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THE EFFECTS OF STRENGTH EXERCISES DONE WITH BOSU FOR 8 WEEKS ON BALANCE AND ANAEROBIC PERFORMANCE

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ABSTRACT

The purpose of this study is to investigate the effects of strength exercises done with bosu on balance and anaerobic performance. 32 volunteers from Gaziantep University Higher School of Physical Education and Sports participated in the study. With randomize method, bosu training group (BTG, n = 12, age = 22,91 ± 2,57 years, height = 176,58 ± 0,10 cm, body weight = 67,16 ± 12,70 kg), core training group (CTG, n = 10, age = 21.00 ± 2.35 years, height = 171,30 ± 0,07 cm, body weight = 61,50 ± 10,89 kg) and control group (CG, n = 10, age = 20,80 ± 0,91 years, height = 172,60 ± 0,08 cm, body weight = 63,50 ± 9,31 kg) were defined. Strength training was applied for 8 weeks, 3 days a week for BTG and CTG. No training program was applied to CG. Biodex balance and Wingate lower extremity and upper extremity anaerobic performance tests were applied to the groups. Among the pre-test and post-test of the groups; overall stability, upper Wingate anaerobic power, lower Wingate anaerobic power values were found significant for BTG and CTG ($p < 0.05$), however, there was no significant difference in these parameters for CG($p > 0.05$). In overall stability index, there was a significant difference between groups in favor of BTG and CTG when compared to CG ($p < 0.05$). However, no significant difference was found between BTG and CTG in overall stability index ($p > 0.05$). Among the groups, there was a significant difference in upper and lower Wingate anaerobic power values in favor of BTG when compared to control group ($p < 0.05$), however, there was no significant difference between BTG and CTG and between CTG and CG ($p > 0.05$). As a result, it can be said that bosu trainings affect balance and anaerobic power values positively.
Key Words: Anaerobic power, Bosu, Core, Balance.

1. INTRODUCTION

Training is controlled exercises that are applied in order to achieve a successful adaptation to the pressures and difficulties of the lifestyle of the person (athlete) (Dick, 2007). In Bayer's work titled Sports Science dictionary, training is defined as all measures (for instance increasing performance in the structure of the muscle by systematic repetitions, by loadings on the stimulation threshold of the muscle and in line with morphological adaptation) taken to increase physical capacity (Bayer, 1987) The athlete should continue performing practices and training where his/her development is controlled in a systematically and pedagogically organized way (Acikada, 2018).

The balance that each sports branch has at a certain level according to its unique characteristics is an integral part of many movement applications. Maintaining balance and body position is an important element in terms of achieving the highest levels of sporting performance. In the event of loss of balance or body position, the athlete may not achieve the performance s/he aims to or may experience injuries and mutilation (Tahhan, Ozdal, Vural, & Mayda, 2018; Vural, Ozdal &Oztutuncu, 2017; Yahya &Oktar, 2008). As also supported by the studies, regarding the performance distinction between the athletes in terms of sporting skills, it is seen that balance may be an important factor among the athletes. Human ability to equilibrate can be defined as a significant factor in the development of other motor systems (Erkmen, 2006). Determining the level of lactic acid and anaerobic threshold produced inactive muscles has an important role in performance development in sports branches where durability, which is among basic motoric properties gains importance. It will be possible to achieve higher performance levels by adjusting the intensities of work and designing the training in light of these indicators that may be obtained. The athletes will be able to show high levels of success by integrating this achievable high-performance level into the competition conditions (Dinc, 1988).

The aim of this study is to investigate the effects of strength exercises performed with BOSU on balance and anaerobic performance. It is thought that knowing to what extent the strength exercises performed with BOSU ball, which has a history that may be deemed short, can affect the balance and anaerobic performance parameters will be beneficial both for the athletes and the coaches. In this context, our research is aimed to contribute to sports sciences.

2. MATERIAL AND METHOD

2.1. Working Group and Experimental Design

The study consisted of healthy male students between the ages of 19-28 studying at Gaziantep University School of Physical Education and Sports. A total of 32 students were included in the study. This study was approved by the Gaziantep University Ethics Committee. The study was conducted and finalized in accordance with the rules stated in the Helsinki Declaration. The students participating in the study were randomly divided into three groups being Bosu Training Group (BAG/ n:10); Core Training Group (CAG/ n:10) and Control Group (KG/ n:10). Bosu and core groups performed a 3-day strength program prepared for them for 8 weeks. No training program was applied to the control group.

2.2. Training Procedure

Subjects, who were informed about the working procedure and applications 1 week before the application, visited the lab before measurements and were informed about biodex balance device and Wingate anaerobic power test. After the subjects, whose height and weight were measured were subjected to balance measurement in Biodex balancing equipment, they were respectively subjected to Wingate lower extremity and Wingate upper extremity anaerobic power tests. Bosu group, core group and control group were subjected to balance and anaerobic performance tests in Gaziantep University School of Physical Education and Sports Performance Laboratory before and after the study. The 8-week training period was planned to be 3 days a week. Training sessions were held on Monday, Wednesday and Friday at the same time every week. Bosu training group and core training group were subjected to a study program consisting of 10 movements with 1-minute loading and 30-second rest interval, where each movement was repeated 3 times. 20 minutes of warm-up and stretching movements were performed before all training sessions.

2.3. Data Collection

Age determination, height measurement (Lohman, Roche & Marorell, 1988), bodyweight measurement of all the participants have performed appropriately (Zorba & Ziyagil, 1995).

Dynamic Balance Test: One-foot dynamic balance test will be applied in the Biodex Balance SD isokinetic equilibrium test mechanism. The subject will place his/her foot on the balancing equipment platform with an angle of 5 degrees; when ready, the servo motors keeping the platform fixed will be activated, the test will be started, and the platform will relax. In this way, it will maintain its balance as 3x20 sec / 10 sec rest, and the test will be terminated. At the end of the test, overall stability, anterior-posterior stability and medial-lateral stability scores will be obtained (Cachupe, Shifflett, Kahanov & Wughalter, 2001).

Anaerobic power test measurement: The Wingate test protocol will be implemented with a bicycle ergometer (894E Peak Bike, Monark Exercise AB, Vansbro, Sweden). Before the test, subjects will be weighed with an electronic scale. Bike seat length will be adjusted separately for each subject. The bodyweight of the subject will be put on the scale of the bicycle as much as 7.50% of the lower extremity and 5.00% of the upper extremity according to the application. The subject will be told that s/he can start the test any time by pressing the button that controls the scale. When the subject feels ready, s/he will press on the button controlling the scale, lower the weight on the scale and weigh down the pedal and starting from this moment, s/he will start to pedal with maximum effort for 30 seconds. The subject will be motivated verbally so that s/he can continue his/her performance together with the beginning of the test. The test will be terminated after the time has elapsed (Buchfuhrer et al, 1983).

2.4. Statistical Analysis

Statistical analyses of this study were performed using the SPSS statistical program (SPSS for Windows, version 22.00). Statistical results were evaluated at a 95% confidence interval and p <0.05 significance level. Since the groups' own pretest and post-test measurements showed normal and homogeneous distribution, Paired Samples T Test was applied to test the significance between them. In the analysis performed by calculating the difference between the pretest and post-test data of the groups for the significance between the groups to be evaluated, relative left handgrip strength, relative leg strength and 30 meters sprint and aerobic power data were found to show the normal distribution and to be homogeneous. Therefore, the data in question were applied One Way ANOVA test and Tukey LSD test was utilized to determine the group in which there is significance.

3. FINDINGS

Statistical analysis of the effects of bosu training applied on the groups were presented in tables as mean and standard deviation.

Table 1. Bosu Training Group Parameters

Variable	Pre-test (n: 12)	Post-test (n: 12)	p
	Mean ± SD	Mean ± SD	
Age (year)	22.91 ± 2.57	22.91 ± 2.57	
Height (m)	1.76 ± 0.10	1.76 ± 0.10	
Weight (kg)	67.16 ± 12.70	66.16 ± 12.31	**0.053**
Overall Stability	1.30 ± 0.66	0.82 ± 0.24	**0.003***
Anterior Posterior Stability	1.11 ± 0.63	0.63 ± 0.14	**0.002***
Medial Lateral Stability	0.58 ± 0.24	0.51 ± 0.19	**0.216**
Upper Extremity Anaerobic Power (w)	304.41 ± 127.48	404.27 ± 208.91	**0.021***
Upper Extremity Relative Anaerobic Power (w/kg)	4.44 ± 1.43	5.69 ± 2.16	**0.011***
Upper Extremity Anaerobic Capacity (w)	211.53 ± 101.48	239.02 ± 107.59	**0.026***
Upper Extremity Relative Anaerobic Power (w/kg)	3.05 ± 1.22	3.40 ± 1.23	**0.074**
Upper Extremity Minimum Power (w)	11.30 ± 143.28	61.62 ± 146.67	**0.281**
Upper Extremity Relative Minimum Power (w/kg)	0.008 ± 2.27	0.726 ± 2.06	**0.300**
Upper Extremity Fatigue Index (%)	113.86 ± 67.33	98.61 ± 42.54	**0.381**
Lower Extremity Anaerobic Power (w)	497.23 ± 220.87	574.96 ± 234.63	**0.004***
Lower Extremity Relative Anaerobic Power (w/kg)	7.07 ± 2.09	8.28 ± 2.34	**0.003***
Lower Extremity Anaerobic Capacity (w)	371.88 ± 158.06	407.59 ± 152.87	**0.007***
Lower Extremity Relative Anaerobic Power (w/kg)	5.30 ± 1.55	5.90 1.55	**0.006***
Lower Extremity Minimum Power (w)	215.86 ± 123.44	189.05 ± 85.52	**0.326**
Lower Extremity Relative Minimum Power (w/kg)	3.01 ± 1.32	2.76 ± 1.12	**0.475**
Lower Extremity Fatigue Index (%)	57.51 ± 13.40	67.20 ± 10.64	**0.026***

Table 1 shows the comparison of the pre-test and post-test results of the physical and physiological parameters of the bosu training group discussed in the study. According to this, there was a significant difference in overall stability, anterior-posterior stability index in favour of post-tests (p<0.05). Significant differences were found in favour of post-test in upper extremity anaerobic power, relative anaerobic power, anaerobic capacity, lower extremity anaerobic power, relative anaerobic power, anaerobic capacity, relative anaerobic capacity and fatigue index values (p<0.05).

Table 2. Core Training Group Parameters

Variable	Pre-test (n: 10)	Post-test (n: 10)	p
	Mean ± SD	Mean ± SD	
Age (year)	21.00 ± 2.35	21.00 ± 2.35	
Height (m)	1.71 ± 0.07	1.71 ± 0.07	
Weight (kg)	61.50 ± 10.89	61.00 ± 10.44	**0.052**
Overall Stability	1.37 ± 0.55	0.89 ± 0.24	**0.005***
Anterior Posterior Stability	0.94 ± 0.32	0.70 ± 0.20	**0.010***
Medial Lateral Stability	0.91 ± 0.46	0.50 ± 0.16	**0.017***
Upper Extremity Anaerobic Power (w)	264.05 ± 150.54	315.45 ± 175.28	**0.002***
Upper Extremity Relative Anaerobic Power (w/kg)	4.10 ± 1.84	4.90 ± 2.30	**0.003***
Upper Extremity Anaerobic Capacity (w)	176.41 ± 102.14	187.12 ± 105.66	**0.418**
Upper Extremity Relative Anaerobic Power (w/kg)	2.72 ± 1.26	4.90 ± 2.30	**0.000***
Upper Extremity Minimum Power (w)	28.34 ± 93.90	8.60 ± 86.67	**0.398**
Upper Extremity Relative Minimum Power (w/kg)	0.28 ± 1.59	0.01 ± 1.49	**0.409**
Upper Extremity Fatigue Index (%)	101.55 ± 49.23	110.57 ± 43.55	**0.399**
Lower Extremity Anaerobic Power (w)	423.01 ± 154.04	475.23 ± 182.34	**0.020***
Lower Extremity Relative Anaerobic Power (w/kg)	6.56 ± 1.41	7.49 ± 1.93	**0.010***
Lower Extremity Anaerobic Capacity (w)	326.48 ± 114.37	341.46 ± 127.83	**0.376**
Lower Extremity Relative Anaerobic Power (w/kg)	5.08 ± 1.03	5.40 ± 1.40	**0.208**
Lower Extremity Minimum Power (w)	157.52 ± 78.31	169.62 ± 65.85	**0.594**
Lower Extremity Relative Minimum Power (w/kg)	2.47 ± 1.00	2.69 ± 0.78	**0.477**
Lower Extremity Fatigue Index (%)	62.09 ± 12.11	64.11 ± 5.54	**0.638**

*p<0.05

In Table 2, the comparison of the pre-test and post-test results regarding the physical and physiological parameters of the core training group is provided. According to this, there was a significant difference in overall stability, anterior posterior stability, medial lateral stability scores in favor of post-tests (p<0.05). Significant differences were found in favor of post-tests in upper extremity anaerobic power, relative anaerobic power, relative anaerobic capacity, lower extremity anaerobic power, relative anaerobic power values (p<0.05).

Table 3. Control Group Parameters

Variable	Pre-test (n: 10)	Post-test (n: 10)	p
	Mean ± SD	Mean ± SD	
Age (year)	20.80 ± 0.91	20.80 ± 0.91	
Height (m)	1.72 ± 0.08	1.72 ± 0.08	
Weight (kg)	63.50 ± 9.31	63.40 ± 9.28	0.591
Overall Stability	1.14 ± 0.45	1.13 ± 0.38	0.864
Anterior Posterior Stability	0.90 ± 0.30	0.83 ± 0.29	0.317
Medial Lateral Stability	0.62 ± 0.32	0.69 ± 0.30	0.161
Upper Extremity Anaerobic Power (w)	325.66 ± 161.10	312.33 ± 138.73	0.292
Upper Extremity Relative Anaerobic Power (w/kg)	4.98 ± 2.02	4.53 ± 1.96	0.079
Upper Extremity Anaerobic Capacity (w)	219.91 ± 107.85	207.15 ± 90.28	0.299
Upper Extremity Relative Anaerobic Power (w/kg)	3.34 ± 1.37	3.00 ± 1.23	0.082
Upper Extremity Minimum Power (w)	22.04 ± 182.71	100.28 ± 58.20	0.231
Upper Extremity Relative Minimum Power (w/kg)	0.20 ± 2.85	1.45 ± 0.82	0.215
Upper Extremity Fatigue Index (%)	101.45 ± 52.70	69.19 ± 13.62	0.096
Lower Extremity Anaerobic Power (w)	495.32 ± 168.16	487.52 ± 152.80	0.788
Lower Extremity Relative Anaerobic Power (w/kg)	7.72 ± 2.19	7.70 ± 1.52	0.957
Lower Extremity Anaerobic Capacity (w)	371.86 ± 111.02	360.15 ± 111.19	0.584
Lower Extremity Relative Anaerobic Power (w/kg)	5.80± 1.35	5.69 ± 1.11	0.671
Lower Extremity Minimum Power (w)	228.59 ± 68.29	202.16 ± 55.96	0.210
Lower Extremity Relative Minimum Power (w/kg)	3.56 ± 0.76	3.21 ± 0.56	0.149
Lower Extremity Fatigue Index (%)	51.83 ± 10.58	57.86 ± 4.49	0.107

Table 3 shows the comparison of the pre-test and post-test results of the physical and physiological parameters of the control group. No significant difference was found in any parameters of the control group (p> 0.05).

Table 4. Comparison of Balance and Upper Extremity Parameters of Groups

Variable	Group No	n	Mean	SD	p	Significant Difference
Overall Stability	1. Bosu Training Group	12	-0.48	0.52	**0.017***	1-3, 2-3
	2. Core Training Group	10	-0.48	0.41		
	3. Control Group	10	-0.01	0.18		
Anterior Posterior Stability	1. Bosu Training Group	12	-0.49	0.55	**0.041***	1-3
	2. Core Training Group	10	-0.24	0.23		
	3. Control Group	10	-0.07	0.22		
Medial Lateral Stability	1. Bosu Training Group	12	-0.07	0.19	**0.002***	2-1, 2-3
	2. Core Training Group	10	-0.24	0.23		
	3. Control Group	10	-0.42	0.45		
Upper Extremity Anaerobic Power (w)	1. Bosu Training Group	12	99.86	128.91	**0.015***	1-3
	2. Core Training Group	10	51.40	37.80		
	3. Control Group	10	-13.33	37.68		
Upper Extremity Relative Anaerobic Power (w/kg)	1. Bosu Training Group	12	1.25	1.43	**0.002***	1-3, 2-3
	2. Core Training Group	10	0.81	0.65		
	3. Control Group	10	-0.45	0.72		
Upper Extremity Anaerobic Capacity (w)	1. Bosu Training Group	12	27.49	37.10	**0.061**	--
	2. Core Training Group	10	10.71	39.93		
	3. Control Group	10	-12.76	36.61		
Upper Extremity Relative Anaerobic Capacity (w/kg)	1. Bosu Training Group	12	0.36	0.62	**0.013***	1-3
	2. Core Training Group	10	0.16	0.32		
	3. Control Group	10	-0.34	0.55		
Upper Extremity Minimum Power (w)	1. Bosu Training Group	12	50.32	153.60	**0.326**	--
	2. Core Training Group	10	-19.74	70.34		
	3. Control Group	10	78.23	192.62		
Upper Extremity Relative Minimum Power (w/kg)	1. Bosu Training Group	12	0.74	2.34	**0.313**	--
	2. Core Training Group	10	-0.30	1.09		
	3. Control Group	10	1.25	2.96		
Upper Extremity Fatigue Index (%)	1. Bosu Training Group	12	-15.25	57.86	**0.200**	--
	2. Core Training Group	10	9.01	32.20		
	3. Control Group	10	-32.25	54.95		

Table 5. Comparison of Lower Extremity Parameters of Groups

Variable	Group No	n	Mean	SD	p	Significant Difference
Lower Extremity Anaerobic Power (w)	1. Bosu Training Group	12	77.73	74.67	0.039*	1-3
	2. Core Training Group	10	52.22	58.46		
	3. Control Group	10	-7.80	89.04		
Lower Extremity Relative Anaerobic Power (w/kg)	1. Bosu Training Group	12	1.22	1.13	0.048*	1-3
	2. Core Training Group	10	0.93	0.90		
	3. Control Group	10	-0.02	1.37		
Lower Extremity Anaerobic Capacity (w)	1. Bosu Training Group	12	35.71	37.84	0.118	--
	2. Core Training Group	10	14.98	50.82		
	3. Control Group	10	-11.71	65.27		
Lower Extremity Relative Anaerobic Capacity (w/kg)	1. Bosu Training Group	12	0.61	0.62	0.083	--
	2. Core Training Group	10	0.32	0.75		
	3. Control Group	10	-0.11	0.81		
Lower Extremity Minimum Power (w)	1. Bosu Training Group	12	-26.81	90.37	0.420	--
	2. Core Training Group	10	12.10	69.19		
	3. Control Group	10	-26.43	61.84		
Lower Extremity Relative Minimum Power (w/kg)	1. Bosu Training Group	12	-0.25	1.18	0.380	--
	2. Core Training Group	10	0.22	0.95		
	3. Control Group	10	-0.36	0.71		
Lower Extremity Fatigue Index (%)	1. Bosu Training Group	12	9.69	13.05	0.364	--
	2. Core Training Group	10	2.02	13.11		
	3. Control Group	10	6.04	10.66		

Tables 4 and 5 provide an intergroup comparison of the physical and physiological parameters discussed in the study. LSD test was used to determine the differences between the groups. In overall stability scores, it was determined that the bosu and core training group had significantly lower scores than the control group ($p<0.05$). In the anterior posterior stability scores, the bosu group was found to have significantly lower scores than the control group ($p<0.05$). It was found that in medial lateral stability scores the core training group had significantly lower scores than the bosu and control groups ($p<0.05$). Regarding upper extremity measurements, in anaerobic power and relative anaerobic capacity values, the bosu group was found to get significantly higher scores than the control group ($p <0.05$). Regarding relative anaerobic power values, bosu and core training groups were found to get significantly higher scores than the control group ($p<0.05$).In lower extremity measurements, regarding anaerobic power and relative anaerobic power values, bosu training group was found to get significantly higher scores than the control group ($p<0.05$).

4. DISCUSSION AND CONCLUSION

In this study, the effects of 8 weeks of strength training performed with BOSU on balance and anaerobic performance were investigated. Volunteers who participated in our study were applied height and body weight measurement, biodex dynamic balance test, Wingate upper extremity and lower extremity anaerobic power tests. In this section, the data obtained in our study are compared with those of similar studies conducted in the literature.

Looking at the studies conducted, it was stated that in the study named Ankle Muscle Activation When Using the Both Sides Utilized (BOSU) Balance Trainer, bosu balance device would provide benefit in balance studies (Laudner & Koschnitzky, 2010). While in another study named Neuromuscular Training Improves Single-Limb Stability in Young Female Athletes, a significant result was found in overall stability, anterior-posterior stability values as a result of the 6 weeks training program, no significant result was found in medial-lateral stability score. The results obtained in this study coincide with the results we obtained in our study (Paterno, Myer, Ford & Hewett, 2004). In the study entitled "Effects of Balance Training on Balance Performance in Healthy Older Adults: A Systematic Review and Meta-analysis," it was stated that balance training is an effective tool not only for general balance in healthy ages but also for the improvement of dynamic/static balance (Lesinski, Hortobagyi, Muehlbauer, Gollhofer & Granacher, 2015); in another study entitled "Effects of 12-Week Proprioception Training Program on Postural Stability, Gait and Balance in Older Adults: A Controlled Clinical Trial," significant differences were found in postural stability, static and dynamic balance in subjects over 65 years after the training program conducted using BOSU and Swiss ball (Antonio, Fidel, Rafael & Martinez, 2013).

Looking at the studies conducted, the differences between the deadlift on a stable surface in the study entitled "Deadlift Muscle Force and Activation Under Stable and Unstable Conditions" and the deadlift performed on BOSU and T-Bow were compared in terms of paraspinal muscle activity and power production. Subjects were subjected to isometric and dynamic tests with 70% of their maximal forces. As a result of the isometric tests, a significant difference was found between deadlift on stable surface and deadlift on BOSU and T-Bow in favor of deadlift on a stable surface in terms of power generation and muscle activity. Similarly, dynamic tests showed a significant difference in terms of muscle activity in favor of deadlift on stable surface at $p<0.05$ (Chulvi-Medrano et al, 2010). In the study titled "Comparison of the Effects of an Eight-Week Push-up Program Using Stable Versus Unstable Surfaces," no difference was found in terms of muscular power and endurance between the push-up training designed using T-Bow and BOSU and applied twice a week for 8 weeks on unstable surface and the push-up training performed on a stable surface (Medrano, Ballester, Tortosa, 2012). Again, in a study titled "Muscle Force Output and Electromyographic Activity in Squats with Various Unstable Surfaces," it was found that although there was a decrease in the power output during the squat, the increase in surface imbalance preserved muscle activity. Based on this situation, it was concluded that squat on an unstable surface may be useful as part of rehabilitation and periodic training programs (Saeterbakken, Fimland & Marius, 2013).

Prieske et al, in their study titled "Neuromuscular and Athletic Performance Following Core Strength Training in Elite Youth Soccer: Role of Instability", applied core strength training on the stable and unstable surface for 2-3 days a week in addition to regular season football training to elite young football players for 9 weeks. At the end of this study, in which they aimed to compare the core strength training performed on stable and unstable surface in terms of neuro-muscular and athletic performance, they found that there was a significant improvement in body muscle strength, sprint and shot performance values as a result of the core strength exercises combined with normal season football training on both stable and unstable surfaces (Prieske, et al, 2015). David G. Behm et al, in their study entitled "Effects of Strength Training Using Unstable Surfaces on Strength, Power and Balance Performance Across the Lifespan: A Systematic Review and Meta-analysis," found that, compared to the control group, strength studies performed on unstable surfaces were effective in improving muscle strength, power and balance in adolescents, young adults and elderly and that when training on unstable surface was compared to training on stable surface, it was found to have extra effects on muscle strength, power and balance performance in healthy adolescents and young adults (Behm, Muehlbauer, Kibele & Granacher, 2015).

As a result, as stated in the above studies, it is observed that exercise on unstable surfaces such as BOSU provides an increase in muscle activity compared to the stable one, indicating a relationship between the level of mobility of the surface and muscle activity, and it is thought to have a positive effect on anaerobic performance.

REFERENCES

ACIKADA, C. (2018). *Antrenman Bilimi, Antrenman İlkeleri Perioddizasyon ve Form Antrenmanları*. Ankara: Spor Yayınevi ve Kitabevi.

ANTONIO, M. A., FIDEL, H. C., RAFAEL, L. V. & MARTINEZ, C. (2013). Effects of 12-Week Proprioception Training Program on Postural Stability, Gait and Balance in Older Adults: A Controlled Clinical Trial. *Journal of Strength and Conditioning Research*, *27*(8), 2180-2188.

BAYER, E.D. (1987). *Dictionary of Sport Science*. Hoffman, Schorndorf.

BEHM, D.G., MUEHLBAUER, T., KIBELE, A. & GRANACHER, U. (2015). Effects of Strength Training Using Unstable Surfaces on Strength, Power and Balance Performance Across the Lifespan: A Systematic Review and Meta-analysis, *Sports Medicine*, 45, 1645-166.

BUCHFUHRER, M. J., HANSEN, J.E., ROBINSON, T.E., SUE, D.Y., WASSERMAN, K. & WHIPP, B. (1983). Optimizing the exercise protocol for cardio pulmonary assessment. *J ApplPhysiol*., *55*(5),1558-1564.

CACHUPE, W.J., SHIFFLETT, B., KAHANOV, L. & WUGHALTER, E. H. (2001). Reliability of biodex balance system measures. *Measurement in physical education and exercise science*, *5*(2),97-108.

CHULVI-MEDRANO, I., GARCIA-MASSO, X., COLADO, JC., PABLOS, C, ALVES de MORAES, J. & FUSTER, M. (2010). Deadlift Muscle Force and Activation Under Stable and Unstable Conditions, *Journal of Strength and Conditioning Research*, *24*(10), 2723-2730.

DICK, F. W. (2007). *Sports Training Principles*. 5. Edition. A&C Black (Publishers) Ltd, London.

DINC, CS. (1988). *İki Anaerobik Eşik Belirleme Yönteminin Karşılaştırılması ve Geçerliği*, Bilim Uzmanlığı Tezi: Hacettepe Üniversitesi Sağlık Bilimleri Enstitüsü, Ankara.

ERKMEN, N. (2006). *Sporcuların Denge Performanslarının Karşılaştırılması*. Doktora Tezi; Gazi Üniversitesi Sağlık Bilimleri Enstitüsü Beden Eğitimi ve Spor Ana Bilim Dalı, Ankara.

LAUDNER, K.G. & KOSCHNITZKY, M.M. (2010). Ankle Muscle Activation When Using the Both Sides Utilized (BOSU) Balance Trainer. *Journal of Strength & Conditioning Research, 24*(1), 218-222.

LESINSKI, M., HORTOBAGYI, T., MUEHLBAUER, T., GOLLHOFER, A. & GRANACHER, U. (2015). Effects of Balance Training on Balance Performance in Healthy Older Adults: A Systematic Review and Meta-analysis. *Sports Medicine*, 45, 1721-1738.

LOHMAN, T.G., ROCHE, A.F. & MARORELL, R. (1988). *Anthropometric standardization reference manual*. Human Kinetics Books, Illionis.

MEDRANO, I.C., BALLESTER, E.M., TORTOSA, L.M. (2012). Comparison of the Effects of an Eight-Week Push-up Program Using Stable Versus Unstable Surfaces. *International Journal of Sports Physical Therapy,7*(6), 586–594.

PATERNO, M.V., MYER, G.D., FORD, K.R., HEWETT, T.E. (2004). Neuromuscular Training Improves Single-Limb Stability in Young Female Athletes. *Journal of Orthopedic & Sports Physical Therapy*, *34*(6),305-16.

PRIESKE, O., MUEHLBAUER, T., BORDE, R., GUBE, M., BRUHN, S., BEHM, D.G. & GRANACHER, U. (2015). Neuromuscular and Athletic Performance Following Core Strength Training in Elite Youth Soccer: Role of Instability. *Scandinavian Journal of Medicine and Science in Sports*. *26*(1), 48-56.

SAETERBAKKEN, A.H. & FIMLAND, M. S. (2013). Muscle Force Output and Electromyographic Activity in Squats with Various Unstable Surfaces. *Journal of Strength & Conditioning Researc*h, *27*(1), 130-136.

TAHHAN, A.M.A.A., OZDAL, M., VURAL, M. & MAYDA, M.H. (2018). Acute effects of aerobic and anaerobic exercises on circulation parameters. *European Journal of Physical Education and Sport Science*, *4*(3),72-80.

VURAL, M., ÖZDAL, M. & OZTUTUNCU, S. (2017). The effect of 4-week two different strength training programs on body composition. *European Journal of Physical Education and Sport Science*, *3*(7), 1-10.

YAHYA, H. & OKTAR, A. (2008). Vücudumuzdaki Kusursuz Denge Sistemi. *Bilim ve Teknik Dergisi*, İstanbul.

ZORBA, E. & ZIYAGIL, M.A. (1995). *Vücut Kompozisyonu ve Ölçüm Metotları*. Ankara: Erek Ofs.