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THE EFFECTS OF CORE TRAINING ON SOME PHYSICAL AND PHYSIOLOGICAL FEATURES OF MALE ADOLESCENT STUDENTS[i]

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Abstract:

The aim of this study was to investigate effects of core training on some physical and physiological parameters on adolescent male students. Totally 24 persons were participated in the study as voluntary. Two groups were formed as experimental group (EG, n = 12, age = 15.30 ± 0.66 year, height = 173.80 ± 7.32 cm, body weight = 64.76 ± 11.68 kg) and control group (CG, n = 12, age = 15.05 ± 0.51 year, height = 170.05 ± 6.32 cm, body weight = 65.57 ± 13.07 kg) from volunteers. Eight weeks core training program was applied to EG, four days per a week in addition to their training. CG wasn't participated in core training during 8 weeks. Age, height, weight, back and leg strength, vertical jump, body fat percentage, 20m shuttle run test, 1min push-up and curl-up measurements and tests were performed by volunteers. When compared pre- and post-values of EG, significances were found in all parameters ($p < 0.05$), except aerobic power. When compared pre and post values of CG, no significance was found in any parameters ($p < 0.05$). Between the groups, there were no significant differences in age, height and aerobic power values. Significant differences were found in all other parameters in favour of EG ($p < 0.05$). As a result, it could be said that there are positive effects of core strength training on some physical and physiological parameters of male students who were between 14-16 years old.

Keywords: core training, aerobic power, anaerobic power, adolescents

[i] This study has been summarized from Hülya Dedecan's master's thesis.

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Introduction

Core strength trainings and their effects have been analysed by many researchers and results that show that they help development of athletes' motor skills, increasing of balance ability and prevention from sports injuries (Biçer et al., 2015; Thomas and William, 2009; Hessari et al., 2011; Takanati, 2011; Sadeghi et al., 2013).

Exercise program that aims to strengthen muscle groups in lumbopelvic area and the deep muscles that are responsible for stabilizing spine, and done by athlete's own body weight is called core training (Takanati, 2012).

Trainers have been directed to alternative power training methods that they can do by their own body weight, due to developmental and injury related risks that power trainings implemented with free weights may cause in athletes especially in adolescence. With the help of core exercises, controlling spine during dynamic movements is taught (Takanati, 2012). In addition, core training program shows benefits in strengthening the respiratory muscles, especially the m. diaphragm muscle (Özdal, 2016a) which is one of the most important respiratory muscles (Özdal, 2016b; Özdal, 2016c). Core training method shows differences than weight training method in terms of implementation, and also it focuses on improving the muscle strength (Thomas and William, 2009).

The aim of this study is to analyse the effects of core strength training which is a kind of strength training, on physical and physiological parameters in male students between 14-16 years old.

Material and Method

24 male students between 14-16 age average, who study in Gaziantep OSB Vocational and Technical High School in Gaziantep province, who are actively doing sports and who participated local and/or national level competitions, participated the study voluntarily. Controlled pre-test and post-test experiment design has been used in the study. Subjects were divided into two equal groups as experimental and control groups. First measurements of both groups were taken a day before 8-week training program (pre-test), last measurements were taken a day after 8-week training program (post-test) at the same time period (14:00-18:00). Experiment group was included in the core training program for 8 weeks and 4 days/week and 2 hours/day. No training program was implemented on control group. All subjects were informed about study plan and aim, parents' permit with written consent that show the participants participated voluntarily, was obtained. Measurements have been made in Gaziantep University

Performance Laboratory. This research has been made with the 09.05.2016 dated no.26 board of ethics decision of Selcuk University Faculty of Sports Science.

Collection of Data

Measurement of length and body weight (Polat et al., 2011), back and leg strength measurement (Akcan and Biçer, 2015), hand grip strength (Yıkılmaz et al., 2015), long jump test by standing (Tamer, 2000), one minute push-up (Yıldız et al., 2016), one minute curl-up test (Yıldız et al., 2016), subcutaneous fat thickness measurements (Akcan and Biçer, 2015), vertical jump measurement and anaerobic strength test measurements (Bilgiç et al., 2016; Akcan and Biçer, 2015), 20m shuttle run test (Bilgiç et al., 2016) was practiced on subjects.

Statistical Analysis

Statistical analysis of this study was made by using SPSS 22.0 statistical program (SPSS Inc., ABD). Statistical results was evaluated according to $p < 0.05$ significance level. Average and standard deviation as identifier values were used. Before starting the statistical processes Shapiro-Wilk test was implemented for normal distribution control. For data sets that show non-normal distribution, Skewness and Kurtosis values were checked. Independent Sample T and Mann-Whitney U tests were used in comparison of dual groups. For the analysis of differences between pre and post-tests of the groups, Paired Samples T and Wilcoxon tests were used.

Results

Measured features of participants in pre and post-tests have been examined and analysed in this section. Intra-group and inter-groups comparisons are presented below.

Table 1: Pre- and post-test analysis of experiment group

		EG (n = 12)			CG (n = 12)		
		Ave.	**SS**	**P**	**Ave.**	**SS**	**P**
Body Weight	Pre-test	64.76	11,68	**0,042**	65.57	13.07	0.125
(kg)	Post-test	61.51	12,02		68.73	13.69	
Back strength	Pre-test	114.62	30,41	**0,002**	99.05	32.11	0.163
(kg)	Post-test	133.46	36,24		107.12	28.44	
Right Hand Grip Strength	Pre-test	34.62	5,86	**0,001**	33.72	18.15	0.131
(kg)	Post-test	39.15	6,77		36.09	10.92	
Left Hand Grip Strength	Pre-test	33.17	4,44	**0,002**	25.65	4.51	0.739
(kg)	Post-test	35.30	4,61		25.80	4.35	
Leg strength	Pre-test	103.22	26,00	**0,000**	90.07	25.20	0.462
(kg)	Post-test	141.20	35,39		95.40	32.92	
Body fat	Pre-test	14.85	3,24	**0,012**	18.37	6.49	0.164
(%)	Post-test	13.63	2,78		17.71	4.18	
Standing long jump	Pre-test	197.10	28,94	**0,001**	174.15	21.22	0.513
(cm)	Post-test	214.15	29,46		171.10	25.63	
Vertical jump	Pre-test	37.00	6,68	**0,017**	30.65	3.65	0.157
(cm)	Post-test	39.65	4,46		29.60	4.82	
Anaerobic Power	Pre-test	80.18	14,71	**0,046**	80.84	14.34	0.411
(kg.m/sec)	Post-test	86.85	11,01		82.32	16.96	
$MaxVO_2$	Pre-test	3.07	0,29	0,746	2.68	0.06	0.240
(lt/min)	Post-test	3.09	0,19		2.69	0.05	
1 min push-up	Pre-test	22.75	10,40	**0,043**	18.40	7.70	0.150
(unit)	Post-test	25.55	13,44		16.20	5.51	
1 min curl-up	Pre-test	26.55	8,17	**0,008**	15.55	6.33	0.953
(unit)	Post-test	32.75	7,99		15.65	5.91	

Analysis between pre and post-tests of the experiment group's measured features are given in Table 1. No significant difference was determined between the pre and post-tests of $maxVO_2$ parameter of experiment group ($p > 0.05$). No significant change was observed between the pre and post-tests of all physical and physiological parameters measured for experiment group ($p < 0.05$). Analysis between pre and post-tests of the control group's measured features are given in Table 1. No significant change was observed between all physical and physiological parameters measured for control group ($p > 0.05$).

Table 2: Comparison of differences of pre and post-tests of EG and CG

	Group	Ave.	SS	p
Body weight	CG	1.65	5.97	**0.043**
(kg)	EG	-3.25	13.69	
Back strength	CG	8.07	40.97	**0.043**
(kg)	EG	18.84	24.18	
Right hand grip str.	CG	2.36	21.30	**0.039**
(kg)	EG	4.53	4.59	
Left hand grip str.	CG	0.15	1.98	**0.010**
(kg)	EG	2.12	2.62	
Leg strength	CG	5.32	31.75	**0.001**
(kg)	EG	37.97	24.44	
Body fat	CG	-0.66	6.06	**0.046**
(%)	EG	-1.23	1.99	
Standing long jump	CG	-3.50	20.44	**0.001**
(cm)	EG	17.05	12.17	
Vertical jump	CG	-1.05	3.19	**0.005**
(cm)	EG	2.65	4.53	
Anaerobic Power	CG	0.52	8.59	**0.043**
(kg.m/sec)	EG	1.67	15.13	
$MaxVO_2$	CG	0.01	0.02	0.684
(lt/min)	EG	-0.02	0.31	
1 min push-up	CG	-2.20	6.56	**0.026**
(unit)	EG	2.80	7.08	
1 min curl-up	CG	0.10	7.43	**0.028**
(unit)	EG	6.20	9.35	

Analysis between pre and post-tests of the experiment group's and control group's measured features are given in Table 1. Significant difference is seen between experiment and control groups in terms of measured weight, back strength, right and left hand grip strength, leg strength, body fat, standing long jump, vertical jump, anaerobic jump, 1 min push-up and 1 min curl-up parameters ($p < 0.05$). No significant difference is seen between groups in $maxVO_2$ test ($p > 0.05$).

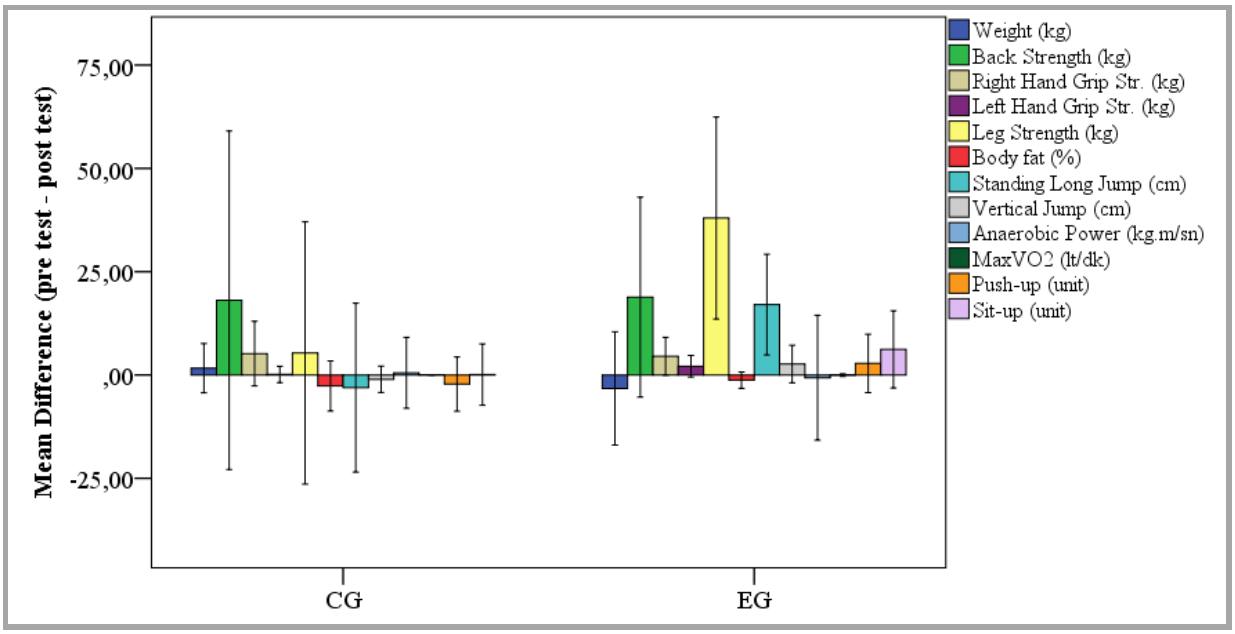

Figure 1: Differences between pre and post-tests of measured features

Discussion

In this study, core training's effects on some physical and physiological features on male students during adolescence were examined. Findings that were obtained in this section have been discussed by comparing with the literature.

After core training program implemented in this study, when pre-test and post-test differences of body weight averages of experiment and control group are compared, a significant difference is obtained in favour of experiment group ($p < 0.05$). Reductions in body fat percentage are seen as a result of burning high amounts of calories (Koç, 2010). Power trainings cause changes on body composition by increasing fat-free body weight with anabolic effect and by decreasing body fat percentage (Harbili, 1999). Similar studies in literature point out this result (Otto et al. 2012; Gremeaux et al., 2012; Abe et al., 2014). It could be said that the significant decline in the body weight is related to the decline in the body fat percentage ($p < 0.05$).

After the core training program implemented in this study, when pre-test and post-test differences of back strength are compared, significant difference is found between two groups in favour of experiment group ($p < 0.05$). Obtained results have similar results with the previous studies done by the researchers (Cosio-Lima et al., 2003; Sekendiz et al., 2010; Carpes et al., 2008; Granacher et al., 2012; Durall et al., 2009; Sukalinggam et al., 2012; Kline et al., 2013). Although it is known that core training that cause this significant change affects mainly core muscles and that it causes exhaustion

in exercise power acutely (Özdal, 2015), it can be said that it is affected by long-term effects of power training with progressively increasing tax.

After the core training program implemented in this study, when pre-test and post-test differences of right and left hand grip strength averages, a significant difference is found in favour of experiment group ($p < 0.05$). It is thought that these results are consistent with the literature (Faigenbaum et al., 2002; Sartorio et al., 2002; Damush et al., 1999).

After the core training program implemented in this study, when pre-test and post-test differences of leg strength averages of experiment and control group are compared, a significant difference is found in favour of experiment group ($p<0.05$). Results have similarities with the literature (Cosio-Lima et al., 2003; Myer et al., 2008; Drinkwater et al., 2007; Fowler et al., 1995). Trunk and pelvic are the areas that core training intensely taxed. Build-up of these muscles will affect both balance and power features of the body positively (Faries and Greenwood, 2007, Reed et al., 2012). Marshall and Murphy stated that after they implement exercises with Swiss ball, abdominal muscles have higher activation during leg strength test and its contributions on test results have been increased (Marshall and Murphy, 2005). In framework of this result, it is thought that core area muscles, by contributing during the test, affects leg strength test results positively.

After the core training program implemented in this study, when pre-test and post-test differences of body fat measurement averages of experiment and control group are compared, a significant difference is found in favour of experiment group ($p < 0.05$). Obtained results show similarities with the previous studies (Prabhakaran et al., 1999; Sillanpää et al., 2008; Tsuzuku et al., 2007). Joshi et al. (2012) stated that fat volume and percentage is an indicator for fitness level in school children (Joshi et al., 2012). Body fat decline obtained in this study is thought to be important due to this reason. Power trainings cause changes on body composition by increasing fat-free body weight with anabolic effect and by decreasing body fat percentage (Harbili, 1999). It could be said that body fat percentage is due to this reason.

After the core training program implemented in this study, when pre-test and post-test differences of standing long jump and vertical jump performance averages of experiment and control group are compared, a significant difference is found in favour of experiment group ($p < 0.05$). Researchers have reported significant increases in lower extremity performance with core power training and stability trainings implemented on core area (Myer et al., 2008, Drinkwater et al., 2007, Cosio-Lima et al., 2003). In the light of this information, changes in standing long jump and vertical jump test performances

can be explained by positively affected leg strength as a result of core training's increase in body and hip power.

Anaerobic power is an important factor for athletic performance (Özdal et al., 2016). After the core training program implemented in this study, when pre-test and post-test differences of anaerobic power performance averages of experiment and control group are compared, a significant difference is found in favour of experiment group ($p < 0.05$). These results show similarities with the similar studies in the literature (Fatouros et al., 2005; Miszko et al., 2003; Slade et al., 2002; Chromiak et al., 2004). As obtained anaerobic power value is obtained by vertical jump, anaerobic power increase is an expected situation with the increase in distance of jump and leg power. It could be said that anaerobic power increase in experiment group is directly related to implement 8-week core training.

After the core training program implemented in this study, when pre-test and post-test differences of maxVO_2 value averages of experiment and control group are compared, no significant difference is found between groups ($p > 0.05$). Results support the literature (Chtara et al., 2005; Sale et al., 1990). Cardiorespiratory compliance amount of exercise is primarily related to training intensity, time and frequency. If intensity is adequate in power training, increase in aerobic capacity will be inadequate. 10-12 weeks training period is suggested for formation of positive effects on aerobic capacity with power training (Chtara et al., 2005). In this study, above mentioned deficiencies are thought to be the reasons for obtaining significant differences in aerobic capacity in experiment group.

After the core training program implemented in this study, when pre-test and post-test differences of 1 minute push-up and 1 minute shuttle performance averages of experiment and control group are compared, a significant difference is found in favour of experiment group ($p < 0.05$). Previous studies did by the researchers support these results (Escamilla et al., 2010; Escamilla et al., 2006; Cosio-Lima et al., 2003). Core strength training has been used quite widely in strength and condition areas (Sato and Mokha, 2009). Core training has positive effects on strengthening core area of the body (Sato and Mokha, 2009; Stanton et al., 2004). Abdominal muscles, paraspinal muscles, gluteal muscles, oblique muscles, pelvic-hip muscles and diaphragm muscle can be represented as body's core area (Shinkle et al., 2012). These explanations can be shown as reasons for this large increase caused by core training implemented in this study on 1 minute shuttle test. In addition, power increase in m.rectus abdominis muscle can be transferred to upper extremities via its collagen tissue (Akuthota and Nadler, 2004; Konin et al., 2003) and this could explain the significant increase in 1 minute push-up test in experiment group.

In framework of the findings obtained in this study, with the help of core training program, positive changes were determined in body, power parameters of upper and lower extremities, body composition features and anaerobic power. Although implemented training program is oriented at body's core area, upper and lower extremities are positively affected too, and this reveals that the core training program supports development ambidextrously. In addition, core training may compose positive changes in body composition in terms of intensity, frequency and time. However, core training program didn't affect the aerobic capacity positively. Training program's total time and intensity is thought to be the reason for this. As a result, it could be said that core training program positively affects the power, body composition and anaerobic power features in young male, however it has no significant effects on anaerobic power.

References

1. Abe T, Loenneke JP, Kojima K, Thiebaud RS, Fahs CA, Sekiguchi O, 2014. Influence of strength training on distribution of trunk and appendicular muscle mass. J Aging Res Clin Pract, 3, 28-30.
2. Akcan F, Biçer M, 2015. Çeşitli Branşlardaki Erkek Sporculara Uygulanan İki Farklı Kuvvet Antrenman Programının Bazı Fiziksel ve Fizyolojik Özellikleri Üzerine Etkisi. Turkish Journal of Sport and Exercise,17(2), 1-7.
3. Akuthota V, Nadler SF, 2004. Core strengthening. Archives of physical medicine and rehabilitation, 85, 86-92.
4. Biçer M, Özdal M, Akcan F, Mendeş B, Patlar S, 2015. Effect of strength training program with elastic band on strength parameters. Journal of Biology of Exercise, 11(2), 111-122.
5. Bilgiç M, Biçer M, Özdal M, 2016. Farklı Branşlarda Spor Yapan 11-13 Yaş Grubu Çocukların 2D: 4D Parmak Oranlarının Sportif Performansla İlişkisinin İncelenmesi. Gaziantep Üniversitesi Spor Bilimleri Dergisi, 1(1), 48-56.
6. Casio-Lima LM, Reynolds KL, Winter C, Paolone V, Jones MT, 2003. Effects of physioball and conventional floor exercises on early phase adaptations in back and abdominal core stability and balance in women. The Journal of Strength & Conditioning Research, 17(4), 721-5.
7. Chromiak JA, Smedley B, Carpenter W, Brown R, Koh YS, Lamberth JG, Joe LA, Abadie BR, Altorfer G, 2004. Effect of a 10-week strength training program and recovery drink on body composition, muscular strength and endurance, and anaerobic power and capacity. Nutrition, 20(5), 420-7.

8. Chtara M, Chamari K, Chaouachi M, Chaouachi A, Koubaa D, Feki Y, Millet GP, Amri M, 2005. Effects of intra-session concurrent endurance and strength training sequence on aerobic performance and capacity. British journal of sports medicine, 39(8), 555-60.
9. Damush TM, Damush JG, 1999. The effects of strength training on strength and health-related quality of life in older adult women. The Gerontologist, 39(6), 705-10.
10. Durall CJ, Udermann BE, Johansen DR, Gibson B, Reineke DM, Reuteman P, 2009. The effects of preseason trunk muscle training on low-back pain occurrence in women collegiate gymnasts. The Journal of Strength & Conditioning Research, 23(1), 86-92.
11. Escamilla RF, Babb E, DeWitt R, Jew P, Kelleher P, Burnham T, Busch J, D'Anna K, Mowbray R, Imamura RT, 2006. Electromyographic analysis of traditional and non-traditional abdominal exercises: implications for rehabilitation and training. Physical Therapy, 86(5), 656-71.
12. Escamilla RF, Lewis C, Bell D, Bramblet G, Daffron J, Lambert S, Pecson A, Imamura R, Paulos L, Andrews JR, 2010. Core muscle activation during Swiss ball and traditional abdominal exercises. J Orthop Sports Phys Ther, 40(5), 265-276.
13. Faigenbaum AD, Milliken LA, Loud RL, Burak BT, Doherty CL, Westcott WL, 2002. Comparison of 1 and 2 days per week of strength training in children. Research quarterly for exercise and sport, 73(4), 416-24.
14. Faries MD, Greenwood M, 2007. Core Training: Stabilizing the Confusion. Strength & Conditioning Journal, 29(2), 10-25.
15. Fatouros IG, Kambas A, Katrabasas I, Nikolaidis K, Chatzinikolaou A, Leontsini D, Taxildaris K, 2005. Strength training and detraining effects on muscular strength, anaerobic power, and mobility of inactive older men are intensity dependent. British journal of sports medicine, 39(10), 776-80.
16. Granacher U, Lacroix A, Muehlbauer T, Roettger K, Gollhofer A, 2012. Effects of core instability strength training on trunk muscle strength, spinal mobility, dynamic balance and functional mobility in older adults. Gerontology, 59(2), 105-13.
17. Gremeaux V, Drigny J, Nigam A, Juneau M, Guilbeault V, Latour E, Gayda M, 2012. Long-term lifestyle intervention with optimized high-intensity interval training improves body composition, cardiometabolic risk, and exercise parameters in patients with abdominal obesity. American Journal of Physical Medicine & Rehabilitation, 91(11), 941-50.

18. Harbili S, 1999. Kuvvet Antrenmanlarının Vücut Kompozisyonu ve Bazı Hormonlar Üzerine Etkisi. Selçuk Üniversitesi, Sağlık Bilimleri Enstitüsü, Yüksek Lisans Tezi.
19. Hessari FF, Norasteh AA, Daneshmandi H, Ortokand MS, 2011. The effect of 8 weeks core stabilization training program on balance in deaf students. Romanian Sports Medicine Society, Medicana Sportiva, 15, 56-61.
20. Imamura RT, 2006. Electromyographic analysis of traditional and nontraditional abdominal exercises: implications for rehabilitation and training. Physical Therapy, 86(5), 656-71.
21. Joshi P, Bryan C, Howat H, 2012. Relationship of body mass index and fitness levels among schoolchildren. The Journal of Strength & Conditioning Research, 26(4), 1006-14.
22. Kline JB, Krauss JR, Maher SF, Qu X, 2013. Core strength training using a combination of home exercises and a dynamic sling system for the management of low back pain in pre-professional ballet dancers: a case series. Journal of dance medicine & science, 17(1), 24-33.
23. Koç H, 2010. Kombine antrenman programının erkek hentbolcularda aerobik ve anaerobik kapasiteye etkisi. Türkiye Kickboks Federasyonu Spor Bilimleri Dergisi, 3(2), 1309-36.
24. Konin JG, Beil N, Werner G, 2003. Facilitating the serape effect to enhance extremity force production. Athlet Ther Today, 8, 54-6.
25. Marshall PW, Murphy BA, 2005. Core stability exercises on and off a Swiss ball. Archives of physical medicine and rehabilitation, 86(2), 242-9.
26. Miszko TA, Cress ME, Slade JM, Covey CJ, Agrawal SK, Doerr CE, 2003. Effect of strength and power training on physical function in community-dwelling older adults. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 58(2), M171-5.
27. Otto WH, Coburn JW, Brown LE, Spiering BA, 2012. Effects of weightlifting vs. kettlebell training on vertical jump, strength, and body composition. The Journal of Strength & Conditioning Research, 26(5), 1199-202.
28. Özdal M, 2015. Acute effects of aerobic and two different anaerobic exercises on respiratory muscle strength of well-trained men. European Journal of Sport and Exercise Science, 4(4), 7-12.
29. Özdal M, 2016a. Acute effects of inspiratory muscle warm-up on pulmonary function in healthy subjects. Respiratory Physiology & Neurobiology, 227, 23-26.
30. Özdal M, 2016b. Effect of core training on inspiratory muscle strength in well-trained men. Journal of Biology of Exercise, 12(1), 23-32.

31. Özdal M, 2016c. Influence of an eight-week core strength training program on respiratory muscle fatigue following incremental exercise. Isokinetics and Exercise Science, 24(3), 225-230.
32. Özdal M, Bostancı Ö, Dağlıoğlu Ö, Ağaoğlu SA, Kabadayı M, 2016. Effect of respiratory warm-up on anaerobic power. Journal of Physical Therapy Science, 28(7), 2097-2098.
33. Polat Y, Biçer M, Patlar S, Akıl M, Günay M, Çelenk Ç, 2011. Examination on the anthropometric features and somatotypes of the male children at the age of 16. Science & Sports, 26(3), 150-156.
34. Prabhakaran B, Dowling EA, Branch JD, Swain DP, Leutholtz BC, 1999. Effect of 14 weeks of resistance training on lipid profile and body fat percentage in premenopausal women. British journal of sports medicine, 33(3), 190-5.
35. Reed CA, Ford KR, Myer GD, Hewett TE, 2012. The effects of isolated and integrated 'core stability'training on athletic performance measures. Sports medicine, 42(8), 697-706.
36. Sadeghi H, Nik HN, Darchini MA, Mohammadi R, 2013. The effect of six- week plyometric and core stability exercises on performance of male athlete. 11-14 years old. Adv. Environ. Biol. 7, 1195-1201.
37. Sale EG, MacDougall JD, Jacobs I, Garner S, 1990. Interaction between concurrent strength and endurance training. Journal of applied physiology, 68(1), 260-70.
38. Sartorio A, Lafortuna CL, Pogliaghi S, Trecate L, 2002. The impact of gender, body dimension and body composition on hand-grip strength in healthy children. Journal of endocrinological investigation, 25(5), 431-5.
39. Sato K, Mokha M, 2009. Does core strength training influence running kinetics, lower-extremity stability, and 5000-M performance in runners? The Journal of Strength & Conditioning Research, 23(1), 133-140.
40. Sekendiz B, Cug M, Korkusuz F, 2010. Effects of Swiss-ball core strength training on strength, endurance, flexibility, and balance in sedentary women. The Journal of Strength & Conditioning Research, 24(11), 3032-40.
41. Shinkle J, Nesser TW, Demchak TJ, McMannus DM, 2012. Effect of core strength on the measure of power in the extremities. The Journal of Strength & Conditioning Research, 26(2), 373-380.
42. Sillanpää EL, Häkkinen AR, Nyman K, Mattila M, Cheng S, Karavirta L, Laaksonen DE, Huuhka N, Kraemer WJ, Häkkinen KE, 2008. Body composition and fitness during strength and/or endurance training in older men. Medicine and science in sports and exercise, 40(5), 950-8.

43. Slade JM, Miszko TA, Laity JH, Agrawal SK, Cress ME, 2002. Anaerobic power and physical function in strength-trained and non–strength-trained older adults. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 57(3), M168-72.
44. Stanton R, Reaburn PR, Humphries B, 2004. The effect of short-term Swiss ball training on core stability and running economy. The Journal of Strength & Conditioning Research, 18(3), 522-528.
45. Sukalinggam C, Sukalinggam G, Kasim F, Yusof A, 2012. Stability ball training on lower back strength has greater effect in untrained female compared to male. Journal of human kinetics, 33, 33-41.
46. Takanati A, 2012. A correlation among core stability, core strength, core power. 3nd kicking velocity in Division II college soccer athletes. Yüksek Lisans tezi, Graduate Athlethic Training Education, California. Pennsylvania.
47. Tamer K, 2000. Sporda fiziksel fizyolojik performansın ölçülmesi ve değerlendirilmesi. Bağırgan Yayımevi, Ankara.
48. Thomas WN, William LL 2009. The relationship between core strength and performance in Division I female soccer players. Offic. Res. J. Am. Soc. Exerc. Physiol. 12, 21-27.
49. Tsuzuku S, Kajioka T, Endo H, Abbott RD, Curb JD, Yano K, 2007. Favorable effects of non-instrumental resistance training on fat distribution and metabolic profiles in healthy elderly people. European journal of applied physiology, 99(5), 549-55.
50. Yıkılmaz A, Biçer M, Gürkan AC, Özdal M, 2016. The evaluation of physical fitness of the primary and secondary schools students in 8-12 age group related to the performance. Beden Egitimi ve Spor Bilimleri Dergisi, 9(3).
51. Yıldız H, Biçer M, Akcan F, Mendeş B, 2016. Ampute futbolcularda hazırlık dönemi çalışmalarının fiziksel ve fizyolojik parametreler üzerine etkileri. Spor ve Performans Araştırmaları Dergisi, 7(1), 45-52.