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Foot Posture and Balance in Marathon Runners, Badminton Players and Footballers

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Abstract

Aim: This study aimed to compare foot posture and balance in marathon runners, badminton players and footballers.**Materials and Method:** Thirty (N=30) marathon runners, Thirty (N=30) football players and Thirty (N=30) badminton players who fulfilled the inclusion criteria, were included in the study. To measure foot posture, foot posture index was used and Y balance test was used to evaluate balance in the participants. **Results and Conclusion:** There was no significant difference in foot postures of marathon runners, badminton players and footballers as measured by Foot Posture Index. Most of them had normal foot posture followed by pronated feet. There was no significant difference in balance of marathon runners, badminton players and footballers as measured Y balance test. Average Y balance score was found highest in footballers, followed by badminton players and marathon runners. There was a negative correlation between Foot Posture and Balance. Correlation between the two variables was statistically significant in marathon runners.

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Key Words: Foot and balance, Postural control, Lower extremity, Injury prevention, Sports participation

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Introduction

Sports help in the development of mental health and physical fitness of the body. Indulging in sports helps our body function smoothly and more efficiently. In professional sports players, one of the major areas of focus is injury prevention. Among the many risk factors for injury in sports person inwhich two factors which have been extensively studied are foot posture and balance. Foot posture has been a focus of research in sports and health science. Factors which may predispose the musculoskeletal injuries of the foot or lower extremity are misalignment of the foot and faulty biomechanics (Bolgla and Malone 2004). In clinical practice, foot posture is commonly assessed for injury prevention and intervention. There are different methods of identifying foot posture such as Foot Posture Index (FPI) and foot print method. FPI has demonstrated good reliability and construct validity (Cornwall et al., 2008; Keenan et al., 2007). Foot Posture Index evaluates the three body planes and provides information on the hindfoot, midfoot and forefoot.The FPI is a criterion based rating system for weight bearing foot alignment, quantifying the degree to which a weight bearing foot can be considered to be in a pronated, supinated or neutral position, providing an indication of the overall foot posture (Cloak et al., 2010; Redmond et al., 2001).The FPI value changes as per the intensity of sports being played (Redmond et al., 2006). Sports such as running and jumping, place a tremendous amount of force on the foot that exceeds several times one's body weight and results in musculoskeletal adaptation and misalignment of the lower extremity (Cloak et al., 2010 ; Menz 2004). To reach the shuttle cock as quickly as possible, good footwork is required along with maintenance of good balance and control (Phomsoupha and Laffaye 2015). In a badminton competition, the frequent lunge step is generally considered to be the main risk factor for lower extremity injuries because badminton players exhibit higher vertical ground reaction forces which are approximately 2.1 to 2.5 times their body weight and may cause their feet to experience a great amount of stress and lead to fatigue and painful conditions (Hu, et al., 2015; Hong et al., 2014; Lee and Yoo 2012 ; Kuntze, et al., 2010). It has observed that due to badminton players' repetitive movements, their achilles tendon, plantar fascia, anterior talofibular ligament of the specific musculotendinous and ligamentous structures are at higher risks of serious injuries (Jørgensen and Winge 1990). Running is an example of a nonball sport. In runners, continuous running modifies plantar pressure owing to the fatigue of repetitive muscle action. Its execution is characterized by a succession of strides driving from support provided by each foot in turn; with one foot in support and the other airborne (Fellin et al., 2010), certain sports lead to one foot type predominating over the others. For example, there are a greater proportion of pronated feet among runners (Nordsiden et al., 2010).Most common injuries found in runners are plantar fasciitis, Achilles tendinopathies (Teyhen et al., 2011). In long distance runners, increased incidence of metatarsal stress fractures can be due to increased peak pressures under the metatarsal heads after exercise (Di Caprio et al., 2010). In athletes with a supinated foot type, there is an increased risk of overuse injury (Nagel et al., 2008). Football or soccer is a team sport played between two teams of eleven players with a spherical ball. The optimal foot type for footballers is different from that for marathon runners due to the functional requirements of participants' feet vary between sporting disciplines (Burns et al., 2005). The focus of the game is on agility and rapid changes of direction, it could be expected that foot posture would have more of an influence on ability and injury in fast sports (Burns et al., 2005). Periods of play are spent in single-leg stance on the non-dominant foot while the dominant foot manipulates the ball (Burns et al., 2005). Most common knee and ankle injuries are ankle sprain, Achilles tendonitis, blisters, turf toe, metatarsal fracture, ligament tear (anterior and posterior cruciate). Risk factor for injuries in football is excessive foot pronation (Reilly 1997), supinated foot types have also been found to be associated with increased risk of sustaining overuse injuries (Nagel et al., 2008 ;McManus et al., 2004). Other studies suggested that pronated foot type is a protective factor against injury (Korpelainen et al., 2001). Balance is one of the main components of coordinative abilities (Ricotti 2011). Postural control (or balance) can be defined statically, as the ability to maintain a base of support with minimal movement, and dynamically, as the ability to perform a task while maintaining a stable position (Winter et al., 1990). Coordination, joint range of motion (ROM) and strength are affected by sensory information acquired from the somatosensory, visual, vestibular systems and motor responses and these factors have an influence on postural control and balance (Davlin 2004).

Postural changes are different according to the sport practiced (Davlin 2004). The technical execution of ball sports involves sprints, jumps, accelerations, and decelerations in different planes and torsional loads or moments on the musculoskeletal system (Cloak et al., 2010). Balance is an important factor in many athletic skills, such as gymnastics, badminton, soccer, basketball and volleyball. An increased risk of multiple lower extremity injuries such as inflammation of the plantar fascia and lateral ankle sprains is due to a high arched foot (Palmieri et al., 2002). Also knee and ankle injuries are common in today's athletes, with ankle sprains and internal knee derangements and result from contact or noncontact mechanisms of injury. Non-contact mechanisms, such as landing from a jump, frequently lead to joint or ligament injuries, that are probably the result of strength deficits or impaired stability and balance (Carson et al., 2012). A greater incidence of medially soft tissue injuries, such as patellar tendinitis, plantar fasciitis and knee pain are found in low arched individuals (Wikstrom et al., 2004; Dahle et al., 1991). An important construct to examine in relation to injury risk is the dynamic balance; it is the ability of an individual to maintain stability of the centre of mass during movement. To screen athletes for increased injury risk, many tools have been developed such as Star Excursion Balance Test, Y Balance Test, Time to stabilization, Modified Bass Test, Dynamic Leap and Balance Test (DLBT) (McCrory et al., 1997).The goals of these tools are to identify individuals with increased susceptibility to injury so that intervention programs can be targeted for individuals with an elevated risk of injury (Shaffer et al., 2013; Kiani et al., 2010). There has been increased research interest in the static and dynamic behavior of the foot in different sports, in the past few years (Nagel et al., 2008; Molloy et al., 2009; Silvers and Mandelbaum 2007). Only few studies have investigated the relationship between sports participation and foot posture. The correlation between foot posture and balance have been studied together among athletes and non-athletes girls (Morrison and Ferrari 2009) and older people (Ghanizadehhesar et al., 2016).However, there is a paucity of such studies in Indian athletes. Also, there are no studies which have compared Foot Posture and balance in athletes playing different sports.The current study therefore aims to compare the two parameters in athletes playing medium impact sports and explore whether a relationship exists between them.

Materials and Methods

The study was cross sectional prospective study carried out over a period of 6 months, 90participantswere included in this study (30 Marathon runners, 30 footballers, 30badminton players).Participants who were willing to participate in this study and had been playing at least 3 times a week and who had symmetrical feet, without joint deformities and who are below 50years of age. Players who were unwilling to participate in the study or who had lower limb surgery or recent injuries, pre-existing neurological, musculoskeletal condition which can affect foot posture and balance were excluded from the study. The study was approved by the Institutional Ethics and Research Committee at D.Y.Patil University. A written consent was obtained from the participants before the study and their confidentiality was ensured. After collecting the demographic information, foot posture was assessed using Foot Posture Index (Cloak et al., 2010).Based on the scoring it was classified as normal, pronated or supinated. Balance was assessed using Y balance test. Three trials were used and the maximum reach score for each direction was extracted for data analysis.

Results and Discussion

Table 1. Mean ± SD of Age of Players

Groups	Mean	SD
Football	19.13	2.71
Marathon	36.27	11.35
Badminton	21.27	8.00

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Table.2. Percent distribution of Players on the basis of gender

Gender	Football		Marathon		Badminton	
	Count	%	Count	%	Count	%
Female	2	6.7%	16	53.3%	5	16.7%
Male	28	93.3%	14	46.7%	25	83.3%

Table 3. Test of Normalityof foot posture

	Groups	Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
Right	**Football**	.109	30	.200*
	Marathon	.122	30	.200*
	Badminton	.134	30	.176
Left	**Football**	.137	30	.158
	Marathon	.129	30	.200*
	Badminton	.118	30	.200*

Table 3 shows that the p-value for all the parameters is greater than that of 0.05 indicates that data is distributed normally and therefore ANOVA was used to test the significance of difference between average score between Football, Marathon and Badminton player.

Table 4. Percent distribution of Players on the basis of right foot posture

Right Foot Posture	Football		Marathon		Badminton	
	Count	%	Count	%	Count	%
Highly supinated	0	0.00%	0	0.00%	1	3.30%
Supinated	0	0.00%	0	0.00%	0	0.00%
Normal	16	53.30%	16	53.30%	15	50.00%
Pronated	13	43.30%	12	40.00%	10	33.30%
Highly pronated	1	3.30%	2	6.70%	4	13.30%

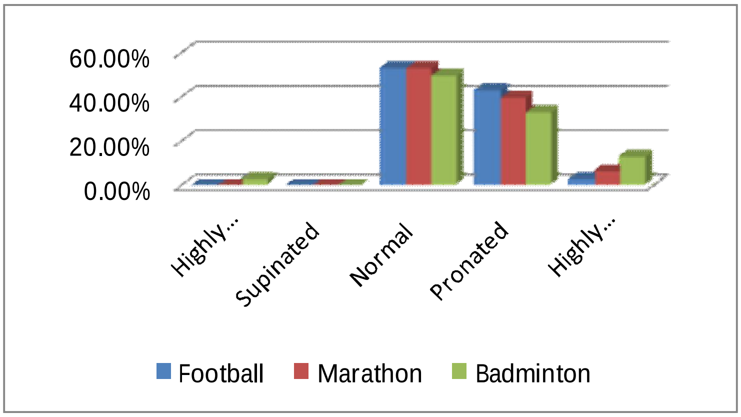

Figure 1. Percent distribution of Players on the basis of right foot posture

Table 5. Chi-Square test of right foot posture

Chi-Square test value	d.f.	p-value
4.443	6	0.617

Table 5 shows that the p-value for the chi-square test is greater than that of 0.05 indicates no significance of association of right foot posture. The percentage across the groups are almost same therefore the percentage difference of right foot posture is not statistical significant.

Table 6. Percent distribution of Players on the basis of left foot posture

Left Foot Posture	Football		Marathon		Badminton	
	Count	%	Count	%	Count	%
Highly Supinated	0	0.00%	0	0.00%	1	3.30%
Supinated	0	0.00%	2	6.70%	0	0.00%
Normal	11	36.70%	15	50.00%	15	50.00%
Pronated	18	60.00%	11	36.70%	10	33.30%
Highly pronated	1	3.30%	2	6.70%	4	13.30%

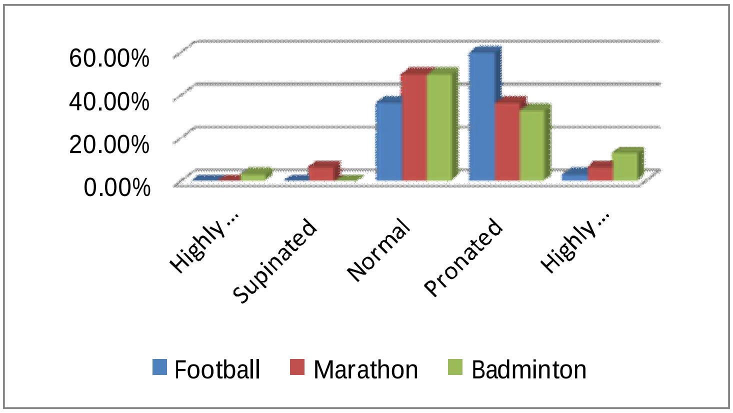

Figure 2. Percent distribution of Players on the basis of left foot posture

Table 7. Chi-Square test of left foot posture

Chi-Square test value	d.f.	p-value
11.704	8	0.165

Table 7 shows that the p-value for the chi-square test is greater than that of 0.05 indicates no significance of association of left foot posture. The percentage across the groups are almost same therefore the percentage difference of left foot posture is not statistical significant.

Table 8. Descriptive Statistics of Y Balance test

Y BALANCE TEST		Groups	
		Mean	Standard Deviation
Rt_1	Football	101.08	16.70
	Marathon	95.61	14.62
	Badminton	98.29	15.29
Lt_1	Football	97.83	17.96
	Marathon	95.69	15.96
	Badminton	97.22	15.38

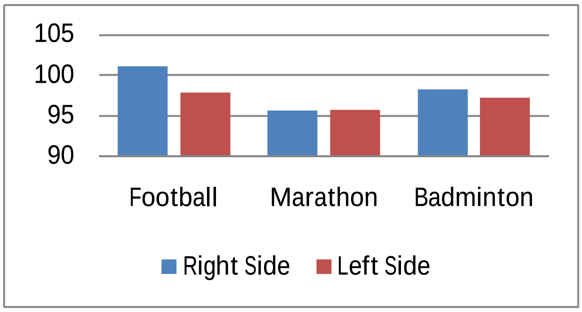

Figure 3. Descriptive Statistics of Y Balance test

Table 9. ANOVA of Y Balance test of right side

	Sum of Squares	**df**	**Mean Square**	**F**	**p-value**
Between Groups	448.270	2	224.135	.926	.400
Within Groups	21063.012	87	242.104		
Total	21511.282	89			

Table 9 shows that the p-value for the ANOVA test is greater than that of 0.05 indicates no significance of difference between the average scores.

Table 10. ANOVA of Y Balance test of left side

	Sum of Squares	**df**	**Mean Square**	**F**	**p-value**
Between Groups	72.822	2	36.411	.134	.875
Within Groups	23599.605	87	271.260		
Total	23672.428	89			

Table 10 shows that the p-value for the ANOVA test is greater than that of 0.05 indicates no significance of difference between the average scores.

Table 11. Spearman's Rank Correlation Coefficient between foot posture and Y balance

	Football	Marathon	Badminton
Right Side	FP & Y balance score	FP & Y balance score	FP & Y balance score
Correlation Coefficient	-0.307	-.393	-0.103
p-value	.099	.032	.587
Interpretation	**NS**	**Significant**	NS
Left Side	FP & Y balance score	FP & Y balance score	FP & Y balance score
Correlation Coefficient	-0.348	-.361	-0.006
p-value	.060	.049	.975
Interpretation	**NS**	**Significant**	NS

Table 11 shows that the p-value less than 0.05 indicate significant correlation. The negative correlation value indicates opposite correlation i.e. lower score indicates more towards pronated. The correlation is calculated by considering the lowest score value at highly supinated to highly pronated.

Figure 4. Spearman's Rank Correlation Coefficient between foot Posture and Y balance of right side

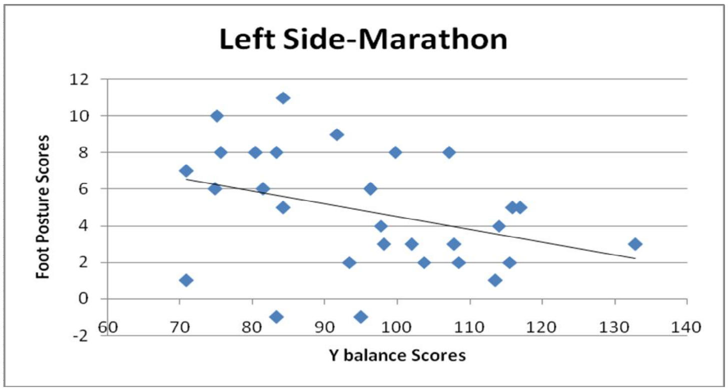

Figure 5. Spearman's Rank Correlation Coefficient between foot Posture and Y balance of right side

Discussion

The study was undertaken to evaluate foot posture and balance in marathon runners, badminton players and footballers. The study was done on a sample size of 90 participants (30 marathon runners, 30 badminton players and 30 footballers). On testing the normality, it is found that data is normally distributed and therefore we used ANOVA to test the significance of difference of average score between Football, Marathon and Badminton players. The first objective of the study was to compare foot posture in marathon runners, badminton players and footballers using Foot Posture Index. Chi square test of association was used to test whether the distribution of type of foot posture changes with respect to sport played. It was found that result p value of chi square test was 0.617 > 0.05(right side) and 0.165 > 0.05 (left side).There was no significant difference in type of foot posture with respect to type of sport played (Table 5 and 7). Cloak et al., (2010) found that runners and basketball players had neutral feet, with a tendency towards pronation. Among the runners, basketball players, and handball players, the differences in FPI seem to be mainly determined by two of the FPI criteria: talar head position and talonavicular prominence (Cloak et al., 2010). The second objective of the present study was to compare the balance in marathon runners, badminton players and footballers using Y Balance Test. ANOVA showed no difference between average score of three type of sports in balance($p>0.05$). Therefore, we concluded that the average Y Balance Test between Marathon runners, badminton players and footballers was almost same (Table 9 and 10). Long term athletic training augments neurosensory pathways and stimulates cutaneous nerve receptors or mechanoreceptors in the muscles, ligaments and joint capsule of knee and ankle joint as demonstrated by improved balance and proprioception (Myers and Anders 2008 ; Aydin et al., 2002). Football players have demonstrated better balance ability than non-athletes (Thorpe and Ebersole 2008). Therefore, the established effects of long term athletic training on balance and proprioception could be one of the rationales for the greater dynamic balance performance of football and field hockey players on SEBT. Bressel et al., (2007) compared static and dynamic balance among collegiate athletes competing or training in soccer, basketball, and gymnastics. Basketball players demonstrated inferior static balance to gymnasts and inferior dynamic balance to soccer players. There was no difference in dynamic balance among gymnasts and football players suggesting that some sensorimotor challenges may be common in these two sports. The differences in the SEBT scores may be due to neuromuscular differences among male and female athletes. As compared to male, female athletes have decreased potential for dynamic stabilization of the knee joint along with strength imbalances. Higher gluteus medius EMG activity was found in male football players than female football players while performing a forward jump single landing task (Henry and Kaeding 2001).Hart et al., (2007) found that, the static balance performance of the basketball players was lower than the performance of volleyball and football players. Basketball players had higher dynamic balance than volleyball and football players.The third objective of our study was to evaluate whether a relationship exists between foot posture and balance in marathon runners, badminton players and footballers. As seen in the results, negative correlation was found in all three sports; however the correlation was statistically significant only in marathon runners (Figure 4 and 5). The relationship was not statistically significant in football and badminton players (Table 11). The surrounding tarsal bones that are connected with the navicular bone, which is the center of the increase or decrease in the medial transverse arch of the foot, are the cuneiform in the anterior direction and the talus in the posterior direction. The reduction in the dynamic balance ability adjustment is believed to be due to the relative lack of connectivity with the talocrural and subtalar articulations that are responsible for foot balance. Different outcome measures and differences in population (our study included sports person where else, this study was done in healthy university students) used by the investigator may also have led to different components of different components of balance being assessed, which may also account for the difference in results.

Conclusion

Based on the results of the present study it was concluded that there was no significant difference in foot postures of marathon runners, badminton players and footballers as measured by Foot Posture Index. Most of them had normal foot posture followed by pronated feet. There was no significant difference in balance of marathon runners, badminton players and footballers as measured Y balance test- Average Y balance score was found highest in footballers, followed by badminton players and marathon runners. There is a negative correlation between Foot Posture and Balance. Correlation between the two variables is statistically non-significant in football and badminton players but significant in marathon runners.

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