

# The effect of fatigue on functional stability in the basketball players with functional ankle instability

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**Abstract:** The purpose of the present study was to assess the effect of basketball-specific fatigue on the dynamic postural control of the basketball players with functional ankle instability. The subjects in this study included 28 basketball players in the Youth League in Kerman. Their ages ranged between 16 and 21 years old. Based on the results of ankle instability questionnaire (CAIT) and the medical approval, the participants were selectively divided in two groups: a group of 16 subjects with functional ankle instability and a group of 12 healthy subjects. "Basketball Movement Specific Circuit" protocol was used to induce basketball-specific fatigue, and Y test was employed to quantify postural control. Specifically, Y test was administered as a pretest and posttest at the beginning and the end of the fatigue protocol. To make sure that the intended fatigue was really induced, Borg Scale was employed and the participants were asked to express their true feeling about the intensity of the exercise at the beginning and the end of the protocol. The result of analyzing data through dependent T-test indicated that dynamic postural control significantly decreased after the induction of fatigue in both groups. In addition, running independent T-test determined that fatigue equally affected the participants of both groups. This means that the participants in the experimental group coordinated postural control mechanisms with fatigue. Based on the results of this study, it can be concluded that both healthy players and those with functional ankle instability are susceptible to ankle sprain when they feel fatigue due to defect in postural control.

**Keywords:** Basketball Specific Fatigue, Dynamic Postural Control, Functional Ankle Instability, Test, Borg Scale, Basketball Movement Specific Circuit

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## 1. Introduction

Postural control plays an important role in sport performance. In other words, it has a crucial and decisive role in an athlete's success in all sport fields, both in fields such as shooting which entails the lowest mobility and in those like gymnastics, wrestling, and basketball which require rapid mobility with the highest balance (Huston JL et al., 2005). Basketball is one of the world's most popular physical activities. Nearly 11% of the world's population play basketball regularly. Unfortunately, since the number of young male and female basketball players is rising, the rate of injuries also increases. Due to the nature of this sport field, a high percentage of injuries were reported to have occurred in the lower limb and ankle (Harmer, 2005). The researchers are still trying to reduce the amount of

injuries in basketball players; they have mainly focused on risk factors such as proprioception ability, the level of kinematic development, the level of competition, and fatigue (Harmer, 2005). Fatigue is a common phenomenon that occurs during exercises and impairs an athlete's kinematic function (Millet et al., 2004). In the last decade, sports scientists have considered fatigue as a factor which negatively affects sport performance. They also investigated the relation between fatigue and postural control and concluded that fatigue and the reduction of postural control can result in skeletal-muscular injury in athletes (Pappas et al., 2007). To investigate the effect of fatigue on the postural control system, the researchers employed various techniques to exhaust the body and the organs especially the limb. These techniques include isokinetic contractions, repetitive movements, isometric

contractions, and functional activities. For example, Nardone et al. (1998) investigated the range of postural volatility in 8 healthy individuals. After the participants ran on a treadmill for 25 minutes, their postural volatility was measured on the dynamometric page. This was done while they put their legs together with both closed and open eyes. They concluded that, 15 minutes after the exercise, postural volatility increased due to fatigue (Nardone et al., 1998). Christina KA et al. (2001) explored the effect of fatigue on ground reaction forces and ankle joint movements in 11 females who were running with the speed of 2.9 meter per second on a treadmill (in the first 50% of stance phase). They investigated dorsiflexor and invertor muscles before and immediately after the induction of fatigue. They concluded that local fatigue in the two groups of muscles had a significant effect on ground reaction forces and ankle motion during walking. Thus, it can play an important role in ankle injuries in trainings and competitions (Christina KA et al., 2001). In addition, Wilkins et al. (2004) studied performance on Balance Error Scoring System (BESS) and investigated how it impairs after fatigue. They made use of a 7-station fatigue protocol to simulate the activity during an exercise. The increase in BESS scores immediately after fatigue indicated that the balance was affected by fatigue (Wilkins JC et al., 2004). Exploring the impact of two types of fatigue on the duration of postural stability defect, Harkins et al. (2005) declared that the higher the amount of fatigue, the greater the defect in postural control system (Harkins et al., 2005). Marco et al. (2007) explored postural control of 20 individuals (15 males and 5 females) on treadmill after they had gone through a series of exhaustive activities. The participants' with mean age ( $6.3 \pm 7.23$ ). The energy page was used to measure the participants' balance. In addition, fatigue was induced through requiring the participants to run on the treadmill (The speed of the treadmill increased every minute). The result proved that there was a significant increase in the body volatility (the reduction of balance) after the application of the fatigue

protocol (Marco et al., 2007). Letafatkar et al. (2009) conducted a research on the effect of muscle fatigue induced by exhaustive exercises on professional athletes' functional stability. The participants of this study consisted of 30 professional male athletes with mean age ( $23 \pm 2.1$ ). Biodex device and Running-based Anaerobic Sprint Test (RAST) were employed to measure balance and induce fatigue respectively. The researchers concluded that muscle fatigue reduces functional and lateral stability; however, it is not likely to affect posterior and anterior stability. This can be explained by the fact that when a person suffers from fatigue, CNS compensates for the disturbances created in the functional stability of the body to some extent (Letafatkar et al., 2009).

As it is clear, to investigate the impact of fatigue on the postural control system, most studies used protocols unrelated to exercises and competitions. Furthermore, few studies have been conducted to explore dynamic postural control; instead, most of them were carried out to investigate the static postural control system through functional tests. On the whole, it seems that there is a lack of research into the relationship between dynamic postural control and exercise-induced fatigue and its related concepts. Consequently, it is essential to explore the effects of whole body fatigue on dynamic postural control through a functional fatigue protocol which is similar to exercises and competitions, and a functional test which measures dynamic postural control.

## 2. Methodology

The subjects of this study were 28 basketball players in the Youth League in Kerman. Based on the results of Cumberland Ankle Instability Tools (CAIT) and medical approval, the participants were selectively divided in two groups: a group of 16 subjects with functional ankle instability and a group of 12 healthy subjects.

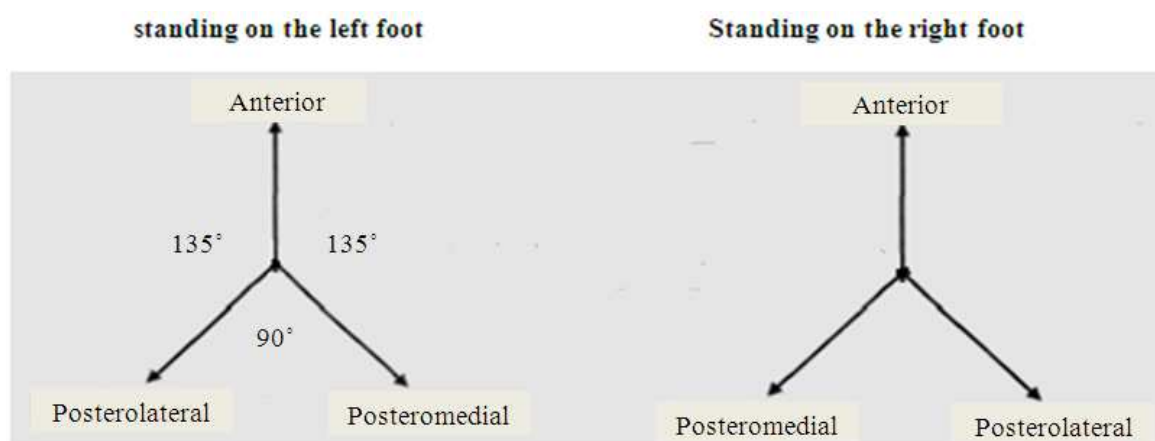


Figure1. The outline of Y balance test

The Y balance test device was used to assess the participants' dynamic postural control. In this device, the

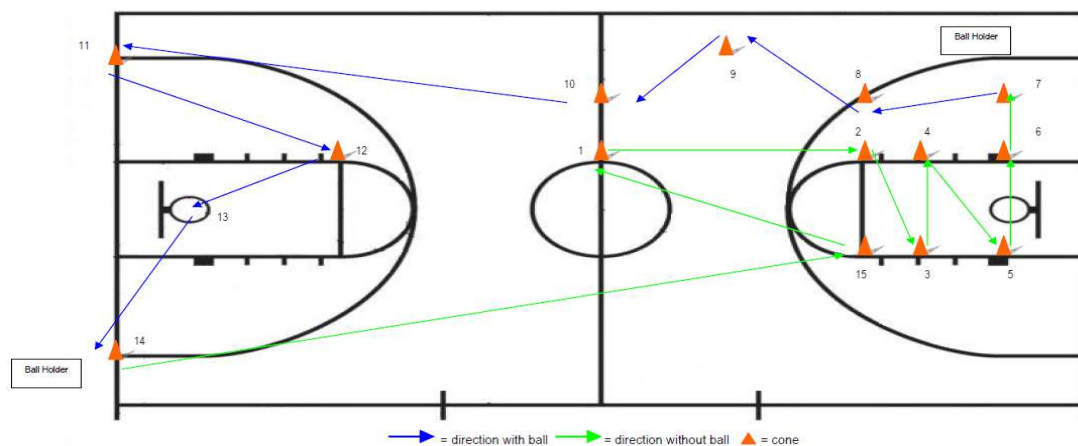
three directions are situated just like a Y (Plisky et al., 2006; Figure1). To normalize data, this test measured the actual

length of the leg which stretched from anterior superior iliac spines to the medial ankle (Gribble *et al.*, 2003). After the experimenter explained the test to the participants, the subjects practiced six times to familiar the procedure. The Y test was performed on the premier feet. If the right foot was premier, the test was performed in the counterclockwise direction; otherwise in clockwise direction (Gribble *et al.*, 2003).

The player stood on one leg in the center of a grid. While maintaining single-leg stance, the player was asked to reach with the free limb in the anterior, posteromedial, and posterolateral directions in relation to the stance foot. The maximal reach distance was measured by marking the tape measure with erasable ink at the point where the most distal part of the foot reached. The trial was discarded and repeated if the player (1) failed to maintain unilateral stance,

(2) lifted or moved the stance foot from the grid, (3) touched ground with the reach foot, or (4) failed to return the reach foot to the starting position. The process was repeated while standing on the other leg. The greatest reach distance of the 3 trials for each direction was used for analysis (Figure2) (plisky *et al.*, 2006). Finally, the mean of the three scores was calculated, and the result was divided by the leg length (cm) and multiplied by 100.

Basketball-specific fatigue protocol (Basketball Movement Specific Circuit) was employed to induce fatigue (Figure2) (Smith, 2004). This protocol is similar to a basketball game in terms of duration, intensity, and movement patterns. It is applicable in a basketball field. It consists of four 4-minute phases with the heart rate of 90% to 95% HRmax. Between each phase, there is a 3-minute active rest (jogging) with the heart rate of 70% HRmax.



**Figure2.** basketball movement specific training circuit. 1-2 forward sprint; 2 pivot left; 2-3 shuffle left; 3-4 shuffle right; 4-5 shuffle left; 5-6 shuffle right; 6-7 run into vertical jump(collect ball upon landing); 7-10 speed dribble ball around cones; 10-11 speed dribble; 11-12 speed dribble; 12-13 lay-up attempt; 13 lay-up rebound; 13-14 speed dribble(drop ball at 14); 14-15 forward sprint; 15-1 back pedal(Smith, 2004).

To ensure that adequate fatigue was attained, the clinicians used the 15-point Borg scale to measure each subjects Rating of Perceived Exertion (RPE). After the participants prepared themselves through a brief warm-up (5-10 minutes of jogging and stretching the lower limb), Y test and PRE were administered as pretests. After they finished the protocol, Y test and PRE were held as posttests (Timothy *et al.*, 2006). In order to compare the postural mean scores in every direction and PRE pretest and posttest in each group, dependent T-Test ( $p < 0.05$ ) was run. Moreover, independent T-Test was used to compare the postural mean scores of the control and experimental

groups.

### 3. Results

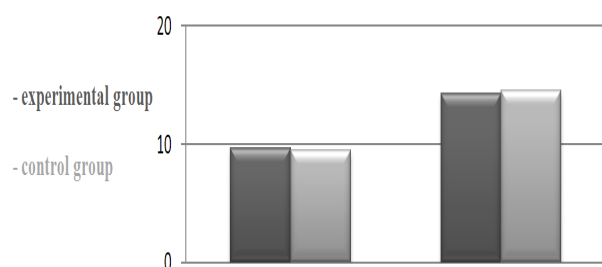
The result of dependent T-Test between the pretest and posttest on mean scores of reach distance in the three directions are presented in the Table 1. there is a significant difference ( $\alpha = 0.05$ ) in all the three directions. However, the result of independent T-test on the mean difference shows not significant difference between the two group ( $\alpha = 0.05$ , Table 2).

**Table 1.** Mean scores of dynamic postural control of the healthy and unstable groups

statistical index variable		N	mean score	Std. deviation	Std. error	t value	df	$\alpha$
experimental	pretest	16	99.93	6.27	1.56	6.48	15	0.000
	posttest	16	92.11	7.03	1.75			
control	pretest	12	103.20	6.38	1.84	6.84	11	0.000
	posttest	12	94.62	6.18	1.78			

**Table 2.** Comparison in mean difference of dynamic postural control between the healthy and unstable groups

Group	N	mean score	Std. deviation	Std. error	t value	df	$\alpha$
unstable group	16	7.81	4.81	1.20	-0.44	26	0.66
healthy group	12	8.58	4.34	1.25			

**Graph 1.** The mean of the change in the perception of pressure in the control and experimental groups

## 4. Discussion and Conclusion

Nardone et al. (1998), Christina KA et al. (2001), Wilkins et al. (2004), Harkins et al. (2005), Marco et al. (2007), and Letafatkar et al. (2009) reported decrease of balance control and increase of body volatility after application of various fatigue protocols. The reduction was attributed to the lack of proper functioning of the muscles and sensory effects of fatigue (Timothy et al., 2006). The application of a fatigue protocol on a part of the body and on the muscles acting on a joint causes the sensory receptors to send messages to the central nervous system. Then, the system, presumably aiming at preventing muscle damage, sends back a message which declares the reduction of the contraction activities of the muscles. Thus, the application of a fatigue protocol results in the reduction of the speed of neural transmission in afferent and efferent neurons ending in a muscle group. This has also been used to explain dynamic balance and reach distance decrease after application of a fatigue protocol (Taylor et al., 2000).

However, Rozzy et al. (1999), found a contradictory result a did not increase the body volatility. One of the reasons for such contradiction results might be due to variation in fatigue-inducing protocols and the test methods employed to measure balance.

In the present study, both groups had impaired postural control after the fatigue protocol; however, there was no significant difference between the two groups. Such results are out of our expectations. We assumed that the experimental group would suffer from more impaired postural control because of the functional ankle instability. Gribble et al. (2004) explored the mixed effects of fatigue and chronic ankle instability on dynamic postural control and drew a conclusion contrary to the present study. they observed that the unhealthy group achieved less reach distance in comparison to the healthy (Gribble et al., 2004). It seems that one of the major reasons for the contradiction

between the results of the present study and those of Gribble et al. (2004) is the application of the single-joint fatigue protocol. In the present study, Basketball-specific fatigue protocol was employed whereas in Gribble's study a protocol a single joint movement, not the whole joints of the limb was used.

The result of the present study cannot be attributed to learning effect in the experimental group because both groups performed exactly the Y.

The participants in the experimental group showed less defect than the participants in the control one. The result indicates that the managed to coordinate postural control mechanisms with fatigue. Compared to injured group, the participants in the control group experienced higher defect in postural control. This might be due to the neuromuscular system's discovery-action capacity. The fatigue might induce decreased excitability of the muscular spindles and the nerve cells of the motor cortex. In addition, fatigue interferes with afferent messages. All these changes together lead to more defect in postural control. Nonetheless, while suffering from fatigue, afferent fibers Ia can get more sensitive to the changes in muscle fiber length. Thus, muscular spindles increase their neural firing (Timothy et al., 2006).

Alternatively, the chronic ankle instability might do not affect the functional performance of the limb (Demeritt et al., 2002). As a consequence, fatigue equally impaired the players' postural control in both groups we concluded that although the players suffered from ankle instability, the defects they experienced in their proprioception abilities did not result in the decrease of functional activities.

According to the findings of the present study, sport-induced functional fatigue can affect dynamic postural control; hence; it is likely to results in injuries and the reduction of athletes' sport performance. Thus, making use of proper trainings to improve the athletes' physical fitness and to reduce the experience of fatigue in a specific activity is highly recommended.

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