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THE EFFECTS OF TEN WEEKS OF CORE TRAINING ON CORE AND MAXIMAL STRENGTH IN MALE WEIGHTLIFTERS

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ABSTRACT

The purpose of this study was to examine the effect of 10 weeks of core training applied together with regular general weight lifting training on selected elements of anthropometric measures (body weight, waist, chest, hip, biceps, thigh, and calf circumference measurements), maximal strength (maximal snatch, maximal clean and jerk, maximal bench press, and maximal squat), and core strength (plank, trunk flexion, trunk extension, lateral flexion). The sample of weight lifters was sampled conveniently and was assigned into two groups: experiemental (n= 10, $\bar{x}_{age}$: 22.1± 1.1 years, $\bar{x}_{height}$: 1.74±.04 cm, $\bar{x}_{weight}$: 74.0±9.3 kg) and control (n= 10, $\bar{x}_{age}$: 22.7±1.1 years, $\bar{x}_{height}$: 1.77±05 cm, $\bar{x}_{weight}$: 73.9±7.6 kg). In this study, which was carried out using a pre-test-post-test quasi-experimental design, the participants were subjected to the basic weightlifting training 3 days a week for 10 weeks. The experimental group, on the other hand, was subjected to the core training program in addition to weightlifting training. Anthropometric measurements, maximal strength, and core strength measurements of the participants were taken twice, before and after the study. Research findings revealed that core training applied in addition to weightlifting training produced a statistically significant decrease in waist circumference and an increase in biceps and calf circumference of the experimental group when compared to the control group. In addition, a significant increase in the clean and jerk strength was revealed in the experimental group's maximal strength measurements compared to the control group. When core strength measurements were examined, it was determined that the endurance of plank, trunk flexion, trunk extension, and lateral flexion were increased in the experimental group. As a result, it can be argued that weightlifting training applied together with core training may have a positive impact on maximal strength and core strength development.

Keywords: Weigthlifting, core training, maximal strength.

INTRODUCTION

The "core region", also called the lumbopelvic-hip complex, anatomically includes the abdominal and oblique muscles in the anterior and lateral parts, the paraspinal and gluteal muscles in the back, the diaphragm above, and the pelvic floor and hip region below (Santana, 2005). In general, all these muscle groups are accepted as the central point where the kinetic chain forces are transferred to the extremity (Turan et al., 2021). For this reason, it is thought that the core region acts as a transition point in extremity activities, stabilization of the center and transmission of force, and constitutes the triggering power and power source in all extremity activities (Akuthota ve Nadler, 2004; Akuthota et al., 2008). In addition, efficient transfer of the force from the leg to the body or from the body to the leg is possible by increasing the strength of the core region muscles working in coordination (Karacaoğlu, 2015).

The core region plays an important role in establishing a connection between the upper and lower parts of the body during movement, transferring energy between these regions, supporting the load reflected on the body, and protecting the spine and nerve conduction (Shirey et al., 2012). In almost all sports activities, power is transferred to the arms and legs through the core region. For example, in an athlete throwing a baseball, the force is first generated in the lower extremity and then the force is transferred to the contralateral external obliques, thereby producing a progressive muscle movement along the arm (Hirashima et al., 2002). When interpreted in terms of sports performance, it can be said that the higher the core strength, the greater the force production in the arms and legs. Athletes who practice movements such as throwing can benefit from this feature. For example, a baseball player with better core strength can hit the baseball faster (Willardson, 2007). It is thought that the core area, which is well trained and developed, contributes to the optimum level of power production, as well as contributes to the transmission of power and movements for functional athletic performance (Asgharifar, 2009).

Core training is the training of the muscles in the core region with the individual's own body weight by keeping the spine stable (Fig, 2005). The purpose of core training is to stimulate the motor system by improving neuromuscular coordination. While doing this, core training includes basic goals such as being effective in terms of activation intensity, reacting to sudden situations as soon as possible and creating coordinated muscle patterns (Hibbs al., 2008; Yue et al., 2007). While it has been reported that a trained core area is important for efficient performance and the prevention of injuries (McGill, 2010), it has been emphasized that core training practices significantly improve balance performance, dynamic postural control (Kachanathu, Tyagi, Anand, 2014; Freeman et al., 2010; Sadeghi, Shariat, Asadmanesh, Mosavat, 2013) and athletic performance (Prieske et al., 2016; Imai et al., 2014; Butcher et al., 2007).

It was emphasized that a trained core area is important for efficient performance and the prevention of injuries, and core training practices significantly improve balance performance, dynamic postural control and athletic performance (Kachanathu, Tyagi, Anand, 2014; Freeman et al., 2010; Sadeghi, Shariat, Asadmanesh, Mosavat, 2013). In the researches, after the core stability training applied, a significant increase was found in breathing and flexibility in healthy individuals (Hodges, Gandevia, 2000; Szczygieł et al., 2018, Sato & Mokha, 2009; Sekendiz, Cuğ, Korkusuz, 2010), and in strength, speed and vertical jump performance in 5000 m runners sporcularda kuvvet, sürat ve dikey sıçrama (Afyon & Boyacı, 2016; Saeterbakken & Fimland, 2011; Sharma et al., 2012; Butcher et al., 2007).

In a study, core training applied to young male football players 2 days a week for 8 weeks showed significant increases in the motoric characteristics, right hand grip, balance, vertical jump distance, flexibility, anaerobic power and back strength performances of football players (Dilber et al., 2016). Similarly, it was revealed that core strength training applied to young elite football players for 9 weeks contributed significantly to a 5% significant increase in the trunk extensor muscles of the football players and to the 10-20 m sprint and shooting performance (Prieske et al., 2016). Similarly, it was revealed that core strength training applied to young elite football players for 9 weeks contributed significantly to a 5% significant increase in the trunk extensor muscles of the football players and to the 10-20 m sprint and shooting performance (Prieske et al., 2016).

When the literature is examined, it has been determined that there are studies that examine the effects of core training in addition to the general training programs applied for many different sports branches, while there are almost no studies in which core training is applied in the weightlifting, which is an Olympic branch (Myer et al., 2006; Sharma et al., 2012; Kachanathu et al., 2014; Samson et al., 2007). Similarly, although there are some studies with long-term observation of strength/power athletes, such studies are very few, especially for weightlifters (Hornsby, 2017).

Among trainers and sports scientists, what features should be emphasized in weightlifting training (de Villarreal et al., 2012) and which is the best practice for weightlifting training is still controversial (González-Badillo et al., 2006). In order to increase the athletic performance of already strong and well-trained athletes, strength training programs with various advanced features should be created (Suchomel et al., 2016). For these reasons, in this study, anthropometric measurements (body weight, waist, chest, hip, biceps, thigh, and calf circumference measurements), maximal strength (maximal snatch, maximal clean and jerk, maximal bench press, and maximal squat), and core strength (plank, trunk flexion, trunk extension, lateral flexion) were investigated.

METHOD

Research Design

This study was carried out using a quasi-experimental design with pretest-posttest comparison group. The pretest-posttest comparison group design is the measurement of the dependent variable before and after the experimental research (Karasar, 1999). In this model, the participants are divided into two groups as the experimental group and the control group. This study was initiated after obtaining written informed consent from the participants in accordance with the Declaration of Helsinki, after obtaining the approval of the Social and Human Sciences Ethics Committee of Van Yüzüncü Yıl University.

Population/Sample

In the study, 20 male athletes doing regular weightlifting training were determined by convenience sampling method, and they were divided into two groups as 10 experimental ($\bar{x}_{age}$: 22.1± 1.1 years, $\bar{x}_{height}$: 1.74±.04 cm, $\bar{x}_{weight}$: 74.0±9.3 kg) and 10 control groups ($\bar{x}_{age}$: 22.7±1.1 years, $\bar{x}_{height}$: 1.77±05 cm, $\bar{x}_{weight}$: 73.9±7.6 kg).

Data Collection

All participants in both the intervention and control group received 10-weeks of weightlifting training (pushing, pulling, squat exercises for lower and upper body) 3 days a week, which included 10 minutes of warm-up, 60 minutes of basic weightlifting and 10 minutes of cool-down applied by the weightlifting trainer. In addition to weightlifting training, core training program and 10 minutes of cool-down after core training were applied to the intervention group. Before starting the training program, the intervention group was taught the During this trial period, the mistakes made by the athletes while performing the movements were corrected and the movements were made as desired. Thus, the athletes were enabled to perform the movements with similar effectiveness.

The 12 different movements (plank, lateral plank, knees up lunch, superman, legs lower, Russian twist, heal thuch, aquaman, sit up, crosscross, jackknife, bicyle crunch) in the core training program used in this research were determined based on Willardson's (2014) book "Developing the Core" and were applied over weeks in order from simple to difficult. During the 10-week training program, the first 3 weeks (1-3) average 60 minutes of weightlifting and 30 minutes of core training, the next 4 weeks (4-7) an average of 60 minutes of weightlifting and 45 minutes of core training, the last three weeks (8-10) weeks an average of 60 minutes of weightlifting, and 60 minutes of core training was carried out. The training program is presented in Table 1.

Table 1. 10-Weeks Supervised Core Training Program Content

Number of movements	Number of weeks	Number of sets	Number of repetitions	Duration/sec	Rest between sets/sec
12	1	1	2	30	45
12	2	1	2	30	45
12	3	1	2	30	45
12	4	1	2	30	45
12	5	1	2	45	60
12	6	1	2	45	60
12	7	1	2	45	60
12	8	1	2	45	60
12	9	2	2	30	45
12	10	2	2	30	45

Anthropometric, maximal strength and core strength measurements of the experimental and control groups were taken before the training programs started and after the completion of the 10-week training programs.

Holtain brand height meter with ±1mm precision was used for height measurement and ± 100 g precision scale was used for body weight measurements. The value obtained as a result of the measurements was recorded in terms of height (cm) and body weight (kg). Circumference measurements were recorded in cm by measuring the waist, chest, hips, biceps, thighs and calves with an inelastic tape measure. All measurements were performed in accordance with the Anthropometric Standardization Reference Manual (ASRM) and International Biological Program (IBP) guidelines (Weiner & Lourie 1969; Tanner et al., 1969).

For maximal strength measurement of the participants, maximal snatch, maximal clean and jerk, maximal bench press, and maximal squat were measured with the 1-RM strength test method, guided by the Exercise Physiology Laboratory Manual (Beam & Adams, 2013). Measurements were carried out by giving the participants appropriate rest intervals during the application. Their best scores were recorded in kg.

The Plank test used in the study was applied with reference to the "Sport-Specific Core Muscle Strength & Stability Plank Test" protocol, the validity and reliability (95%. 0.94-0.99) of which was assured by Tong et al. (2014). In the study, it was applied to determine trunk flexion, trunk extension and lateral flexion, taking into account the trunk flexion, trunk extension and lateral flexion test protocol guidelines applied to measure core endurance (McGill, 2002; Okada et al., 2011). In these tests, the duration that the athlete remained in his position was recorded in seconds with a stopwatch, and after 3 minutes, the test of the athletes who still continued to maintain their position was terminated. Each athlete was given a 15-minute rest interval, 2 measurements were taken and the best score was recorded.

FINDINGS

The results obtained from the study and the statistical analyzes of these results are presented in tables below. As seen in Table 2, when the anthropometric measurement pre-test averages of the experimental and control groups were compared, no significant difference was found in all anthropometric measurements (p>0.05).

Table 2. The Differences between the Experimental and Control Groups in Pre-test Scores of the Anthropometric Measurements

Anthropometric measurements	*Groups*	*N*	*Mean Rank*	*Sum of Ranks*	*U*	*p*
Body weight (kg)	Intervention	10	10.40	104.00	49.000	.940
	Control	10	10.60	106.00		
Waist circumference (cm)	Intervention	10	9.05	90.50	35.000	.271
	Control	10	11.95	119.50		
Hip circumference (cm)	Intervention	10	10.10	101.00	46.000	.761
	Control	10	10.90	109.00		
Biceps circumference (cm)	Intervention	10	12.70	127.00	28.000	.090
	Control	10	8.30	83.00		
Thigh circumference (cm)	Intervention	10	10.20	102.00	47.000	.819
	Control	10	10.80	108.00		
Calf circumference (cm)	Intervention	10	11.25	112.50	42.500	.563
	Control	10	9.75	97.50		

Test: Mann Whitney-U Test

As seen in Table 3, when the post-test anthropometric measurement results of the experimental and control groups were compared, there was a decrease in waist circumference measurements (U=24,000, p=.049) and the increase in biceps (U=15.500, p=.008) and calf circumferences in the experimental group (U=21.500 and p=.029) was statistically significant (p<0.05).

Table 3. The Differences between the Experimental and Control Groups in Post-test Scores of the Anthropometric Measurements

Anthropometric measurements	*Groups*	*N*	*Mean Rank*	*Sum of Ranks*	*U*	*p*
Body weight (kg)	Intervention	10	10.55	105.00	49.500	.970
	Control	10	10.45	104.50		
Waist circumference (cm)	Intervention	10	7.90	79.00	24.000	.049*
	Control	10	13.10	133.00		
Hip circumference (cm)	Intervention	10	9.05	90.50	35.00	.268
	Control	10	11.95	119.50		
Biceps circumference (cm)	Intervention	10	13.95	139.50	15.500	.008*
	Control	10	7.05	70.50		
Thigh circumference (cm)	Intervention	10	11.65	116.50	38.500	.380
	Control	10	9.35	93.50		
Calf circumference (cm)	Intervention	10	13.35	133.50	21.500	.029*
	Kontrol	10	7.65	76.50		

Test: Mann Whitney-U Test

As presented in Table 4, when the maximal strength pre-test averages of the experimental and control groups were compared, no significant difference was found in the measurements for the maximal strength parameters ($p>0.05$).

Table 4. The Differences between the Experimental and Control Groups in Pre-test Scores of the Maximal Strength Measurements

Maximal Strength Measurements	Group	*N*	*Mean Rank*	*Sum of Ranks*	*U*	*p*
Maksimal snatch (kg)	Intervention	10	9.40	94.00	39.000	.396
	Control	10	11.60	116.00		
Maksimal clean and jerk (kg)	Intervention	10	12.15	121.50	33.500	.209
	Control	10	8.85	88.50		
Maksimal squat (kg)	Intervention	10	9.95	99.50	44.500	.671
	Control	10	11.05	110.50		
Maksimal bench press (kg)	Intervention	10	10.25	102.50	47.500	.849
	Control	10	10.75	107.50		

Test: Mann-Whitney U Test

Table 5 presents the findings for the maximal strength post-test comparison of the experimental and control groups after ten weeks of exercise. According to these findings, when the mean scores of the experimental and control groups are compared, only the increase in maximal jerking force measurements ($U=21.500$ and $p=.029$) is statistically significant ($p<0.05$).

Table 5. The Differences between the Experimental and Control Groups in Post-test Scores of the Maximal Strength Measurements

Maximal Strength Measurements	*Group*	*N*	*Mean Rank*	*Sum of Ranks*	*U*	*p*
Maksimal snatch (kg)	Intervention	10	11.45	114.50	40.500	.472
	Control	10	9.55	95.50		
Maksimal clean and jerk (kg)	Intervention	10	14.50	145.00	10.000	.002*
	Control	10	6.50	65.00		
Maksimal squat (kg)	Intervention	10	11.55	115.50	39.500	.427
	Control	10	9.45	94.50		
Maksimal bench press (kg)	Intervention	10	11.70	117.00	38.000	.364
	Control	10	9.30	93.00		

Test: Mann Whitney-U Test

Table 6 presents information on the comparison of the core strength pre-test averages of the experimental and control groups. Accordingly, a significant difference was found only in trunk flexion (U=14.500 and p=.005) measurements (p<0.05).

Table 6. The Differences between the Experimental and Control Groups in Pre-test Scores of the Core Strength Measurements

Core Strength Measurements	*Group*	*N*	*Mean Rank*	*Sum of Ranks*	*U*	*p*
Plank (sn)	Intervention	10	9.40	94.00	39.000	.397
	Control	10	11.60	116.00		
Trunk Flexion (sn)	Intervention	10	14.05	140.50	14.500	.005
	Control	10	6.95	69.50		
Trunk Extention (sn)	Intervention	10	9.65	96.50	41.500	.508
	Control	10	11.35	113.50		
Lateral Flexion (sn)	Intervention	10	12.90	129.00	26.000	.052
	Control	10	8.10	81.00		

Test: Mann-Whitney-U Test

As seen in Table 7, when the core strength post-test averages of the experimental and control groups were compared, in all measurements made plank (U=1000 and p=.000), trunk flexion (U=000 and p=.000), trunk extension Statistically significant differences were found in (U=000 and p=.000) and lateral flexion (U=4,000 and p=.000) measurements (p<0.05).

Table 7. The Differences between the Experimental and Control Groups in Post-test Scores of the Core Strength Measurements

Core Strength Measurements	*Group*	*N*	*Mean Rank*	*Sum of Ranks*	*U*	*p*
Plank (sn)	Intervention	10	15.40	154.00	1.000	.000*
	Control	10	5.60	56.00		
Trunk Flexion (sn)	Intervention	10	15.50	155.00	.000	.000*
	Control	10	5.50	55.00		
Trunk Extention (sn)	Intervention	10	15.50	155.00	.000	.000*
	Control	10	5.55	56.00		
Lateral Flexion (sn)	Intervention	10	15.10	151.00	4.000	.000*
	Control	10	5.90	59.00		

Test: Mann Whitney-U Test

DISCUSSION

In this study, with the aim of investigating the effects of core training combined with the general training of weightlifters, core training performed regularly for 10 weeks in male weightlifters, maximal strength measurements of maximal snatch, maximal jerk, maximal bench press, maximal squat force measurements and core strength measurements of plank, trunk flexion, trunk. The effect on extension and lateral flexion measurement times was investigated.

The findings showed that the applied weightlifting and core trainings resulted in a decrease in waist circumference and an increase in biceps and calf circumference from the anthropometric measurements of the experimental group. Weightlifting and core training showed a significant increase only in jerking strength, one of the maximal strength measurements of the experimental group. When core strength measurements were examined, an increase was observed in the measurement times of plank, trunk flexion, trunk extension, and lateral flexion in the experimental group.

There are national and international studies that support or do not parallel these research findings. In one of the studies revealing the effect of core exercises on body composition, Sever (2016) in his study, which aimed to reveal the effect of static and dynamic core exercises on the speed and agility performance of football players, found that anthropometric measurements (weight, body mass index, waist, hip circumference, waist/hip ratio and body weight) were measured. determined that there was no difference in any variable between the pre-test and post-tests, dynamic and static core exercises applied did not affect the body composition of the football players, but increased the core stabilization test scores. Similarly, Karacaoğlu (2015), in his study with the participation of male volleyball players, did not find a significant difference in the body weight values of volleyball players after core training, and concluded that core training has no effect on body composition. On the other hand, in a study examining the effect of core stability training applied 3 days a week for 8 weeks on the fitness parameters of individuals, Rogers and Gibson (2009) found that core stability trainings caused a decrease 1.2% in body fat percentage, 2.7 cm in waist, 1.7 cm in chest and 0.5 cm in arm circumference, respectively, in the experimental group. Similarly, Kaya (2019) reported that there was a significant decrease in waist and hip circumferences of all athletes in the pre-test post-test results of 12-week combined land training for elite swimmers aged 8-12. These findings in the literature do not coincide with the results in which the circumference measurements change depending on the core exercises obtained in this study. The change in anthropometric parameters caused by resistance exercises is bidirectional in terms of some variables (weight, circumference measurements, BMI) due to increased muscle growth and energy expenditure. In this respect, the change in body weight and body fat percentage and the change in waist circumference are evaluated together, helping to gain an idea about the rate of reduction in muscle formation and fat mass (Hibbs, 2008). Based on these information, it is thought that the decrease in waist circumference from anthropometric measurements, the increase in biceps and calf circumference measurements without any change in body weight in the experimental group in which weightlifting and core exercises were applied together in this study, created a sufficient anabolic effect due to the high motor unit stimulation and occurred due to hypertrophy. Looking at the pre-test-post-test values of the control group, the reason for the significant increase in the biceps circumference only suggests that the fact that this group only did weightlifting exercises was insufficient to create a change in body composition.

It has been stated in many studies that core training increases sportive performance by contributing to strength development. In one of these studies, Nesser et al. (2008) examined the relationship between core stability, strength and power measures of 1st league American football players and revealed that there was a significant relationship between these three variables. In addition, 8-week core strength training was applied to male handball players by Balaji and Murugavel (2013), and at the end of the study, it was observed that there were significant improvements in the subjects' leg explosive power and upper body strength. Similarly, in a study, it was reported that core training applied for 12 weeks in athletes in various branches significantly improved the muscle strength and muscular endurance of the athletes (Yang Dae-seung, 2014). Considering the national and international studies examining the effects of core training applied in addition to the general training program in athletes, Sekendiz et al. (2010), Afyon and Boyacı (2016) and many researchers (Samson, 2005; Thomas and William, 2009; Jim et al., 2012; Afyon, 2014) for optimal sportive performance, the application of core training in addition to general training in terms of strength and endurance highlighted the positive developments. This finding also coincides with the significant improvement in the jerk force, which is one of the maximal force measurements of this study.

In the literature, it is mentioned that trunk endurance capacity has a protective effect in terms of passive structures in the spine and that the spine is related to the elements of endurance and control rather than stabilization, strength (Evans et al., 2007). It is stated that while strong abdominals do not provide the expected protection against injury, durable muscles can reduce the risk of low back pain (Grenier and McGill, 2007). For this reason, it is thought that central region-based movement approaches to improve trunk endurance are important in training planning, especially in the weightlifting branch, where maximum force transfer from the lower extremity to the upper extremity is carried out quickly with high weights. From this point of view, when we look at the findings in this study, a statistically significant increase was observed in the mean of pre-test-post-test measurements in plank, trunk flexion, trunk extension and lateral flexion measurement times in core strength measurements of the experimental group after ten weeks of weightlifting and core training together. On the other hand, a statistically significant increase was obtained only in plank times after the weightlifting training program applied alone. Similar to the findings of this study, Sandrey and Mitzel (2013) applied a core stabilization program 3 days a week for 6 weeks in their study with the participation of track and field athletes, and after the program, the athletes' trunk flexor, extensor, right-left plank endurance times were improved between 120% and 250%. They also found that the training program had a high level of effect in terms of time-dependent change. Schiling et al. (2013) investigated the effects of isometric and dynamic core strength training programs on trunk endurance, strength and sportive performance, and reported that they saw significant improvement in the extensor endurance test of the dynamic group and the right plank test of the isometric group at the end of 6 weeks. Contrary to the research findings obtained in this study, Michael et al. (2005) applied a core training program 2 days a week in addition to rowing training for 8 weeks in middle-aged male rowers, and as a result of the study, it was revealed that there was no improvement in back isometric and flexor endurance measurements in the experimental group. Literature samples generally report that core training programs applied in addition to the branch-specific general training program lead to an increase in time and effect on trunk endurance test scores (Lust et al., 2009; Dendas, 2010; Saeterbakken et al., 2011; Brillave 2014). In line with this information, it can be stated that core training has a positive effect on body endurance.

CONCLUSION and RECOMMENDATIONS

Weightlifting and core training applied for 10 weeks within the scope of the study caused an increase in maximal strength measurements, maximal jerking force, and core strength measurements in plank, trunk flexion, trunk extension, and lateral flexion times in the experimental group. In line with the results, it is recommended to apply core training together in addition to weightlifting training. Based on the literature that core training can train small and large muscle groups at the same time and at a similar level, it is thought that core training alone will not be enough for especially large muscle groups to produce a high level of strength and power performance. Therefore, it is suggested that weight training applied together with core exercises may have a positive effect on the development of core strength. In addition, it is recommended that core training should be included in the general training programs of all branches. In the studies to be applied later, it is thought that performing core training on moving and still surfaces or using auxiliary materials (resistance bands, swiss balls, boşu ball) can increase the efficiency of core training.

ETHICAL TEXT

In this article, the journal writing rules, publication principles, research and publication ethics, and journal ethical rules were followed. The responsibility belongs to the author(s) for any violations that may arise regarding the article.

The ethical approval for this study was obtained from Van Yüzüncü Yıl University, 19.09.2018/69398.

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