individuals with supinated feet, the forefoot is in adduction when compared to the rear foot resulting in more toes being easily seen on the medial side. Conversely, pronation of the foot results in more toes being easily seen on the lateral side as the forefoot abducts. Depending on the types of foot posture the toe grip and toe strength also varies. The toes appear to play an important role in stabilizing the body when the centre of mass is displaced in standing, walking and running. This reduced grasping ability of the toes may contribute to loss of balance and falls (Cote et al., 2005;Alonso et al., 2016;Tong et al., 2013). The position of the forefoot and toes as a result of pronation or supination of the feet could thereby influence balance and agility. Depending on the type of foot posture, the force generation and muscular activity, the speed and balance may also differ (Irez & Sekulic., 2014; Rouissi et al.,2016).These factors could provide an explanation as to how foot posture has an association with agility.

With balance being an integral part of agility there have been contradictory studies on the relation between foot posture and balance. While Cote *et al.* (2005), Tong et al (2013) and Pradhan et al (2020) stated that foot posture has no influence on dynamic balance; Abdulwahab and Kachanathu (2015) reported that static balance in healthy individuals is affected by an increase in the foot posture index. The results of a study conducted by Song et al. (2021) on foot pressure, ground reaction force, foot posture and balance ability in young individuals with varied foot arch height showed that there was no significant difference in the peak vertical force in individuals with flexible flatfeet and normal feet. However, static balance in people with flexible flatfeet was significantly lower than in people with normal feet. Cobb et al (2004) too reported decreased anteroposterior postural stability (root mean square COP velocity) during eyes-open and eyes-closed single-limb–stance condition testing in participants with low-arch structures. These findings was however contradicted by Cobb et al (2014) and Hertel et al (2002) who in their studies reported that increased arch height is associated with decreased postural stability.

On further analysis through logistic regression, it was found that players with supinated feet had more influence on agility compared to other two types of foot postures ($p<0.05$). This can be due to the fact that players with supinated feet put more pressure on lateral aspect of the foot thereby contributing to lateral stability. It is hypothesized that a supinated foot being in a closed packed position and with relatively less mobility is more stable. This would have helped players with supinated foot in balancing, and changing directions there by showing an improved agility in the results of the present study.

While there is paucity of literature on relationship between foot posture and agility, Algaba-Del-Castillo J et al (2023) in their study found no significant relationships between quality of movement and the type of foot posture. Hertel, Gay and Denegar (2002) found that individuals with high-arched foot had a higher area of displacement of the Center of Pressure. Hertel et al (2002) and Tsai et al (2006) in their study reported that individuals with pronated and supinated feet had higher postural oscillation than those with neutral arch feet.

It is not possible to obtain a general consensus from the results reported in the study. However, one thing which is apparently important to be considered is that it is not possible to analyse and predict agility based on one single factor of foot posture alone, because agility involves a complex interaction of multiple intrinsic and extrinsic factors such as the muscles that are activated, the rate of muscular activity and activated muscles synergies. Strategies for keeping balance, vision, and proprioception are among the other factors which are to be considered for agility. Overall, the result of this study shows that foot posture also influences agility in amateur football players. Hence, foot posture of the players need to be considered

Table 2. Association between foot posture and agility in amateur soccer players

Test Statistics	Agility
Chi-Square	13.4
df	2
Asymp. Sig.*	0.001

*($p<0.005$).

Table 3. Logistic regression analysis of foot posture on agility in amateur soccer players

Foot Posture	Sig	Std Error	Exp (B)	95%confidence interval for Exp (B)	
				Upper Bound	Lower Bound
Supinated Feet	0.038	0.609	3.53	1.073	11.664
Pronated Feet	0.433	0.769	0.54	0.121	2.471

while planning agility training and rehabilitation of football players.

Clinical Implications

Understanding the relationship between foot posture and agility can aid in better training and rehabilitation of football players. It may also be used to identify the factors related to injury and further in the prevention of injury in football players. Results of the study can be used for pre-season assessment and screening of football players.

Limitations and Future Scope of Study

As the study was done on amateur football players, the results cannot be generalized to the entire population of football players. The study included only players with bilaterally the same foot postures. The results may vary according to dominant and non-dominant foot postures.

Future studies can be done on professional football players. To further clarify the association between foot posture and agility, studies can be done on a larger scale. Results of the study can be helpful in forming a protocol for proper rehabilitation, injury prevention or successful performance of football players. Studies can be done to check if an arch support for supinated,pronated and normal foot postures can enhance agility.

Further, researchers should investigate the effect of foot type on muscle activity patterns and joint forces during these balance tasks to better understand the potential neuromuscular and biomechanical compensations for altered structural stability.

CONCLUSION

A conclusion can be made from the study that a correlation exists between foot posture and agility in amateur soccer players. Supinated foot posture was found to have a greater influence on agility when compared to pronated or normal foot postures. It therefore becomes essential to assess foot posture while designing agility training and rehabilitation programs for soccer players.

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Author's Contribution

A.S: contributed to the Conceptualization, study design and protocol, data collection, data analysis, Writing Original Draft, Editing. S.S: Conceptualization, study design and protocol, Supervision, data analysis, Writing, Review and Editing. M.P: Study design and protocol, Supervision, Writing, Review, Editing and Formatting.

DATA AVAILABILITY

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

DECLARATIONS

Ethics Approval and Consent to Participate

This study was approved by the research ethics committee of Ramaiah Medical College, Bangalore (Approval ID: MEU-PT/EC/02/2018). The details of the study was explained to all the participants prior to study recruitment. A written Informed consent was obtained from all the participants. The procedures of the study were conducted according to the Declaration of Helsinki.

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