Turkish Journal of Sport and Exercise /Türk Spor ve Egzersiz Dergisi
http://dergipark.gov.tr/tsed
Year: 2019 - Volume: 21 - Issue: 3 - Pages: 464-473
DOI: 10.15314/tsed.632003

ISSN: 2147-5652

The Effect of Balance Exercises on Success Level of Air Pistol Shooters*

Ahmet Serhat AYDIN[1A], Serkan Revan[2B]

[1]*General Directorate of Mapping, Turkey.*

2Selçuk University, Faculty of Sports Science, Turkey.

Address Correspondence to S. REVAN, e-mail: serkanrevan@gmail.com

(Received): 11.10.2019 / (Accepted): 25.12.2019

A:Orcid ID: 0000-0003-4507-2174- *B:* 0000-0002-9056-3514

**This article was produced by Ahmet Serhat AYDIN from Selçuk University, Institute of Health Sciences, Department of Coaching Education.*

Abstract

The aim of this study is to research the effects of air pistol balance shootings on shooting success, which performed for 12 weeks with certain air pistol shooters.49 volunteer shooters has participated in the shootings, which composed of 25 women between 15-17 ages (n=13 experiment, n=12 control) and 24 men (n=12 experiment, n=12 control) from three shooting sports club in Ankara. While the experiment and control groups continued shooting trainings, experiment groups were practised balance exercises with bosu ball three times a week during 12 weeks following the shooting training. SPSS 23 package program was used in the analysis of the obtained data. In order to determine whether the data showed normal distribution, normality analysis was conducted and the distribution was found to be normal. The comparison of the control and experimental groups were analyzed by independent sample t test and the pre- and post-test comparisons were analyzed by paired sample t test. Pearson correlation analysis was used to determine the relationship between achievement score and static and dynamic balance. In the statistical analyzes used in the research, the significance level was accepted as 0.05 and 0.001. At the end of 12 weeks, on both women and men experiment and balance groups, significant differences were detected between dynamic balance pre-test and post-test results ($p<0.05$). As for the static balance results of both genders, only on the experiment groups considerable differences were found ($p<0.001$).As a result of the study it can be concluded that the balance exercises practiced for 12 weeks have affected the shooting performance positively by improving static and dynamic balance.

Key Words: Shooting, Balance Training, Air Pistol.

INTRODUCTION

Shooting is a static sport where the shooter's body coordination, condition and concentration are at the forefront. The main factors that influence shooter's shooting success are keeping the balance during shooting, setting the correct and proper position, controlled squeezing of the trigger and the athlete's resistance to various environmental conditions (17). In addition to the shooter's talents and skills, his cautiousness, concentration on his shot and target, his determination and motivation for shooting also affect the shooter's performance. Although shooting is a static sport, after considering such factors it can be understood that it requires self sacrifice (38). In order to display a good performance in sports, the athlete should develop his/her psychological and physiological features. Similarly, an athlete must achieve his or her own development in order to achieve superior degrees in shooting. After having a proper and fruitful preperation period, squeezing the trigger will affect positively on his/her shooting performance (10,17). This preparation period includes the training before shooting and physical and mental self-preparedness during the shooting (38).

The athlete's balance control is of great importance on his performance in static sports such as shooting and archery, as well as in dynamic sports such as football, wrestling and gymnastics. In literature, balance is defined as the ability to react

quickly and effectively against instability and external perturbations, in order to regain stability by making postural adjustments before, during and after voluntary movement (40). Balance position should also be taken and maintained in the shooting branch. Balance is of great importance in maintaining body composition for a successful shot. In shooting, body oscillation is one of the most important factors affected directly by the balance. The oscillation of the athlete's body left and right or back and forth during the shooting adversely affects the athlete's performance (37). Physiological condition of the shooter is one of the main factors that affects body oscillation and consequently his/her balance. In some studies where the correlation between balance and athlete's body weight is investigated, it was found that the body oscillation increases as the body weight increases (6,44).

This study aimed to analyze the effects of twelve weeks of balance training of air pistol shooters on their shooting success.

MATERIAL & METHOD

Research Group

The study was practiced on totally 49 volunteer athletes aged 15 to 17, of whom 25 females (n=13 experimental, n=12 control) and 24 males (n=12 experimental, n=12 control) compete in three shooting sports clubs in Ankara. Prior to the application, the participants were informed about the tests to be applied within the scope of the research and the application processes, and a consent form was obtained regardingvoluntary participation.

Measurements Applied in Research

Height and body weight measurements:

The height measurements of the subjects were made by Holtain brand stadiometer. Height measurements were taken while the body weights were balanced on both legs, the heels touched the platform perpendicular to the hip and scapula, and subjects were in upright position. Body weights (kg) were measured by Tanita brand mechanical weighing machine with 100 grams measurement precision, participants were as light clothes as possible, and Body-Mass Index (BMI) was measured by dividing body weight into square of body height (kg/m2).

Dynamic Balance:

Dynamic balance was measured by Star Balance Test. The subjects lied down the ground on which star-shaped directions (totally 8 directions) drawn, with a 45-degree angle, and their lying distance was recorded in cm. Prior to the implementation, the subjects were given 180 seconds to recognize the test and 120 seconds rest between implementations. Also 5 seconds were given between each lyings to let them stand ontheir two feet. Balance point was measured by the following formula: Balance point= distance / leg length x 100 (5,41).

Static Balance:

Static balance was measured by Flamingo Balance Test (FBT). The subjects stepped on 50 cm long, 4 cm high, and 3 cm wide wooden balancing equipment and stayed in balance. They held their foot with their same side hand, bending it from the knee, and pulling it towards the hip. Time started while the subjects were in balance with one foot, and they tried to stay in this position for 1 minute. Time was stopped when the balance was broken.Time resumed when the research group re-balanced on balancing equipment. Test was continued for 1 minute in that way. When the time was up, each attempt by the subjects to achieve balance (after each falling) was counted, and this number was recorded as the score of the subjects (26).

10m Air Pistol Shooting Test:

During the air pistol shooting competitions, the athletes are given a 15 minute official test shooting time for 10 meter shots. Duration of the competition for male athletes is 1 hour 15 minutes for 60 shots, and for women athletes 50 minutes for 40 shots. Each shot is rated as 10 points. Competitions are rated for men at 600 points and for women at 400 points. In order to determine the effect of the training program on shooter's performance, the experimental group and the control group executed 10 m air pistol shooting before the training program.

Training Protocol

While the experimental and control groups continued shooting trainings, the experimental group was subjected to balance exercises 3 days a week for 12 weeks after shooting trainings. Bosu ball was used during balance exercises.

Name of the Activity	Number of Sets	Number of Training (Weekly)	Duration of the Training			Rest
			1-4 Weeks	5-8 Weeks	9-12 Weeks	
Flamingo on Bosu	3	3	20 sec	25 sec	30 sec	Full
Squat on Bosu	3	3	20 sec	25 sec	30 sec	Full
Jump on Bosu	3	3	20 sec	25 sec	30 sec	Full
Step on Bosu	3	3	20 sec	25 sec	30 sec	Full
Jump to Bosu	3	3	20 sec	25 sec	30 sec	Full
Stork on Bosu	3	3	20 sec	25 sec	30 sec	Full
One-Leg Balance on Bosu	3	3	20 sec	25 sec	30 sec	Full
Knee-Balance on Bosu	3	3	20 sec	25 sec	30 sec	Full
180-360 Spiral on Bosu	3	3	20 sec	25 sec	30 sec	Full
Glider	3	3	20 sec	25 sec	30 sec	Full

Statistical Analysis

SPSS 23 package program was used in the analysis of the obtained data. In order to determine whether the data showed normal distribution or not, normality analysis was conducted and the distribution was found to be normal. The comparison of the control and experimental groups were analyzed by independent sample t test and the pre-test and post-test comparisons were analyzed by paired sample t test. Pearson correlation analysis was used to determine the correlation between achievement score and static and dynamic balance. Level of significance was accepted as 0.05 and 0.001 in the statistical analyzes used in the research.

RESULTS

The arithmetic mean and standard deviation values of ages, heights, body weights, BMIs, and sporting ages of the female experimental and control groups participated in the study are given in Table 1below.

Table 1. The arithmetic mean and standard deviation values of ages, heights, body weights, BMIs, and sporting ages of the female experimental and control groups

	Group	n	Arithmetic mean	Standard Deviation
Age (year)	Control	12	15.66	0.77
	Experimental	13	15.61	0.65
Height (m)	Control	12	1.57	0.05
	Experimental	13	1.60	0.04
Body Weight (kg)	Control	12	51.90	6.54
	Experimental	13	56.15	7.47
BMI (kg/m^2)	Control	12	20.93	1.65
	Experimental	13	21.71	2.59
Sporting Age (year)	Control	12	2.50	0.67
	Experimental	13	2.30	0.48

The arithmetic mean and standard deviation values of ages, heights, body weights, BMIs, and sporting ages of the male experimental and control groups participated in the study are given in Table 2 below.

Table 2. The arithmetic mean and standard deviation values of ages, heights, body weights, BMIs, and sporting ages of the male experimental and control groups

	Group	n	Arithmetic mean	Standard Deviation
Age (year)	Control	12	15.33	0.77
	Experimental	12	15.91	0.66
Height (m)	Control	12	1.66	0.08
	Experimental	12	1.74	0.06
Body Weight (kg)	Control	12	63.10	9.06
	Experimental	12	66.63	9.62
BMI (kg/m²)	Control	12	22.76	2.72
	Experimental	12	21.82	2.47
Sporting Age (year)	Control	12	2.50	0.67
	Experimental	12	2.25	0.62

Table 3. Comparison of dynamic pre-test and post-test values of the female experimental and control groups

		n	Arithmetic mean	Standard Deviation	t	p
Control	Dynamic Balance Right FootPre-Test	12	640.48	64.34	-2.549	<0.05
	Dynamic Balance Right Foot Post-Test	12	652.63	50.53		
Experimental	Dynamic Balance Right Foot Pre-Test	13	578.28	76.72	-11.847	<0.001
	Dynamic Balance Right Foot Post-Test	13	735.38	73.27		
Control	Dynamic Balance Left Foot Pre-Test	12	642.71	61.56	-2.205	>0.05
	Dynamic Balance Left Foot Post-Test	12	656.01	52.71		
Experimental	Dynamic Balance Left Foot Pre-Test	13	575.44	68.95	-9.707	<0.001
	Dynamic Balance Left Foot Post-Test	13	734.98	71.79		
Control	Dynamic Balance Pre-Test	12	641.59	61.74	-2.504	<0.05
	Dynamic Balance Post-Test	12	654.32	49.98		
Experimental	Dynamic Balance Pre-Test	13	576.86	71.65	-11.653	<0.001
	Dynamic Balance Post-Test	13	735.18	69.70		

While there was a significant difference between the dynamic balance of the right foot pre-test and post-test values in the female control group ($p<0.05$), no significant difference was found in the left foot pre-test and post-test values ($p>0.05$). A significant difference was observed between pre-test and post-test values of dynamic balance ($p<0.05$). In addition to that, there was a significant difference between the pre-test and post-test values of the dynamic balance right foot, left foot and dynamic balance of the experimental group ($p<0.001$) (Table3).

Table 4. Comparison of static balance pre-test and post-test values of the female experimental and control groups

		n	Arithmetic mean	Standard Deviation	t	P
Control	Static Balance Right Foot Pre-Test	12	6.75	2.09	0.000	>0.05
	Static Balance Right Foot Post-Test	12	6.75	1.65		
Experimental	Static Balance Right Foot Pre-Test	13	5.07	3.37	5.926	<0.001
	Static Balance Right Foot Post-Test	13	1.61	1.55		
Control	Static Balance Left Foot Pre-Test	12	7.66	2.38	2.646	<0.05
	Static Balance Left Foot Post-Test	12	6.50	1.44		
Experimental	Static Balance Left Foot Pre-Test	13	5.00	2.48	6.178	<0.001
	Static Balance Left Foot Post-Test	13	2.07	1.32		
Control	Static Balance Pre-Test	12	7.20	2.10	1.765	>0.05
	Static Balance Post-Test	12	6.62	1.36		
Experimental	Static Balance Pre-Test	13	5.03	2.86	6.575	<0.001
	Static Balance Post-Test	13	1.84	1.23		

While there was no significant difference between the static balance right foot and static balance pre-test and post-test values of the female control group ($p>0.05$), it was found that there was a difference between the static balance left foot pre-test and post-test values ($p<0.05$). In the experimental group, a significant difference was observed between pre-test and post-test values of static balance, right foot, left foot and static balance ($p<0.001$) (Table 4).

Table 5. Comparison of success point pre-test and post-test values of the female experimental and control groups

		n	Arithmetic mean	Standard Deviation	t	P
Control	Success Point Pre-Test	12	316.25	17.05	-.410	>0.05
	Success Point Post-Test	12	317.16	11.30		
Experimental	Success Point Pre-Test	13	332.61	24.76	-6.366	<0.001
	Success Point Post-Test	13	352.30	18.60		

While there was no significant difference between the pre-test and post-test scores of the female control group, there was a significant difference between the pre-test and post-test values in the experimental group ($p<0.001$) (Table 5).

Table 6. Comparison of dynamic balance pre-test and post-test values of the male experimental and control groups

		n	Arithmetic mean	Standard Deviation	t	P
Control	Dynamic Balance Right Foot Pre-Test	12	667.26	52.98	-4.713	<0.01
	Dynamic Balance Right Foot Post-Test	12	676.50	52.38		
Experimental	Dynamic Balance Right Foot Pre-Test	12	663.11	71.28	-7.966	<0.001
	Dynamic Balance Right Foot Post-Test	12	787.33	51.90		
Control	Dynamic Balance Left Foot Pre-Test	12	662.65	64.52	-4.819	<0.01
	Dynamic Balance Left Foot Post-Test	12	677.06	58.49		
Experimental	Dynamic Balance Left Foot Pre-Test	12	642.86	67.81	-8.540	<0.001
	Dynamic Balance Left Foot Post-Test	12	786.77	54.71		
Control	Dynamic Balance Pre-Test	12	664.95	54.71	-5.802	<0.001
	Dynamic Balance Post-Test	12	676.78	51.43		
Experimental	Dynamic Balance Pre-Test	12	652.98	67.27	-8.673	<0.001
	Dynamic Balance Post-Test	12	787.05	52.68		

A significant difference was found between the pre-test and post-test values of the dynamic balance of right foot, left foot and dynamic balance of both male control and experimental groups (p<0.001) (Table 6).

Table 7. Comparison of static balance pre-test and post-test values of the male experimental and control groups

		N	Arithmetic mean	Standard Deviation	t	P
Control	Static Balance Right Foot Pre-Test	12	7.75	2.37	-.959	>0.05
	Styatic Balance Right Foot Post-Test	12	8.16	2.24		
Experimental	Static Balance Right Foot Pre-Test	12	6.16	2.94	7.607	<0.001
	Styatic Balance Right Foot Post-Test	12	2.50	1.67		
Control	Static Balance Left Foot Pre-Test	12	8.58	2.93	2.702	<0.05
	Styatic Balance Left Foot Post-Test	12	7.33	2.34		
Experimental	Static Balance Left Foot Pre-Test	12	7.16	3.15	5.457	<0.001
	Styatic Balance Left Foot Post-Test	12	3.58	2.50		
Control	Static Balance Pre-Test	12	8.16	2.44	1.283	>0.05
	Styatic Balance Post-Test	12	7.75	2.13		
Experimental	Static Balance Pre-Test	12	6.66	2.87	8.006	<0.001
	Styatic Balance Post-Test	12	3.04	1.88		

While there was no significant difference between the static balance right foot and static balance pre-test and post-test values of the male control group (p>0.05), there was a significant difference between the static balance left foot values (p<0.05).In the experimental group, a significant difference was observed between the pre-test and post-test values of the right foot, left foot and static balance (p<0.001) (Table 7).

Table 8. Comparison of competition pre-test and post-test values of the male experimental and control groups

		N	Arithmetic mean	Standard Deviation	t	P
Control	Success Point Pre-Test	12	492.33	24.42	.394	>0.05
	Success PointPost-Test	12	491.75	25.48		
Experimental	Success Point Pre-Test	13	489.00	21.20	-8.338	<0.001
	Success PointPost-Test	13	525.16	14.68		

While there was no significant difference between pre-test and post-test scores of male control group (p>0.05), there was a significant difference between pre-test and post-test values in the experimental group (p<0.001) (Table 8).

Table 9. The correlation between dynamic and static balance values and success results of experimental and control group

		Dynamic Balance	Static Balance
Success Point	r	.358*	.243
	p	.012	.093

A significant correlation was found between the success points of the athletes and the dynamic balance values (p<0.05). Although there is no significant difference between static balance values and success points statistically, a very low level of correlation was observed between them (Table 9).

Table 10. The correlation between dynamic and static balance values and success results of control group

		Dynamic Balance	Static Balance
Success Point	r	.220	.239
	p	.301	.261

No significant correlation was found between the dynamic balance and static balance and success points of the athletes in the control group (Table 10).

Table 11. The correlation between dynamic and static balance values and success results of experimental group

		Dynamic Balance	Static Balance
Success Point	r	.518**	.295
	p	.008	.152

There was a significant correlation between dynamic balance and success point ($p<0.01$). Although there is no significant difference between static balance and success points statistically, a very low level of correlation was observed between them (Table 11).

DISCUSSION

This study aimed to analyze the affects of twelve weeks lasted balance trainings on the success of air pistol shooters. At the end of the research, results showed that balance exercises increased the static balance and shooting success of both female and male experimental groups. While a significant correlation had been observed between success points and dynamic balance values of the participants prior to the trainings, after the balance training, only a significant correlation was observed between success points and dynamic balance values of the experimental group.

Analysing the balance of athletes in terms of performance is very important for trainers and athletes (25). In this study, it was found that balance training increased the dynamic balance in both control and experimental groups. It is believed that, increase in dynamic balance performance of the control group was caused by routine shooting trainings. In one of the studies conducted on biathlon athletes, it was stated that dynamic balance performance did not have a significant effect on the shooting performance of biathletes (7). In addition, Çağlayan (13) reported that dynamic balance practices in young male soccer players increased the dynamic balance. Erkmen (19) stated in his study where he compared the balance performances of the athletes that, balance parameters of the athletes in different branches became different. In another research on university students who do not do physical exercise, it was found that 10 weeks of exercises with the Swiss ball, caused a significant progress in dynamic balance values (12), of which is in parallel to our study. In the researches on disabled people, it has been found that balance training affected dynamic and static balance performances positively (15,39). In a study where the effect of balance on performance of elite alpine skiers was investigated, it was found that the average race scores of the skiers in the experimental group were higher than the control group and the balance training had a positive effect on the performance (3). The dynamic balance data obtained via portable platform before and after the implemented program showed that, balance exercise performances on both balance board and the bosu ball improved similarly for both groups (14). In another study, it was found that balance training not only improve balance performance, but also affect quickness and power performance (23). In a study on soccer players, it was reported that balance training improved the technique and balance performance, when balance training combined with technique (4). In a study comparing the static and dynamic balances of athletes in different branches, it was observed that the balance performances of soccer players were higher compared to other branches (2). In a study comparing the balance performances of female soccer players and sedentaries, it was stated that there were significant differences between the groups and the clubs that gained high level of success, also had better balance level (24). In a study where the effects of different balance exercises on volleyball players' static and

dynamic balance performance were investigated, it was found that balance exercises increased lower extremity muscle stabilization and static balance exercises were more effective on balance performance compared to dynamic balance exercises (18).

It was put forward that postural balance was both directly and indirectly related to rifle stability, shooting accuracy and shooting success, and it was suggested to implement additional balance training programs to improve postural skills of shooters. Good level of postural balance has a positive effect on the performance of the shooter, as it reduces the barrel movement. It is known that balance training increased the static balance and shooting performance in both men and women (33). In our study, no correlation was found between static and dynamic balance values of both control and experimental groups before balance training, however, after the balance training, a correlation was found between success point and dynamic balance. Aalto et al. (1) found high correlation between shooters' static balance and performance levels, as a result of their researches. In a different study, it was stated that special training including balance exercises applied to gun shooters increased the static and dynamic balance, and along with the increase, positively affected total shooting scores (30). Basically, the results of these studies support our findings in this study. Similarly, Park et al. (34) reported that, balance and breathing training applied to air rifle athletes for 6 weeks increased their shooting performance. Ball et al. (8) realised during their study on elite rifle shooters that, there was a correlation between the variables the oscillation at aiming point and shooting performance. Tutkun (43) stated that the harmony between the body and target is related to balance and has an effect on the shooting success. In another study conducted on the shooters, it was detected that the shaking in the body during shooting was caused by poor balance performance and this poor balance performance occured as a result of not being able to perform a complete and accurate series of movements requiring hand-eye coordination, affected aiming negatively and reduced the shooting performance (22,31). Era et al. (16) determined that less than 10% change in postural oscillation of elite rifle shooters had a decisive role in scores. In the study conducted on national air pistol athletes, Hawkins and Sefton (27) stated that different foot width affected shooting performance, as well as postural balance and gun stability. Tang et al. (42) concluded that, the postural balance oscillations of air pistol shooters were related to their talents and elite shooters had an impact on shooting success when they achieved to control pistol-hand coordination. In another study on pistol shooting accuracy, it has been reported that, the differences between experienced shooters at different levels were not related to the purpose or cognitive component of the task, but related to postural balance (20). Similarly, a significant correlation was found between body oscillations and performances of elite male pistol and rifle shooters during a competition (32).

In a study conducted on elite level air rifle shooters to determine the most important factors identifying the shooting performance, it was indicated that postural balance had no direct effect on performance, even less than 1% of quality trigger squeezing score (29). Zemkova (45) found that despite the increase in postural oscillation along with fatigue during shooting, it did not effect the professional shooters' accurate shooting performances. In a different study, it was concluded that fluctuations in body balance oscillation during shooting had no affect on the performance of elite pistol shooters, and shooters' errors were individual and specific, and it has been reported that private analysis should be preferred when examining the performances of elite level athletes (9). In a study, the effects of different stance angles on shooting performance was investigated, and no significant differences were found (28). In other studies related to shooting, Gould et al. (21) stated that there was no correlation between cognitive anxiety and shoting success, however somatic anxiety affected shooting performance. During the shooting, it has been proved that the target can be successfully hit by reducing the distortion of the arm-elbow stabilization in the vector line from the pistol barrel to the target (36). In another study conducted on police officers, it was found that shooting success rates did not decrease during test shootings and during the shootings executed right after fatigue

exercises (11). Sade et al. (35) applied state-trait anxiety and self-control questionnaires on 55 rifle shooters and reported that athletes with low levels of anxiety had better performance.

This research has many limitations. 15-17 is the age of the study, dealing with the limited number of athletes shooting in Turkey are among branches of limitations. Another factor that might affect the outcome of this study is the movements and procedural experiences of the participants in balance exercises. In conclusion, it can be said that balance exercises increase static balance and shooting success in both female and male experimental groups.

REFERENCES

1. Aalto H, Pyykkö I, Ilmarinen R, Kähkönen E, Starck J. Postural stability in shooters. ORL J Otorhinolaryngol Relat Spec, 1990; 52 (4): 232-238.
2. Aksakal M. Farklı branşlarda yorucu egzersizin dinamik ve statik denge performansı üzerine etkileri. Yüksek Lisans Tezi, Atatürk Üniversitesi Sağlık Bilimleri Enstitüsü, Erzurum, 2014.
3. Aktaş S. Elit düzeydeki alp disiplini kayakçilarda dengenin performans üzerine etkisi. Yüksek Lisans Tezi, Niğde Üniversitesi Sosyal Bilimler Enstitüsü, Niğde, 2009.
4. Akyüz C. Futbolda top sürme, top saydırma ve şut atma teknikleriyle birleştirilmiş denge antrenmanlarının futbolcuların teknik ve denge düzeylerine etkisi. Yüksek Lisans Tezi, Marmara Üniversitesi Sağlık Bilimleri Enstitüsü, İstanbul, 2017.
5. Arslanoğlu E, Aydoğmuş M, Arslanoğlu C, Şenel Ö. Badmintoncularda reaksiyon zamanı ve denge ilişkisi. Beden Egitimi ve Spor Bilimleri Dergisi, 2010; 4 (2): 131-6.
6. Aslan AK. Genç futbolcularda sekiz haftalık core antrenmanın denge ve fonksiyonel performans üzerine etkisi. Doktora Tezi. Selçuk Üniversitesi Sağlık Bilimleri Enstitüsü, Konya, 2014.
7. Ateş B. Biatlon sporcularında atış performansı ve denge performansı arasındaki ilişki. Gelecek Vizyonlar Dergisi, 2017; 1 (1): 21-25.
8. Ball KA, Best RJ, Wrigley TV. Body sway, aim point fluctuation and performance in rifle shooters: Inter- and intra-individual analysis. Journal of Sports Sciences, 2003; 21, 559–566.
9. Ball KA, Best RJ, Wrigley TV. Inter- and Intra-Individual Analysis in Elite Sport: Pistol Shooting. Journal of Applied Biomechanics, 2003;19 (1): 28-38.
10. Bayraktar B, Kurtoğlu M. Sporda performans, etkili faktörler, değerlendirilmesi ve araştırılması. Klinik Gelişim, 2009; 22 (1): 16–24.
11. Brown MJ, Tandy RD, Wulf G, Young JC. The effect of acute exercise on pistol shooting performance of police officers. Motor Control, 2013;17 (3): 273-82.
12. Cuğ M. Effects of Swiss Ball Training On Knee Joint Reposition Sense, Core Strength and Dynamic Balance in Sedentary Collegiate Students. The Graduate School Of Social Sciences of Middle East Technical Universıty, The Degree of Doctor of Philosophy, The Department of Physical Education and Sports Ankara, 2012.
13. Çağlayan A. Genç Erkek Futbolcularda Dinamik Denge Uygulamalarının Pliometrik Antrenmanlara Göre İzokinetik Kas Kuvveti, Pozisyon Hissi Belirleme Ve Top Sürme Becerisi Üzerine Etkisi. Doktora Tezi. Marmara Üniversitesi Sağlık Bilimleri Enstitüsü Beden Eğitimi ve Spor Anabilim Dalı, İstanbul, 2015.
14. Çelik B. Voleybolcularda Farklı Zemin Üzerindeki Dinamik Denge Antrenmanlarının Propriosepsiyon Üzerine Etkisi. Yüksek Lisans Tezi, Ege Üniversitesi Sağlık Bilimleri Enstitüsü, İzmir, 2014.
15. Demiröz Hİ. Geç Dönem Spastik Serebral Palside Dinamik Dengenin Fonksiyonel Düzey Ve Yürüme Temposuna Etkisi. Yüksek Lisans Tezi, Hasan Kalyoncu Üniversitesi, Sağlık Bilimleri Enstitüsü Fizyoterapi ve Rehabilitasyon Anabilim Dalı, Gaziantep, 2018.
16. Era P, Konttinen N, Mehto P, Saarela P, Lyytinen H. Postural stability and skilled performance: a study on top-level and naive rifle shooters. J Biomech, 1996; 29: 301–6.
17. Erdoğan M, Sağıroğlu İ, Şenduran F, Ada M, Ateş O. Elit atıcıların el kavrama kuvveti ile atış performansları arasındaki ilişkinin incelenmesi. Spor Bilimleri Dergisi, 2016; 6 (3): 22-30.
18. Erdoğan CS, Er F, İpekoğlu G, Çolakoğlu T, Zorba E, Çolakoğlu FF. Farklı denge egzersizlerinin voleybolcularda statik ve dinamik denge performansı üzerine etkileri. Spor ve Performans Araştırmaları Dergisi, 2017; 8 (1): 11-18.
19. Erkmen N. Sporcuların Denge Performanslarının Karşılaştırılması. Doktora Tezi, Gazi Üniversitesi Sağlık Bilimleri Enstitüsü Beden Eğitimi ve Spor Ana Bilim Dalı, Ankara, 2006.
20. Goonetilleke RS, Hoffmann ER, Lau WC. Pistol shooting accuracy as dependent on experience, eyes being opened and available viewig time. Appl Ergon, 2009; 40 (3): 500-8.
21. Gould D, Petlichkoff L, Simons J, Vevera M. Relationship between competitive state anxiety inventory-2 subscale scores and pistol shooting performance. Human Kinetics Journal, 1987; 9 (1): 33-42.
22. Guyton AC, Hall JE. Textbook of Medical Physiology Philadelphia: Elsevier Saunder (11th ed.), 2006.
23. Güler Ö. Genç Futbolcularda Denge Antrenmanlarının Çabukluk ve Güç Performansına Etkileri. Yüksek Lisans Tezi, Celal Bayar Üniversitesi Sağlık Bilimleri Enstitüsü, Manisa, 2012.
24. Gürkan AC. Birinci ve Bölgesel Ligde Oynayan Elit Kadın Futbolcuların Denge Dağılımlarının İncelenmesi. Sağlık bilimleri enstitüsü, Yüksek Lisans Tezi, Beden Eğitimi ve Spor Anabilim Dalı, Gazi Üniversitesi, Ankara, 2011.
25. Gürkan AC. İşitme Engelli Elit Erkek Sporcuların Statik Denge Değerlerinin Karşılaştırılması, Sağlık bilimleri enstitüsü, Doktora tezi, Beden Eğitimi ve Spor Anabilim Dalı, Gazi Üniversitesi, Ankara, 2013.
26. Hazar F, Taşmektepligil Y, Puberte öncesi dönemde denge ve esnekliğin çeviklik üzerine etkilerinin incelenmesi. Spormetre Beden Eğitimi ve Spor Bilimleri Dergisi, 2008; 6 (1): 9-12.
27. Hawkins RN, Sefton JM. Effects of stance width on performance and postural stability in national- standard pistol shooters. J Sports Sci, 2011; 29 (13): 1381-7.
28. Hawkins RN. Effects of stance angle on postural stability and performance with national -standard air pistol competitors. Eur J Sport Sci, 2013; 13(5): 483-9.
29. Ihalainen S, Kuitunen S, Mononen K, Linnamo V. Determinants of elite-level air rifle shooting performance. Scand J Med Sci Sports, 2016; 26 (3): 266-74.
30. İskender T. Ateşli Tabanca Atıcılarında Uygulanan Özel Antrenmanların Bazı Motorik Özellikler Üzerine Etkisi.

Doktora Tezi. Gazi Üniversitesi Sağlık Bilimleri Enstitüsü, Ankara, 2010
31. Konttınen N, Lyytınen H, Vııtasalo J. Preparatory heart rate patterns in competitive rifle shooting. J Sports Sci, 1998; 16 (3): 235-42.
32. Mon D, Zakynthinaki M, Cordente C, Barriopedro M, Sampedro J. Body sway and performance at competition in male pistol and rifle Olympic shooters. Biomedical Human Kinetics, 2014; 6: 56-62.
33. Mononen K, Konttinen N, Viitasalo J, Era P. Relationships between postural balance, rifle stability and shooting accuracy among novice rifle shooters. Scandinavian Journal of Medical Sciences and Sports, 2007; 17 (2): 180-185.
34. Park HK, Kim DW, Kim TH. Improvements of shooting performance in adolescent air rifle athletes after a 6-week balance and respiration training programs. J Sport Rehabil, 2019; 28 (6): 552-557.
35. Sade S, Bar-Eli M, Bresler S, Tenenbaum G. Anxiety, self control and shooting performance. Percept Mot Skills, 1990; 71 (1): 3-6.
36. Scholz JP,· Schöner G,· Latash ML. Identifying the control structure of multijoint coordination during pistol shooting. Exp Brain Res, 2000; 135 (3): 382-404.
37. Sağıroğlu İ, Erdoğan M, Ada M, Kamuk U, Ateş O. Ateşli ve havalı silahlar atıcılarında postural statik denge ve vücut kütle indeksi arasındaki ilişkinin araştırılması. Spor Bilimleri Dergisi, 2016; 6 (1): 33-40.
38. Sağlam H, Genç H. Atıcılık ve Atış Sporu. Düet Reklam Basın Yayın, Ankara, 2007.
39. Shamsabad MD. 8-13 Yaş Arası Hafif Zekâ Geriliği Olan İlköğretim Öğrencilerinde Egzersizin Statik Denge, Dinamik Denge ve Reaksiyon Zamanı Üzerine Etkisinin İncelenmesi. Doktora Tezi. Gazi Üniversitesi, Sağlık Bilimleri Enstitüsü, Beden Eğitimi ve Spor Anabilim Dalı, Ankara, 2015
40. Sucan S, Yılmaz A, Can Y, Süer C. Aktif futbol oyuncularının çeşitli denge parametrelerinin değerlendirilmesi. Sağlık Bilimleri Dergisi, 2005; 14 (1): 36-42.
41. Şahin G, Şeker H, Yeşilırmak M, Çadır A. Denge diski egzersizlerinin dinamik denge ve duruş kontrolü üzerindeki etkisinin incelenmesi. Spor ve Performans Araştırmaları Dergisi, 2015; 6 (1): 50-57.
42. Tang WT, Zhang WY, Huang CC, Young MS, Hwang MS. Postural tremor and control of the upper limb in air pistol shooters. J Sports Sci, 2008; 26 (14): 1579-87.
43. Tutkun KY. Silah Kültürü ve Atış Becerileri, Seçkin Yayımevi, 2005.
44. Yosmaoğlu HB, Yakut Y, Baltacı G. Fazla kilolu ve normal kilolu bireylerde alt ekstremite nöromusküler koordinasyon farklılıkları. Fizyoterapi Rehabilitasyon, 2011; 22 (3): 249-254.
45. Zemkova E. Postural Sway Response to Exercise. Czech Republic: Albert, 86, 2010.