

Research Article

THE EFFECT OF MUSCULAR FATIGUE ON THE DYNAMIC AND STATIC BALANCE AMONG THE MALE STUDENTS (11-15) IN THE SECONDARY SCHOOL

*Mostafa Setamdideh¹, Mohammad Esmail Mahtabi Shiraz² and Logman Ghaderi³ and Sajjad Mobasseri⁴

¹Department of Physical Education, Sardasht Branch, Islamic Azad University, Sardasht, Iran

²Department of Physical Education, Ajabshir, Iran

³Department of Exercise Physiology, Physical Activity and Health, Miyaneh Branch, Islamic Azad University, Miyaneh, Iran

⁴Department of Sport Physiology, Urmia University, Urmia, Iran

*Author for Correspondence

ABSTRACT

With respect to the fact that fatigue is an undeniable component of sports, The aim of the present study is to determine the effect of muscular fatigue the Dynamic and static balance among male students (11-15) in the secondary school. 30 secondary school students were selected in random cluster type, from bahman school, group 2, district 4, karaj city. 15 students for experiment group and 15 students for control group were selected in a way that all were relatively in an equal age, height and weight. The experiments were performed under 2 conditions before fatigue (3 repetition) and after fatigue (3 repetitions). It means after completion of the pre-test was taken from the subjects. It was similar to the pretest but there was a difference. The experiment group was affected by the dependent variable of the muscular fatigue. The subject was asked to run slowly on the treadmill, and then gradually we made the treadmill faster until he felt exhaustion. The treadmill speed was regulated based on symon fatigue protocol. The subject stood on Biodex system and was asked to do the dynamic and static balance test. He stood barefoot on system and did the test with open eyes. Then the replacement of the center of foot pressure (cop) was studied. For analyzing the data, the independent and dependent t-test 0/05 alpha was used on a significance level. For homogeneity of the variance, Levin test was used. Then to compare the fluctuation index in 2 studied group, co-variance analysis was done. Based on the gained results, after fatigue, in replacement distance of the foot pressure center, in experiment group there was a significance difference in the static balance as compared with the control group. In the final conclusion, the results of the present study showed that the fatigue has the significance effect on controlling of the static balance in the experiment group.

Keywords: *The Fatigue, The Dynamic, The Static, Biodex Balance System*

INTRODUCTION

Keeping body position for doing well optimum in daily activities or in sport complicated motions is an original referent hence the static balance for evaluation and determining the level of nervous-intellectual in different or various level in sport activities will be an essential function (Mahtabi *et al.*, 2014; Nourbakhsh *et al.*, 2001).

The physical fitness is discussed as muscular skeleton health index and the lack of physical fitness can alter the pressure degree on the joint and lead to the joint cartilage damage and serious postural abnormality (Stroebe *et al.*, 2009). It is necessary to maintain the physical balance while doing routine activities and sport skills. The balance is surely one of the inseparable components of all routine activities and is the vital factor of athletes and nonathletes' success (Rabiee *et al.*, 1391). On the other hand the lack of a suitable physical condition is one of the reasons of more fatigue. Since the more the body remains aloof from the balance and fitness, the more it needs energy to maintain its straight. Because the muscles which are related to the body posture, have less mechanical score to keep the balance. Instead they should be involved in the movement which might result in the fatigue. Total inequality of the strength in antagonist and agonist muscles of an organ and inadequacy of muscle flexibility could have negative body

Research Article

influences. Although extensive studies recently have been carried out to assess the fatigue and control posture by balance test and Biodex system. But there are slight studies in the field of studying fatigue process related the exercise and physical movement and its effects on controlling the static posture. In these studies, in different age group with having posture abnormality, the fatigue often affected the balance. Also considering studies related to the balance, it has been proved that probably the fatigue affects the physical balance and there's a significant relationship between the fatigue and the balance. That is the fatigue affects the balance. Hoseini *et al.*, (2011) have discussed the effects of fatigue on the athletes' static posture control, having ankle injuries. He argued that the fatigue especially accompanied by the injuries or disorders is one of the balance decreasing factors. In a research which was carried out by Anbarian *et al.*, (2011), postural deviations on Biodex system in 3 following indexes were used to study the mechanical balance function of the studied groups: the anterior-posterior firmness index, the interior-exterior part, the total firmness. When the subject in both groups stood on a relatively firm surface with eyes open, there wasn't any difference in their postural deviations in the entire 3 firmness index. In another research which have been carried out by Rabiee *et al.*, (1391) on 16 cases having knee valgus trouble and 16 normal cases to restore the balance after exerting disorder, the results revealed that the people with knee valgus in comparison to the normal cases in the balance restore had a weaker function after exerting the external disorder. Rozzi *et al.*, (1991) studying the fatigue effect on the balance conclude that there wasn't any increase in body fluctuation after the fatigue. It means the fatigue didn't affect the balance. Gribble *et al.*, (2004) in a research studied the compound effects of fatigue and the chronic infirmness of the ankle on controlling the static stature. They discussed that the unhealthy group's infirm foot in comparison to the healthy group's foot had a weak function after the fatigue. In another research which has been done by Simoeau *et al.*, (2006) to study the effects of the average fatigue on controlling the static balance, the subject's balance after the fatigue was decreased. In this study the number of the subjects for controlling the static balance was 10.6 males and 4 females with the average age of 22 ± 1.7 . Their main task was the balance regulation and COP maintenance during the fast walking on the treadmill which at last led to the fatigue and their balance was challenged. Aydog *et al.*, (2006) discussed the static balance condition of patients with ankylosing spondylitis disorder and the control group using the Biodex system. They reported that there's no difference between the patients with ankylosing spondylitis disorder and the control group in the static balance function. And there isn't any significant difference between the postural fluctuation and the center of foot pressure in both groups. Lytinen *et al.*, (2010) reported the lack of a significant difference in people's balance amount having knee osteoarthritis and normal people. In the field of reformative and rehabilitative movements the muscular-endurance is less focused than the muscle strength and the flexibility. Naturally the exercise protocols are less described in the field of muscular-endurance improvement and promotion. There are several ways to measure the muscular-endurance. One of these ways is to study the muscular fatigue. The muscular fatigue is described as disability of the muscles to maintain a specified strength in long term (Edwards, 1981). The function and the structure of the body is in a way that can prepare a potential by itself to gain fitness. Nevertheless, the unpleasant habits, the wrong lifestyles and its relevant activities can cause the stress on this mechanism that leads to the physical structure disorders. Since the fatigue effect on the lower organ the students in this range of age have been ambiguous and also it has been rarely studied in this area, besides there isn't any special agreement about it, in the present study we've concentrated on the effect of muscular fatigue on the static balance the male students (Lytinen *et al.*, 2010; Menzo *et al.*, 2005; Mahtabi *et al.*, 2014; Nourbakhsh *et al.*, 2001; Hertel *et al.*, 2002) in the secondary school. The methodology: this research is a semi-experimental one. 30 secondary students were selected in random cluster type from Bahman school, group 2, district 4 of karaj city. 15 students in the experiment group and 15 students in the control group were selected in a way that all were relatively in on equal age, weight and height. None of the subjects had any kind of regular of exercise experience and any involvement in a certain sport field. After they've been informed about the research process, they announced their willingness to participate in the experiment in the written form. The lack of the surgery antecedent, breakage, burn, serious injuries or strokes in the upper or lower organs and the absence of the

Research Article

artificial organ in the leg, the knee and the ankle, were the subjects' general conditions. The independent and dependent variables of this research respectively were the muscular fatigue and the static balance.

The Measuring Means

The following measuring means were utilized to achieve the research goal:

- 1) The height-meter and the digital scale to measure the height and the weight.
- 2) The letter of satisfaction.
- 3) SPSS software, version 16.
- 4) Biodex steadiness system.
- 5) Excel software.
- 6) Treadmill.

MATERIALS AND METHODS

The Method

At the beginning of each section, the subject's spender 6 minutes to warm up. The first 3 minutes was the slow walking and the next 3 minutes was the tensional movements. Both groups took a pre-test, in a way that at first they have been informed about all the research processes, and then they've been asked to do the test with the aim of familiarity. After ending of the pre-test, the subjects have been asked to take a post-test-a test similar to the pre-test- but it had a difference with the pre-test. We exposed the experimented group into the independent variable of the muscular fatigue. The control group doesn't affected by the independent variable. We led the subject to the treadmill. He was asked to run slowly on the treadmill then gradually the treadmill speed increased until he felt fatigue. The intensity and the scale of the treadmill speed were regulated based on Symon fatigue protocol. The subject's main task was the balance regulation and COP protection during the fast walking on the treadmill that finally led to the fatigue and the people's balance was challenged. The average speed 1/86 kilometers per second which was variable among the people from 0/85 to 3/6. The experiment involved 3 sets of jogging on the treadmill until he couldn't maintain his speed and it caused the imbalance. The experiment time was 1 hour (Root *et al.*, 1997). After the muscular fatigue the subject was led to the Biodex system and he was asked to do the static balance test. The subject stood barefoot on the system and did the static balance test with the open eyes. When the subject's heel separated from Biodex plate or when he ended his knees, the test was stopped and reported. The amount of fluctuation in the foot pressure center is considered as the balance measuring variable. The subject did each of the above stages 3 times. At last, the average of 3 repetitions was considered to assess the balance.

The Statistical Method

To analyze the data, the descriptive and inferential statistics were used. In the descriptive statistics section the mean and the standard deviation were used and in the inferential statistics section Kulmogruv-Smirnof was utilized to determine the normality of data distribution. To test the research hypothesizes the independent and dependent t-test with a significance level of alpha 0/05 was applied. For homogeneity of both tests, Levin test was applied. Then to compare the fluctuation index in both research groups co-variance analysis has been used. All of the statistical analyses were carried out by SPSS 16 and Excel (2010) software.

RESULTS AND DISCUSSION

The Research Findings

Table (1, 2) shows the descriptive statistics. It demonstrates the posture fluctuation index under two conditions; the open eyes and the close eyes, the soft surface and the hard surface, for both the experiment group and the control group in the pretest and the post-test. To determine the normality of the data distribution Kulmogruv-Smironof was applied. Considering the research results in table 3,4, the result for each variable proves the normality of the data distribution and there wasn't any significant difference.

Research Article

Concentrating on the results of Levin index test which is bigger than 0/05 for the both test, it can be said that they are homogeneous. So, there's no prevention to use the co-variance test.

Table 1: The subjects' mean and standard deviation of the Static balance

The index	The test	The mean of standard deviation			
		The experiment		The control	
The Static balance		The pretest	The posttest	The pretest	The posttest
	The open eyes				
	The rigid surface	2.26±0.573	1.71±0.76	2.33±0.880	2.37±0.76
	The closed eyes				
	The rigid surface	2.82±0.714	2.26±0.80	2.95±0.951	2.85±0.80
	The open eyes				
	The soft surface	2.51±0.637	1.90±0.79	2.68±0.654	2.82±0.79
	The closed eyes				
	The soft surface	2.77±0.414	1.94±0.75	2.50±0.444	2.53±0.75

Table 2: The subjects' mean and standard deviation of the Dynamic balance

The index	The test	The mean of standard deviation			
		The experiment		The control	
The Static Dynamic		The pretest	The posttest	The pretest	The posttest
	The open eyes				
	The rigid surface	2.24±0.573	1.70±0.76	2.23±0.880	2.27±0.76
	The closed eyes				
	The rigid surface	2.80±0.714	2.16±0.80	2.95±0.951	2.75±0.80
	The open eyes				
	The soft surface	2.41±0.637	1.89±0.79	2.88±0.654	2.82±0.79
	The closed eyes				
	The soft surface	2.67±0.414	1.84±0.75	2.50±0.444	2.43±0.75

Table 3: The result of Kulmogruf- Smirnof test-the measured index

The test	The group	The experiment				The control			
		The pre-test		The post-test		The pre-test		The post-test	
The Static balance		z	sig	z	sig	z	sig	z	sig
	The open eyes								
	The rigid surface	0.787	0.566	0.490	0.970	0.690	0.727	0.379	0.999
	The closed eyes								
	The rigid surface	0.815	0.520	0.388	0.988	0.507	0.959	0.578	0.892
	The open eyes								
	The soft surface	0.482	0.974	0.655	0.758	0.703	0.401	0.409	0.996
	The closed eyes								
	The soft surface	0.611	0.849	0.520	0.950	0.553	0.637	0.613	0.847

Research Article

Table 4: The result of Kulmogruof- Smirnof test-the measured index

The test	The group	The experiment				The control			
		The pre-test		The post-test		The pre-test		The post-test	
		z	sig	z	sig	z	sig	z	sig
Static Dynamic	The open eyes								
	The rigid surface	0.687	0.566	0.490	0.970	0.690	0.727	0.379	0.999
	The closed eyes	0.715	0.520	0.388	0.988	0.507	0.959	0.578	0.892
	The rigid surface								
	The open eyes								
	The soft surface	0.582	0.974	0.655	0.758	0.703	0.401	0.409	0.996
	The closed eyes	0.621	0.849	0.520	0.950	0.553	0.637	0.613	0.847

Based on the gained results from co-variance analysis test (table 5, 6), the effects of group differences and the measurement stages ($f = 445.058$, $sig = 0.001$, $p = 0.05$) show that the muscular fatigue affects the secondary school male students' (Lytinen *et al.*, 2010; Menzo *et al.*, 2005; Mahtabi *et al.*, 2014; Nourbakhsh *et al.*, 2001; Hertel *et al.*, 2002) posture stableness in comparison to the control group on the soft surface with closed eyes.

Table 5: The effect of fatigue on the Static balance on the soft surface with the closed eyes , based on co-variance analysis test.

The source	change	The sum of the mean deviation squares	The optional scale	The average of the sum of the mean deviation squares	The optional level (f)	The significance level (p)
The effect of the measurement stages		967/1093	2	140/78	954/10	$P < 0/001$
The group differences effects		479/3174	1	479/3174	445/058	0/001
The effect of group differences and the measurement stages		967/1093	2	140/78	954/10	0/001
The effects of the intra-group errors		107/000	57	133/7		
The effects of the inter-group errors		967/1200	59	607/123		

Research Article

Furthermore the result of the independent and dependent t-test reveal that the muscular fatigue affects the experiment group’s balance on the rigid surface with the eyes closed and open. While there wasn’t any change in the control group. Nevertheless there was a significant difference between the static balance of the control and the experiment group with the eyes open and closed on the rigid surface in the post-test.

Table 6: The effect of fatigue on the Dynamic balance on the soft surface with the closed eyes, based on co-variance analysis test

The change source	The sum of the mean deviation squares	The optional scale	The average of the sum of the mean deviation aquares	The optional level (f)	The significance level (p)
The effect of the measurement stages	367/1012	2	273/63	918/5	/001
The group differences effects	840/3667	1	840/3667	343/035	/001
The effect of group differences and the measurement stages	367/1012	2	273/63	918/5	/001
The effects of the inter-group errors	139	57	692/10		
The effects of the inter-group errors	367	59	100/8		

The Discussion

The research findings proved that the fatigue could affect the dynamic and static balance. So the fatigue as an important factor in the balance controlling should be assessed more. Furthermore the results revealed that the replacement distance of the pressure center before applying the fatigue protocol, statistically showed a significant difference. But the pressure center replacement in the experiment group showed a significant difference after applying the fatigue. In comparison to applying the fatigue and also in comparison with the control group. When the subjects in both groups stood on a relatively stable with open eyes, there wasn’t any difference in their postural deviations in the entire 3 firmness index. In other words, when the muscles felt the fatigue, it caused the balance restore disorder and postural fluctuation in the standing posture increased and led to COP after applying the fatigue in the standing posture that was statistically significance. The after momentary fluctuation (the maximum speed) in the anterior-posterior side, was observed, which showed that the fatigue is suggestion of some changes in the control condition. The faster momentary fluctuations could compensate for the movement and the sense deficiency caused by the circumferential muscular fatigue that is accompanied by the separate control of the required static balance. The result of the present study doesn’t match with the result of the following researchers: Khanna *et al.*, (2008), Bot *et al.*, (1999), Rozzi *et al.*, (1391), Lytinen *et al.*, (2010). But if parallels that of under mentioned researchers: Gue *et al.*, (2006), Durmus *et al.*, (2010), Tetsuhiko *et al.*, (2007), Anbarian *et al.*, (1388–1389), Mahtabi *et al.*, (1392), Sinaki *et al.*, (2005), Hoseini *et al.*, (1388) and Symon *et al.*, (2006). In justifying the homogeneity of the present study with the prior studies and the muscular fatigue influence on the dynamic and static balance in two groups, it can be said it’s likely that the quality of the anterior element and the articular surface of the spinal column structure be different from one person to another or from one group to another. So it isn’t important to acquire different results in the different groups. And also it isn’t likely that influencing the fatigue on the balance among the subjects in the present study be due to such factors. In justifying the research results can be mentioned it is probable that when there’s more in stability due to the fatigue in the learning part, the students use the compensatory

Research Article

mechanism more to keep their balance. These compensatory mechanisms often appear in the anterior posterior sides. In a study undertaken by Symon *et al.*, (2006), Wilkins *et al.*, (2004), the subjects' balance decreased after the fatigue process.

This paralleled the present study. Totally the findings reveal that the muscular fatigue of the sense system in fluencies the posture fluctuations as compared with the moveable output. It's likely that the heterogeneity of some results with the prior study results is due to the different balance assessment methods. Therefore the present study results could be utilized in teaching posture fluctuation to the people in the aforesaid age group. Nevertheless there's still a need to greater studies in this area to determine how the adopted ways are useful to restore the posture fluctuation.

REFERENCES

- Anbarian M, Bakhiari M, Zarei P and Yalfani E (No Date).** The physical balance restore mechanism facing sudden external disorder in Sajital plate in patients with Kyphosis. *Sport Medicine Journal* (4) 115-132.
- Anbarian M, Mokhtari M, Zarei P and Yalfani E (2011).** The comparison of posture control particulars in patients with Kyphosis and control group. *The Scientific Journal of Hamedan Medicine Science University; the 16th review* 4 53-60.
- Aydog E, Depedid R, Bal A, Eksioğlu E and Cakci A (2006).** Static postural balance in ankylosing spondylitis patients. *Rheumatology* 45 445-448.
- Black Burn T, Guskiewicz KM, PeTschaur MA and PrenTice WE (2000).** Balance and stability: the relative contribution of proprioception and muscular strength. *Journal of Sport Rehabilitation* 9 315-328.
- Bot SD, Caspers M, Van Royen MC, Toussain HM and Kingma I (1999).** Biomechanical analysis of posture in patients with spinal kyphosis due to ankylosing spondylitis: pilot study. *Rheumatology* 38(5) 441-443.
- Durmus B, Altay Z, Ersoy Y, Baysal O and Dogan E (2010).** Postural stability in patients with ankylosing spondylitis. *Disabil Rehabil, ahead of print static postural control. Journal of Sports Rehabilitation* 13 54-66.
- Edwards RHT (1981).** Human muscle function and fatigue. In: *Human Muscle Fatigue: Physiological Mechanisms*, edited by Porter R and Whelan J, London, England: pitman medical 1-18, ciba foundation symposium 82.
- Hoseyni Mehr S, Daneshmandi H and Norasteh E (1388).** Effects of fatigue on the athletes static and static posture control, having the ankle injuries. *Journal of the Research in Physical Education (Sport Medicine Specialized)* 25 107-120.
- Khanna P and Kapoor G Zutshi (2008).** Balance deficits and recovery time line after different fatigue protocols. *Indian Journal of Physiotherapy and Occupational Therapy* 2 30.
- Liedoux WR and Hillstrom HJ (2002).** The distributed plantar vertical force of neutrally aligned and pes planeus feet. *Gait and Posture* 15 1-9.
- Lytinen T, Liikavainio TB, Ragge T, Hakkarainen M, Karjalainen PA and Arokoski JPA (2010).** Postural control and thigh muscle activity in men with knee osteoarthritis. *Journal of Electromyography and Kinesiology* 20(6) 1066-74.
- Menzo HB, Morris ME and Lord SR (2005).** Foot and ankle characteristics associated with impaired balance and functional ability in older people. *Journal of Gerontology* 60a(12) 1546-1552.
- Mahtabi MS, Alijani E, Razmi V, Dadashpoor M and Dadashpoor B (2014).** The effect of muscular fatigue on the Dynamic balance among the male students (11-15) in the secondary school. *Journal in Environmental Biology* 27(3) 362-366.
- Nourbakhsh P, Sepasi H and Rezaee S (2001).** The effect of three different types of fatigue protocols on static balance in female athlete students. *Sport sciences research center, Islamic Azad University, Karaj Branch* 6(2) 133-148.
- Hertel J, Gay MR and Denegar CR (2002).** Differences in postural control during single-Leg stance among healthy individuals with different foot types. *Journal of Athletic Training* 37(2) 129-132.

Research Article

- Gribble PA, Hertel J, Denegar CR and Buckley WE (2004).** The effect of fatigue and chronic ankle instability on static postural control. *Journal of Athletic Training* **39**(2) 156-161.
- Guo X, Chau WW, Hui-Chan CW, Cheung CS, Tsang WW and Cheng JC (2006).** Balance control in adolescents with idiopathic scoliosis and distributed somatosensory function. *Spine* **31** E437-40.
- Punakallio A (2005).** Balance abilities of workers in physically demanding jobs: with special reference to fire fighters of different ages. *Journal of Sports and Medicine* **4**(8) 7-14.
- Rabiee M, Jafar Nejad Garv T, Binabaji H, Hoseyni Nejad SA and Anbarian M (1391).** The assessment of situational response after imposing the sudden disorder in patients with knee valgus. *Journal of Shahr Kord Medicine Science University, the 14th Review* **2** 90-100.
- Root ML, Orien WP and Weed HJ (1977).** Normal and abnormal function of the foot. *Clinical Biomechanics* **2**.
- Rozzi S, Yuktanandana P, Pincivero D and Lephart SM (1997-1999).** *Role of Fatigue on Proprioception and Neuromuscular Control* (Human kinetics publications).
- Simoneau M, Begin F and Teasdale N (2006).** The effect of moderate fatigue on static balance control and attention demands. *Journal of Neuro Engineering and Rehabilitation* **3** 22.
- Sinaki M, Brey RH, Hughes CA, Larson DR and Kaufman KR (2005).** Balance disorder and increased risk of falls in osteoporosis and kyphosis: significance of kyphotic posture and muscle strength. *Osteoporosis International* **16**(8) 1004-1010.
- Stroebel Suzanne J, Hans DE Ridder, Cilas J Wilders and Suria M Ellis (2009).** Influence of body composition on the prevalence of postural deformities in 11 to 13 years old black South African children in the North West province. *South African Journal in Sport, Physical Education and Recreation* **31**(1) 115-127.
- Tetsuhiko S, Yukio U and Takahiko Y (2007).** Relationship of kyphosis with balance walking ability in elderly. *Rigakuryoho Kagaku* **22**(4) 489-494.
- Vollestad NK (1997).** Measurement of human muscle fatigue. *Journal of Neuroscience Methods* **74** 219-227.
- Wilkins JC, Mcleod TC and Perrin DH (2004).** Performance on the balance error scoring system decreases after fatigue. *Journal of Athletic Training* **39**(2) 156-161.
- Yaggie J and McGregor S (2002).** Effect of isokinetic fatigue on the maintenance of balance and postural limits. *Archives of Physical Medicine and Rehabilitation* **83** 24-228.