Akdeniz Spor Bilimleri Dergisi

Mediterranean Journal of Sport Science

MJSS

ISSN 2667-5463

Does Acute Fatigue in Fitness Athletes Have an Effect on Balance Performance?

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DOI: https://doi.org/10.38021asbid.1212280

ORİGİNAL ARTICLE

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Received:
30.11.2022

Accepted:
08.03.2023

Online Publishing:
28.06.2023

Abstract

This study was conducted to determine the effect of acute fatigue on balance performance in male athletes performing fitness exercises. For this purpose, our hypothesis; (i) is that after maximum loading, the balancing performance will be adversely affected. The sample of our study consisted of a total of 17 volunteer athletes between the ages of 21-28 who regularly do fitness at Academy Fitness Center in Bingöl Province. In our study, balance measurements were taken before and after the "Bruce protocol". SPSS 23 package program was used in all statistical evaluations. Arithmetic mean of age, height, body weight and BMI values of the subjects were given. The age, body weight, height and BMI values of the group participating in the study were determined as 23.93 years, 74.37 kg, 1.77 m, 23.53 kg/height2, respectively. It was found that there was a statistically significant difference in the right-left standard deviation values in the static balance data before and after loading with eyes open ($p<0.05$). It was found that there was a statistically significant difference in the forward-backward standard deviation values ($p<0.000$). It was determined that there was a statistically significant difference in the values of right-left oscillation speed, forward-backward oscillation speed, center of pressure plot analysis. ($p<0.000$). No statistically significant difference was detected in the oscillation field value. ($p>0.05$). It was found that the balance performances of the athletes decreased significantly after fatigue. We can state that fatigue is an important factor affecting stability and balance skills. As a result, it is thought that acute loads may increase the risk of injury in athletes with the decline in balance ability. For this reason, we think that exercises aimed at improving balance ability should be included in training planning.

Keywords: Acute, Fatigue, Balance, Performance.

Fitness Sporcularında Akut Yorgunluğun Denge Performansı Üzerine Etkisi Var Mıdır?

Öz

Bu çalışma Fitness egzersizi yapan erkek sporcularda akut oluşturulan yorgunluğun denge performansı üzerine etkisini belirlemek amacıyla yapıldı. Bu amaç doğrultusunda hipotezimiz; (i) maksimum yüklenmeden sonra denge performansının olumsuz etkileneceğidir. Çalışmamızın örneklemi, Bingöl ili Akademi Fitness merkezinde düzenli olarak fitness yapan 21-28 yaş arası toplam 17 gönüllü sporcudan oluşturuldu. Çalışmamızda denge ölçümleri "Bruce protokolü" öncesinde ve sonrasında alındı. Tüm istatistiksel değerlendirmelerde SPSS 23 paket programı kullanıldı**.** Deneklerin yaş, boy, vücut ağırlığı ve BKİ değerlerinin aritmetik ortalamaları verildi. Araştırmaya katılan grubun yaş, vücut ağırlığı, boy ve BKİ değerleri sırasıyla 23,93 yıl, 74,37 kg, 1,77 m, 23,53 kg/boy^2 olarak tespit edildi. Gözler açık yüklenme öncesi ve sonrası statik denge verilerinde sağa-sola standart sapma değerlerinde istatistiksel olarak anlamlı fark olduğu tespit edildi ($p<0.05$). Öne-arkaya standart sapma değerlerinde istatistiksel olarak anlamlı fark olduğu tespit edildi ($p<0.000$). Sağa-sola salınım hızı, öne arkaya salınım hızı, basınç merkezi çizim analizi değerlerinde istatistiksel olarak anlamlı fark olduğu tespit edildi ($p<0.000$). Salınım alanı değerinde ise istatistiksel olarak anlamlı fark tespit edilmedi ($p>0.05$). Sporcuların denge performanslarının yorgunluk sonrasında önemli düzeyde azaldığı tespit edildi. Yorgunluğun, stabilite ve denge becerilerini etkileyen önemli bir faktör olarak ifade edebiliriz. Sonuç olarak, akut yüklenmelerin denge yeteneğinde oluşacak gerileme ile sporcuların sakatlık riskini arttırabileceği düşünülmektedir. Bu nedenle denge yeteneğinin geliştirilmesine yönelik egzersizlerin antrenman planlamasında yer alması gerektiğini düşünmekteyiz.

Anahtar Kelimeler: Akut, Yorgunluk, Denge, Performans.

Introduction

One of the most preferred sports branches to protect and improve health is fitness. Fitness contains many movements that the body needs (İnce, 2007). For the individual to be more fit during his daily life and to perform the activities of daily life in the most effective way, his body must be mobile and fit. Activities such as climbing stairs, carrying loads, sleeping in daily life can be done more comfortably depends on the body being fit. The fitter the body, the more easily all such activities can be done. Fitness contributes positively to the daily movements as it makes the individual's body fitter (Bilgili, 2000). One of the most important biomotor abilities in daily movements is balance performance.

Balance can be considered as an element of movement technique and conditioning that can be improved (Seulic Et al., 2013). It has two separate components, dynamic and static. Dynamic balance includes postural control, neuromuscular control, strength, flexibility, and coordination components of the lower limb. At the same time, it tries to maintain body position in motion. (Crossley Et al., 2011). Static balance includes postural control, lower limb cutaneous, articulation and muscular information, visual return (Bayrakdar and Boz, 2020). Balance is also expressed in the form of anterior-posterior(front-back) and medial-lateral (right-left) balance, which indicates a change in the position of the center of gravity of the body (Şimşek and Arslan, 2019).

The main feature of the balance system is to stabilize the visual during field head movements and control the body despite gravity. In body balance control, the vestibular and visual system play a dominant role. The balance system is formed by processing the impulses from the vestibular, visual and somatosensory system in the central nervous system and revealing the appropriate responses in the musculoskeletal system (Coşkun, 2012). Balance plays an important role in successfully demonstrating skills and maintaining movement patterns (Şimşek and Karakuş, 2020).

Since anaerobic glycolysis is the dominant energy system in muscle metabolism in high-intensity exercises, the concentration of lactic acid (LA) in muscle and blood increases significantly during this type of exercise (Bayrakdar Et al., 2020). Because LA is so potent, it decomposes into Lactate + H+ ions, causing metabolic acidosis (decrease in pH) and fatigue (Günay and Cicioğlu, 2005). Therefore, the rate at which LA is removed from muscle and blood is an important part of recovery, especially as it improves repetitive exercise performance. Since LA is used as fuel for mitochondria in active muscles, exercise intensity (metabolic activity of the muscle and energy expenditure rate) and blood flow rate significantly affect the rate at which LA is removed from the blood (Hazır and Gül, 2015). Physiological responses to the elimination of LA at optimal speed after exercise and its effect on subsequent exercise performance vary depending on recovery time and type of exercise (Günay and Cicioğlu, 2005).

When the literature is examined, the balance parameters after fatigue are not examined too much, and it was made to determine the effect of acute fatigue on static balance in male athletes who do fitness exercises. For this purpose, our hypothesis is; (i) balance performance will be adversely affected after maximum loading.

Method

Research Model and Research Group

The model of our study is experimental. The sample of our study was formed from a total of 17 volunteer athletes aged 21-28 who regularly do fitness at the Academy Fitness center in Bingöl. Individuals who had not suffered any lower extremity injury or head concussion in the last 6 months and who had not done intensive training before 48 hours were included in the study. Before the study, the subjects were informed about the applications to be performed.

Applied Tests and Measurements

Height, Body Weight and Body Mass Index

The measurement was taken with an Inbody brand body analyzer with an accuracy of ±1mm. The height lengths of the subjects were measured in anatomical posture, with bare feet, heels united, volunteers were asked to hold their breath, after the head was placed in a position so that the overhead table touched the vertex point in the frontal plane, and the values were recorded in cm. Weight measurements of the subjects were measured with a scale with an accuracy of ± 100 g. During the measurement, the subjects had only shorts on, their feet were naked, and their anatomical posture was recorded as kg. It was calculated by dividing the body weight (kg) of the volunteers by the square of the height (m) value (kg/m2) (Sever, 2018; Bayrakdar Et al., 2019).

Balance Measurements

Static Balance (Stabilometric Platform)

In the evaluation of gravitational deviations in athletes, Pagani TM brand stabilometric platform (Elettronica Pagani, Italy) was used. The stabilometric platform is a non-invasive method that measures body oscillations in a standing position. This system consists of a platform measuring 50x50 cm and a computer system to which this platform is connected, which continuously calculates the athlete's body weight and the position of the center of gravity. They were asked to climb on the platform so that the angle between the athlete's feet was 15 degrees in each direction and the distance between the heels was 2 cm, and they were asked to slowly count inside, looking in front of them in an upright but comfortable position. The evaluation time was determined as 60 seconds in total from 30 seconds with the eye open and closed. During the evaluation, attention was paid to the absence of a visual or auditory warning that would distract the athlete (Posturology and Stabilometry, 2003; Elettranica Pagani, www.elettronicapagani.it). As a result of the stabilometric evaluation, the following data were obtained;

- The average of the oscillations of the center of gravity in the anterior-posterior direction is in millimeters,
- The average of the oscillations of the center of gravity in the mediolateral direction was recorded in millimeters.
- Body balance (anterior-posterior balance/right-left lateral balance) was determined.

Fatigue Protocol

The Bruce protocol was applied on the treadmill (mav tech Germany) in order to create fatigue. After 3 minutes of warm-up at 0% inclination and 1.161 km/h, the exercise application was started with the first level of the protocol, 1.7 mph (2.7 km/h) speed and 10% slope. Every 3 min. also the slope has been increased by 2% and the speed by 2.5 mph (Bruce, 1972). The protocol was terminated when the subjects' level of voluntary burnout was reached. Immediately after the end of the fatigue protocol, the subjects were asked to remove their shoes and socks and the balance test was repeated.

Analysis of Data

SPSS 23 package program was used in all statistical evaluations. Shapiro-Wilks test was used to determine the normality distribution of the measured parameters. Paired Sample t test was used to compare balance scores before and after fatigue. The data were evaluated at a significance level of 0.05.

Ethical Principles

During the current research, “the Directory for Scientific Research and Publishing Ethics for Higher Education Institutions” were taken into consideration. Also, voluntary participation form was taken from all the athletes participating in the research.

Findings

Arithmetic averages of age, height, body weight and BMI values of the subjects were given. The age, body weight, height and BMI values of the group participating in the study were determined as 23.93 years, 74.37 kg, 1.77 m, 23.53 kg/height2, respectively.

Table 1

Comparison of The Results of The Subjects' Eyes Open Before and After Loading

Variables (Eyes are opened)	Pre-Test x̄±SS	Post Test x̄±SS	In-group variance (%)	t	p
Right-Left standard deviation (mm)	-0,21±0,42	-0,01±0,35	-0,2 (95,23)	-2,465	**0,026**
Forward-Backward standard deviation (mm)	-0,43±0,46	-0,09±0,45	-0,34 (79,06)	-3,396	**0,004**
Right-Left Average Oscillation Speed (mm/s)	0,93±0,40	1,40±0,35	-0,47 (-50,53)	-4,544	**0,000**
Forward-Reverse Average Oscillation Speed mm/s)	1,03±0,43	1,82±0,57	-0,79 (-76,69)	-6698	**0,000**
Pressure center drawing analysis (mm)	44,28±19,17	73,83±21,73	-29,55 (-66,73)	-5,911	**0,000**
Oscillation Area (cm^2)	10,76±20,49	9,98±7,56	0,78 (7,24)	0,135	0,895

*x̄: Arithmetic Mean, SS: Standard deviation, *p<0.05*

When Table 1 was examined, it was found that there was a statistically significant difference in the right-left standard deviation values in the static balance data of the subjects before and after loading with their eyes open (p<0.05). It was found that there was a statistically significant difference in the forward-backward standard deviation values (p<0.004). It was determined that there was a statistically significant difference in right-left oscillation speed, forward oscillation speed, pressure center drawing analysis values (p<0.000). There was no statistically significant difference in the oscillation field value. (p>0.05).

Table 2

Comparison of The Results Before and After Loading with Eyes Closed

Variables (Eyes are closed)	Pre-Test x̄±SS	Post Test x̄±SS	In-group variance (%)	t	p
Right-Left standard deviation (mm)	-0,21±0,63	-0,11±0,59	-0,1 (47,61)	-0,756	0,461
Forward-Backward standard deviation (mm)	-0,40±0,67	0,20±1,14	-0,6 (150,0)	-2,120	0,051
Right-Left Average Oscillation Speed (mm/s)	1,06±0,44	1,27±0,38	-0,21 (-19,81)	-2,083	0,550
Forward-Reverse Average Oscillation Speed mm/s)	1,35±0,65	1,61±0,45	-0,26 (-19,25)	-1,741	0,102
Pressure center drawing analysis (mm)	54,56±25,08	66,41±19,69	-11,85 (-21,71)	-2,054	0,058
Oscillation Area (cm^2)	4,35±3,26	4,36±3,79	-0,01 (-0,22)	-0,019	0,985

*x̄: Arithmetic Mean, SS: Standard deviation, *p<0.05*

When Table-2 was examined, there was no statistically significant difference in the right-left standard deviation, Front-back standard deviation, Right-left oscillation speed, forward oscillation speed, pressure center drawing analysis, Oscillation field value in the static equilibrium data of the subjects before and after loading with the eyes closed (p>0.05).

Discussion and Results

This study was conducted to determine the effect of acute fatigue on static balance in male athletes who performed fitness exercises. The age, body weight, height and BMI values of the group participating in the study were determined as 23.93 years, 74.37 kg, 1.77 m, 23.53 kg/height2, respectively. As seen in Table 1, it was found that there was a statistically significant difference in the values of right-left standard deviation, front-back standard deviation, right-left oscillation speed, forward oscillation speed, pressure center drawing analysis values in the static balance data of the subjects before and after loading with eyes open. There was no statistically significant difference in the oscillation area value. As a result of the research, it is seen that there is a significant decrease in the balance data of the athletes after fatigue.

Cardiovascular changes during sporting activities (Holtzhausen and Noakes, 1995; Whyte Et al., 2000), endocrine effects (Ginsburg Et al., 2001) and changes in the use of energy resources (Laursen Et al., 2002), cause a number of effects on postural control. For this reason, researchers are focusing on the effects of fatigue on postural control. In many researches, the effects of fatigue on posture muscles during standing posture are investigated. In these studies, it is often reported that muscular fatigue has worsening effects on postural control (Ledin Et al., 2004). In addition, consumer physical activities performed; (McKenna, 2003) worsens proprioceptive and extroceptive information and/or integration and/or reduces the effectiveness of the muscular system, (Bizid Et al., 1993) reduces motor-neuron outputs or sensitivity of type III and IV muscle affents, also (Lundin Et al.,1993) after strenuous exercises, for example, it adversely affects the ability of the lower extremity joint angle to catch the same angle again (Nardone Et al., 1997; Lepers Et al., 1997; Gauchard Et al., 2002; Zemkova Et al., 2010). In response to fatigue, kinesthetic awareness, and motor control decreases (Walsh Et al.,2004).

The negative effects of fatigue have been observed in studies examining the effects of fatigue on balance performance and using different fatigue protocols. (Erkmen Et al., 2009) found that the balance performance of football players decreased significantly after fatigue. In another study examining the effect of fatigue on balance performance; While the body release path is significantly wider after exercise compared to pre-workout, they note that heavy exercise that causes a significant increase in fatigue can affect body release (Bove Et al., 2005). In addition, a significant decrease in balance ability has been reported after isokinetic fatigue (Surenkök Et al., 2006).

Muscular fatigue affects nerve-muscle control both directly and indirectly (Susco Et al.,2004). While the deterioration or deterioration of the learning expected from the joint position sense creates the direct effect; as a result of muscular fatigue, joint kinesthesia and changes in the feeling of position causing joint laxity creates an indirect effect (Lepers Et al., 1997; Seliga Et al., 1991; Rozzi Et al., 2000; Forestier Et al., 2002). In this context, we can express muscle fatigue as an important factor affecting stability and balance skills. Several studies have supported that fatigue due to the type, duration, and intensity of exercise worsens postural stability (Nardone Et al., 1997; Lepers Et al., 1997; Gauchard Et al., 2002; Zemkova Et al., 2010; Simsek Et al., 2020).

As can be seen in Table 2, there was no statistically significant difference in the right-left standard deviation, front-back standard deviation, right-left oscillation speed, forward oscillation speed, pressure center drawing analysis, and oscillation area value in the static equilibrium data of the subjects before and after loading with eyes closed. In the literature research conducted (Akyıldız, 2021). The effects of lower extremity static muscle fatigue on balance components Static blindfolded, dominant single leg and non-dominant single leg static balance pre-test and post-test values were statistically not differentiated. In another study, the effect of different fatigue models on dynamic balance in male volleyball players stated that there was no statistically significant difference in the effect of volleyball players' training fatigue on dynamic balance, butthere was a significant difference in the effect of wingate fatigue model on dynamic balance. It was stated that the fact that training fatigue has no effect on dynamic balance is because there are training phases and rests between the resurrections. They noted that the Wingate fatigue model found a significant difference in dynamic balance, while athletes reached the peak point in a short time, and therefore their balance skills weakened (Mansuroğlu, 2020). In a study called the effect of maximal loading on balance performance in football players They stated that the increase in balance skills because of fatigue in football players, contrary to expectations, was due to learning (Altay and Erikoğlu, 2009)

It was found that the balance performances of the athletes decreased significantly after fatigue. We can express fatigue as an important factor that affects stability and balance skills. We think that this decrease in balance ability due to the loads made may increase the risk of injury of athletes, so exercises to increase balance ability should be added to training planning.

Contribution Content Declaration of the Researchers

The process related to the method and findings part of the research was carried out by the third author; the process related to the introduction part was carried out by the first and second author; the process related to the discussion and conclusion part was carried out by the first and the fourth author.

Conflict Statement

The authors do not have a conflict statement regarding the research.

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