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Impact of Various Foot Arches on Static and Dynamic Balance Among Trained Football Players - A Pilot Study

Abhilash PV[1], Bhaskara Bhandary[2], Gayatri Karki[3]
[1]Associate Professor, [2]Associate Professor, [3]Postgraduate Student (Corresponding Author)
Laxmi Memorial College of Physiotherapy, Mangalore, Karnataka, India[1]
A.J Institute of Medical Science, Mangalore, Karnataka, India[2]
Laxmi Memorial College of Physiotherapy, Mangalore, Karnataka, India[3]
Rajiv Gandhi University of Health Sciences, Karnataka, India

Abstract
Background: *Football being a multi directional game contains forceful and expulsive activities (e.g. tackling, jumping, kicking, turning and changing pace). Lower extremity alignment is a major influencing factor in controlling maximum of these activities. In which, the feet requires proper weight distribution during many body motions. It seems reasonable that even minor biomechanical alternation in the support surface may influence balance strategies, also the foot arches structure and function varies from person to person. Hence, it is crucial to rule out the differences in these foot arches and balance strategies among trained football players. This study aims to compare the dynamic and static balance in-between various foot arch among trained football players.*
Materials and Methods*: 24 trained football players between the ages 20 to 30 years were recruited in this study. The Navicular Drop Test (NDT), Lower Quarter-Y Balance Test (LQ-YBT) and Single Leg Stance Test (SLST) in both eyes open (SLSTEO) and eyes closed (SLSTEC) were used to assess for foot arch type, dynamic balance and static balance respectively.*
Results: *Independent t-test showed a statistically very high significant difference in LQ-YBT, SLSTEO and SLSTEC in-between three foot arch groups (p<0.05).*
Conclusion: *This study concludes that the supinated foot arch group possess good dynamic and static balance compared to other two foot arch groups. Thus, the balance component does differ according to the different foot arch among trained football players.*

Keywords: *Trained football players; foot arches; dynamic balance; static balance.*

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I. Introduction

The lower extremity chain is connected with foot, ankle, knee and hip-joint. Of these, the feet are placed at the farthest point and acts as support base, considering that the foot is that the most distal segment within the lower extremity chain and represents a relatively small base of support upon which the body maintains balance, it seems reasonable that even minor biomechanical alternation within the support surface may biggest influence balance strategies.[1, 2]Football contains forceful and expulsive activities (e.g., tackling, jumping, kicking, turning and changing pace)[3] for all of those activities lower extremity function and structures plays a crucial role.

Foot features a complex structure which performs a broad sort of functions in several postural and dynamic tasks.[4,5]This versatility can only be achieved through its unique arch-shaped architecture and its powerful intrinsic and extrinsic muscular activity, which is liable for the upkeep and control of foot arches, postural corrections during disturbances, and torque generation during body displacement.[6,7] Even with this unique and specialized structure, a high prevalence of injuries related to sports practices like, football occurs in this complex. With regard to arch of the foot, it also can affect proprioceptive inputs through the movement of joints, change within contact area and muscle strategy for maintaining the steadiness of the base of support which varies from person to person.[8]

Compared to basketball players and active control subjects footballer are expected to possess superior static uni-pedal and dynamic balance ability, as balance is a measure of lower extremity function and is defined as the process of maintaining the centre of gravity within the body's base of support[1] for which the arches of foot plays an important role. Inefficient balance strategies can also leads to poor athletic performance.[9]During a match, football players frequently perform lower extremity passing, shooting, and dribbling skills with football cleats on grass field. They need to maintain an edge of balance as they run at high speed, change direction rapidly and powerfully kick the ball to pass or shoot. Furthermore, players must conserve balance as they're prevented by opposing players and check out to steal the ball.[2]

Foot may be a significant element of the four main anatomy trains, the superficial back line, the superficial battlefront, the lateral line and the spiral line[10]. The plantar intrinsic foot muscles are a neighbourhood of the superficial back line, and alongside plantar fascia, they control the upkeep of the longitudinal foot arch. They permit bringing both ends of the foot closer to every other, maintaining proper relations between the heads of the first and the fifth metatarsals and the heel bone. Additionally, the longitudinal arch of the foot is enhanced by the plantar ligament and therefore the plantar calcaneonavicular ligament which are located in deeper layers. The dysfunctions within the plantar surface of foot may cause problems which are transmitted to the upper parts of the anatomy trains.

A dysfunction of this part is often associated with hyperextension of the knee, shortening and reduction of flexibility of the hamstring muscles, increased cervical lordosis, and decreased lumbar lordosis.[11]High-arched and low arched foot types seem to be a risk factor for overuse injuries in sport activities.Dahle[12] found knee pain more common in football players with pronated or supinated foot types, compared with neutral foot type. Williams et al found high-arched players to possess more ankles, bony, and lateral sided injuries, while low-arched runners had more knee, medial sided and soft tissue injuries.[13]

Specifically there's a difference in plantar loading between straight line tasks and multi directional movements.[4] Plantar loading is usually influenced by the structures of the foot,[4] and football being a multidirectional game, it's vital to rule out the balance among them in several foot arches. Also, a specific foot arches leads to different injury patterns among athletes.[5]There is a paucity in studies showing impact on both the dynamic and static balance due to either one or two different foot arches among trained footballers. Also balance being the major component for qualitative performance among football player, this study aims to provide a clinical significance by reducing injury risk and focusing on, not only the hip, knee and core aspects but also the foot aspects during rehabilitation and during training sessions.

II. Materials and Methods

This pilot study was carried out in football clubs, in and around Dakshina Kannada, Karnataka, India from 2020 September to June 2021. Twenty-four trained football players fulfilling inclusion and exclusion criteria were recruited using convenience sampling technique and then equally allotted to one of three groups; Neutral Foot (NF), Supinated Foot (SF) and Pronated Foot (PF) on the basis of NDT, i.e., eight players in each groups. All participants were verbally explained about the study in brief and were recruited in the study after written consent.

Study Design: Cross-sectional pilot study

Study Location: Football clubs, in and around Dakshina Kannada, Karnataka.

Study Duration: September 2020 to June 2021

Sample size: Twenty-four football players.

Sample size calculation: A sample size was calculated based on the study by Kelleher LK et al[14] with 95% confidence level, 80% power. The actual sample size calculated was 30 for the crossectional study, among which 24 were included for this pilot study.

Subjects & selection method: Twenty-four trained football players fulfilling inclusion and exclusion criteria were recruited using convenience sampling technique and then equally allotted to one of three groups; Neutral Foot (NF), Supinated Foot (SF) and Pronated Foot (PF) on the basis of NDT, i.e., eight players in each groups.

Inclusion criteria:

1. Age- 20 to 30 years.
2. 3 or more years of competitive experience.
3. Regular practicing players- minimum 2 hours/day for minimum 3 days/week.
4. Not involved in any balance training program apart from their typical sports training.

Exclusion criteria:

1. Healthy Recreational football players.
2. Players who report LBP or a history of lower extremity injuries that required treatment or that might have inhibited performance in last 12 months.
3. Players' undergone lumbar spine or any lower extremity surgery in the last 6 months.
4. Vestibular problems, e.g., vertigo.
5. Not given consent or otherwise unwell at the time of investigation.

Procedure methodology

A written consent was obtained from each player after detailed explanation of the procedure. All the players were asked to fill a performa that included age, weight, height, leg dominance, playing hours (min/day, day/ week). After initial assessment each player were assessed by NDT and were divided into 3 groups according to NDT values, i.e., NF, SF and PF, 8 in each group according to the leg dominance and players were asked to perform lower extremity dynamic balance by LQ-YBT. SLST was carried out in Single Leg Stance Test Eye Open (SLSTEO) and Single Leg Stance Test Eye Closed (SLSTEC) conditions for dominant leg. All the test were carried out in a random fashion either LQ-YBT first, or SLST (SLSTEO, SLSTEC) to reduce sequencing error. Each test was carried out for 3 times after one initial trial rest of 30 sec was given between the trial and 5 min between the tests.

OUTCOME MEASURES

1. **Foot arches measurement:** The Navicular Drop Test (NDT) was used to determine the foot arch type; it was first described by Brody in 1982 as a means of quantifying the amount of foot pronation in runners. At first, the player were positioned in standing so there is full weight bearing through the lower extremity ensuring the foot is in the subtalar joint neutral position. The most prominent part of the navicular tuberosity was marked using marker along with the use of small blank paper marking the same prominence in standing position. The players were asked to relax in closed kinetic sitting position and the amount of sagittal plane excursion was measured with ruler. The foot were divided into three foot arch type, i.e., Supinated <5mm, Neutral 6-8mm and Pronated ≥ 10-15mm.[1,15]

2. **Dynamic balance:** The Lower Quarter Y-Balance Test (LQ-YBT) is an instrumented version of components of the Star Excursion Balance Test (SEBT) developed to improve the repeatability of measurement and standardize performance of the test[10]. The test utilizes the anterior, posterior-medial, and posterior-lateral components of the SEBT. The posterior line was positioned 135 degrees from the anterior line with 45 degrees between the posterior lines. The participants stand on the leg they used for kicking the ball, with the most distal part of the great toe placed on the center of the grid. While maintaining a single-leg stance, they used the opposite leg to reach as far as possible toward the end of the line along a grid in the anterior, posterior-medial and posterior-lateral directions. Then, they touched the ground lightly with the most distal part of the reaching foot before returning to the starting position the reach distance was then measured using a tape measurement. The subject's hand was held at the iliac crest during the test. All tests were performed barefoot to rule out the influence of shoes. After six practice trials were completed the participants took rest for 30sec and then performed three test trials in each direction[12]. The test was discarded and then repeated in the same manner incase participant failed to maintain the unilateral stance, lifted or moved the standing foot from the grid or failed to return the reaching foot to the starting position. The longest reach distance in each direction was for the analysis. For an accurate analysis the data of reach distance was normalized with the leg length to exclude the influence of leg length.[13]The leg length was measured with a tape measure from the anterior superior iliac spine to the center of the ipsilateral medial malleolus.[12]The composite score was calculated according to the formula.[10]
{(sum of all three directions)/ (limb length x 3)} x100

3. **Static balance:** The Single Leg Stance Test (SLST) is described as a method of quantifying static balance ability.[8] It is a valid measure and useful in explaining other variables of importance such as frailty and self-sufficiency in activities of daily living, gait performance and fall status. Before the SLST is performed the players were asked to kick a ball placed on the floor in front of him and the kicking limb was recorded as the dominant limb. Players were asked to stand barefoot on the limb of their choice, with the other limb raised so that the raised foot is near but not touching the ankle of their stance limb. Prior to raising the limb the subjects were instructed to cross his arms over the chest. Stopwatch was used to measure the amount of time, the players were asked to stand on one limb. Time ended when subject either used his arms (i.e., uncrossed arms), used the raised foot (moved it toward or away from the standing limb or touched the floor), moved the weight-bearing foot to maintain his balance (i.e., rotate foot on the ground), a maximum of 45 seconds is elapsed or opened eyes on eyes closed trials. The procedure was repeated 3 times and each time was recorded. The best and average of 3 trials was recorded and performed 3 trials with eye open and 3 trials with eye closed, 1 trial with eye one and 1 trial with eye closed equals to 1 trial set. At least 5 min rest after each trial set was given.

STATISTICAL ANALYSIS

Statistical package SPSS ver.26.0 was used to do the analysis. Descriptive features of all three groups are expressed in means with a standard deviation ($\bar{X} \pm SD$). Independent t-test was used to compare the difference in dynamic and static balance in-between the three groups, a p-value of <0.05 was considered statistically significant.

III. Results

Twenty-four male trained football players who participated in this study were allocated to three groups, i.e., Neutral Foot (NF), Supinated Foot (SF) and Pronated Foot (PF).

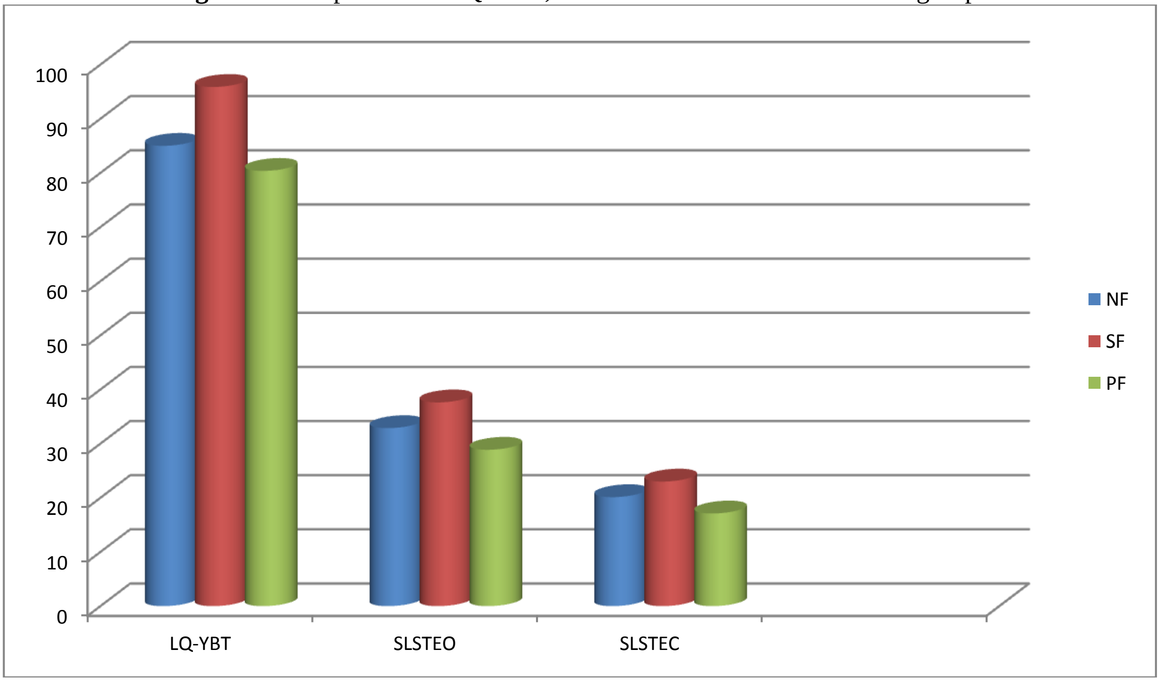
Table 1: Descriptive statistics of Age, LQ-YBT, SLSTEO and SLSTEC in three different foot arches

	NF	**SF**	**PF**
Age	24.125± 1.125	24 ± 1.51	23.5 ±1.19
LQ-YBT	85 ± 3.07	95.87 ± 3.18	80.37 ± 1.505
SLSTEO	32.87 ± 1.45	37.62 ± 1.68	28.87 ± 1.35
SLSTEC	20.12 ±1.125	23 ± 1.069	16.87 ± 1.125

Table 2: Comparison of LQ-YBT, SLSTEO and SLSTEC in between groups

		t-value	**Sig p-value**
NF & SF	LQ-YBT	6.956	0.000
	SLSTEO	6.030	0.000
	SLSTEC	5.232	0.000
SF & PF	LQ-YBT	12.465	0.000
	SLSTEO	11.462	0.000
	SLSTEC	11.205	0.000
NF & PF	LQ-YBT	3.835	0.002
	SLSTEO	5.682	0.000
	SLSTEC	5.777	0.000

Figure 1: Comparison of LQ-YBT, SLSTEO & SLSTEC in between groups



IV. Discussion

This pilot study was intended to compare the impact of dynamic and static balance in three foot arches among trained football players. All 24 players included in this study had completed the test under the supervision without any fail. Statistically very high significant difference was found in LQ-YBT, SLSTEO and SLSTEC between the three foot arch groups ($p<0.05$).

Decreased dynamic balance is identified as the main risk factors for lower extremity injury Ness et al.[16]In the present study dynamic balance measurement was done using LQ-YBT which is a reliable test for measuring single limb stance excursion distance while performing dynamic balance testing in trained football player.[23, 24] Coughlan et al performed a comparative study between the SEBT and YBT-LQ and observed difference within the anterior reach direction between the two tests, with no differences within the posterolateral and postero-medial reach directions. Both the SEBT and YBT-LQ involve similar movements that are deemed to measure and challenge dynamic balance.[25, 26] Alfonso et al suggested LQ-YBT is a valid test to determine individuals among professional football players susceptible to soft tissue injury and found that, YBT-LQ can be incorporated into physical examination to identify football players prone to risk of injury.[27] Likewise, Springer et al conducted a prospective mixed-model study to determine the normative values for the unipedal stance test with eyes open and closed and found that these test were reliable and valid tool to measure a static balance which is an age specific.[28]

Also, a poor static balance is a risk factor for non-contact anterior cruciate ligament injury among young athletes.[29] Dingenen et al suggested that postural stability measurements during the single-leg stance phase of the double- to single-leg stance transition task may be a useful predictor of injured risk of noncontact lower extremity injury.[18] Comparison made between a foot types an specific tendency can be ruled out, namely a high arch foot also called a supinated foot, normal or neutral foot type is found to have a faster forefoot contact than that of a pronated foot. It is also clear that high arch or supinated foot type spends less time on the rear-foot than pronated foot with rear-foot contact.[19] The results of this study supports the finding of foot types, that being pronated foot decrease balance both in dynamic and static condition.

On comparison, mean values of NF, SF and PF on LQ-YBT and SLST significant increase (Figure 1) in the mean value of LQ-YBT was observed in SF (95.87 ± 3.18cm) which is more effective than the normal or NF(85 ± 3.07cm) and low arch or PF (80.37 ± 1.505cm). The present study supports the findings of study conducted by Sudhakar. S et al, which found to have good dynamic balance in high arch foot type/ SF (84.7±2.3cm) among short distance runner.[20] Another study done by Tsai LC et al on comparison of different structural foot types for measures of standing postural control found that individuals with pronated feet or supinated feet have poorer postural control than those in the neutral group.[21] In favour of the present study, Cote et al concluded that the postural stability is affected by foot type under both static and dynamic conditions.[1] In present study the mean of SLST (SLSTEO and SLSTEC) for each foot arch were NF (32.87 ± 1.45sec, 20.12 ±1.125sec), SF (37.62 ± 1.68sec, 23 ± 1.069) and PF (28.87 ± 1.35sec, 16.87 ± 1.125sec) which was significantly higher than compared to previous study done by El-Kashlan et al (28.8±1.4sec, 18.7±1.6sec) among healthy individuals. These differences appear to be related to structural differences as opposed to differences in peripheral input. These effects should be considered when clinicians use such balance measures to assess injury deficits and recovery.[1]

Abdulwahab et al concluded that higher degrees of foot posture index might have an effect on standing dynamic balance in healthy subjects, these components may require extra attention during the preventive aspects of rehabilitation.[22]On the contrary, Hyong H et al suggested that compensation adaptation of the muscles surrounding the ankle joints to external factors that affect balance such as the visual, auditory, and somatosensory systems, despite the foot shape differences based on the height of foot arch.[9]In the present study the foot arch measurement was done using NDT, which is a reliable test that can be done in clinical setting as well.[30, 31]Based on our own results and studies by other authors we concluded that the foot arch type/structures do impact the balance components among trained football players. Thus, considering these factors would result in qualitative game output among football players.

V. Conclusion

Present study concludes that both dynamic and static balance differs according to foot structures. Supinated foot is found to have a superior dynamic and static balance than other two foot arch group among trained football players. Hence, pre-assessing the foot arch structures, accordingly planning the balance training programs on the basis of variation in foot arch type will help in injury prevention as well as qualitative game performances among trained football players.

References

[1]. Cote KP, Burnet ME, BM, Shultz SJ. Effects of pronated and supinated foot postures on static and dynamic postural stability. J Athl Train. 2005; 40(1): 41- 46.

[2]. Azeem Z, Sharma R. Comparison of dynamic and static stretching on dynamic balance performance in recreational football players. Saudi J Sports Med.2014; 14(2): 134-139.

[3]. Erkmen N, Taskin H, Sanioglu A, Kaplan T, Bastyuk D. Relationships between balance & functional performance in football players. J Hum Kinet. 2010; 26(1): 21-29.

[4]. Salrzman CL, Nawoczenski DA. Complexities of foot architecture as a base of support. J Orthop Sports Phys Ther. 1995; 21: 354-60.

[5]. Dubin A. Gait: the role of the ankle and foot in walking. Med Clin N Am. 2014; 98(2): 205-11.

[6]. Dugan SA, Bhat KP. Biomechanics and analysis of running gait. Phys Med Rehabil Clin N Am. 2005; 16(3): 603-21.

[7]. Ostiak W, Kaczmarek MM, Kasprzak P. Foot and shin in terms of anatomy trains. J Ortho Trauma Surg Relat Res.2011; 5(25): 38-46.

[8]. Melam GR, Alhusiani AA, Perumal V, Burugadda.S, Kaur K. Comparison of static and dynamic balance between football and basketball players with chronic ankle instability. Saudi J Sports Med.2016; 16(3): 199-204.

[9]. Hyong IH, Kang JH. Comparison of dynamic balance ability in healthy university students according to foot shape. J Phys Ther Sci. 2016; 28(2): 661-4.

[10]. Myers TW. Anatomy trains: myofascial meridians for manual and movement therapists.5th ed. USA: Elsevier; 2014.

[11]. Dahle LK, Mueller MJ, Delitto A, Diamond JE. Visual assessment of foot type and relationship of foot type to lower extremity injury. J Orthop Sports Phys Ther.1991; 14(6): 70-4.
[12]. Deng J, Joseph R, Wong C K. Reliability and validity of the sit to stand navicular drop test: do static measures of navicular height relate to the dynamic navicular motion during gait? J Stud Phys Ther Res. 2010; 2(1): 21-28.
[13]. Sonepat H. Effect of wobble board balance training program on static balance, dynamic balance & triple hop distance in male collegiate basketball athlete. Int J Physiother. 2014; 2(4): 657-662.
[14]. Kelleher LK, Frayne RJ, Beach TA, Higgs JM, Johnson AM, Dickey JP. Relationships between the functional movement screen score and y-balance test reach distances. Int J Hum Mov Sports Sci. 2017; 5(3):51-56.
[15]. Brody DM: Techniques in the evaluation and treatment of the injured runner. Orthop Clin North Am. 1982; 13(5): 541-58.
[16]. Ness BM, Comstock BA, Schweinle WE. Changes in dynamic balance and hip strength after an eight-week conditioning program in ncaa division I female soccer athletes. Int J Sports Phys Ther. 2016; 11(7): 1052-64.
[17]. Oshima T, Nakase J, Kitaoka K, Shima Y, Numata H, Takata Y, Tsuchiya H. Poor static balance is a risk factor for non-contact anterior cruciate ligament injury. Arch Orthop Trauma Surg.2018; 138(12):1713-8.
[18]. Dingenen B, Nijs S, Malfait B, Verschueren SM, Janssens L. Postural stability during single-leg stance: a preliminary evaluation of noncontact lower extremity injury risk. J Orthop Sports Phys Ther. 2016; 46(8):650-657.
[19]. Scott SH, Winter DA. Talocrural and talocalcaneal joint kinematics and kinetics during the stance phase of walking. J Biomech 1991; 24(8):743-752.
[20]. Sudhakara S, Krithika SV , Padmanabhan K, Kumar GM, Nathan CS, Gopika R, Samuel AJ. Impact of various foot arches on dynamic balance and speed performance in collegiate short distance runner: a cross-sectional comparative study. J Orthop. 2018; 15(2): 114-117.
[21]. Tsai LC, Yu B, Mercer VS, Gross MT. Comparison of different structural foot types for measures of standing postural control. J Orthop Sports Phys Ther.2006; 36(12):942-53.
[22]. Al Abdulwahab SS, Kachanathu SJ. The effect of various degrees of foot posture on standing balance in a healthy adult population. Somatosens Mot Res. 2015; 32(3): 172-176.
[23]. Willams DS, McClay IS, Hamill J. Arch structure and injury patterns in runners. Clin Biomech. 2001; 16: 341-347.
[24]. Butler RJ, Lehr ME, Fink ML, Kiesel KB, Plisky PJ. Dynamic balance performance and noncontact lower extremity injury in college football players: an initial study. Sports Health. 2013; 5(5): 417-22.
[25]. Robinson RH, Gribble PA. Support for a reduction in the number of trials needed for the star excursion balance test. Arch Phys Med Rehabil. 2008; 89(2): 364–70.
[26]. Coughlan GF, Fullam K, Delahunt E, Gissane C, Caulfield BM. A comparison between performance on selected directions of the star excursion balance test and the y-balance test. J Athl Train. 2012; 47(4): 366-71.
[27]. Gonell AC, Romero JA, Soler LM. Relationship between the y- balance test scores and soft tissue injury incidence in a soccer team. Int J Sports Phys Ther. 2015; 10(7): 955-66.
[28]. Springer BA, Marin R, Cyhan T, Roberts H, Gill NW. Normative values for the unipedal stance test with eyes open and closed. J Geriatr Phys Ther. 2007; 30(1): 8-15.
[29]. Oshima T, Nakase J, Kitaoka K, Shima Y, Numata H, Takata Y, Tsuchiya H. Poor static balance is a risk factor for non-contact anterior cruciate ligament injury. Arch Orthop Trauma Surg.2018; 138(12):1713-8.
[30]. Vauhnik R, Turk Z, Pilih IA. Intra-rater reliability of using the navicular drop test for measuring foot pronation. Hrvatski Sportskomedicinski vjesnik.2006; 21 (1): 8-11.
[31]. Eslami M, Damavandi M, Ferber R. Association of navicular drop and selected lower-limb biomechanical measures during the stance phase of running. J Appl Biomech. 2014; 30(2): 250-4.

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