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Core Power, Court Power: How Core Training Tennis Enhances Tennis Performance

Core Gücü, Saha Gücü: Core Antrenmanı Tenis'in Performansını Nasıl Artırır?

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CORE POWER, COURT POWER: HOW CORE TRAINING TENNIS ENHANCES TENNIS PERFORMANCE

ABSTRACT

Tennis is a multidimensional sport requiring a combination of technical, tactical, and physical capacities, where core stability plays a pivotal role in performance and injury prevention. The aim of this study was to examine the effects of a six-week structured core training program on balance, agility, and anaerobic performance parameters in male university-level tennis players. A total of 30 male students aged 18–23 years from Sivas Cumhuriyet University voluntarily participated in the study. Participants were randomly divided into two groups: an experimental group (n=15) and a control group (n=15). All participants underwent pre- and post-test assessments including flamingo balance test, vertical jump test, pro-agility test, and a core strength test (crunch test). The experimental group received core training sessions three times per week in addition to their regular tennis training, while the control group only followed the standard tennis training program. The intervention period lasted for six weeks. Statistical analysis was performed using paired sample t-tests for within-group comparisons and independent sample t-tests for between-group comparisons. The results indicated that the experimental group showed statistically significant improvements in balance ($p<0.05$), vertical jump height ($p<0.01$), agility ($p<0.01$), and core strength ($p<0.001$) after the intervention. The control group showed minor but significant improvements in agility and vertical jump ($p<0.05$), possibly due to the general benefits of consistent tennis training. No significant changes were observed in body weight or height in either group. In conclusion, the findings suggest that integrating core training into the routine conditioning programs of tennis players may significantly enhance physical performance, particularly in terms of balance, agility, and anaerobic capacity. Trainers and coaches are therefore encouraged to incorporate structured core-focused exercises into annual training plans to optimize athlete development and long-term performance gains.

Keywords: Core Training, Tennis, Agility, Balance, Physical Performance.

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CORE GÜCÜ, SAHA GÜCÜ: CORE ANTRENMANI TENİS'İN PERFORMANSINI NASIL ARTIRIR?

ÖZ

Tenis, teknik, taktik ve fiziksel kapasitelerin bir arada kullanılmasını gerektiren çok boyutlu bir spordur ve core stabilitesi performans ve sakatlıkların önlenmesinde önemli bir rol oynamaktadır. Bu çalışmanın amacı, altı haftalık yapılandırılmış bir core antrenman programının üniversite düzeyindeki erkek tenisçilerde denge, çeviklik ve anaerobik performans parametreleri üzerindeki etkilerini incelemektir. Çalışmaya Sivas Cumhuriyet Üniversitesi›nden 18-23 yaş arası toplam 30 erkek öğrenci gönüllü olarak katılmıştır. Katılımcılar rastgele iki gruba ayrılmıştır: deney grubu (n=15) ve kontrol grubu (n=15). Tüm katılımcılara flamingo denge testi, dikey sıçrama testi, pro-agility testi ve core kuvvet testini (crunch testi) içeren ön ve son test değerlendirmeleri yapılmıştır. Deney grubu düzenli tenis antrenmanlarına ek olarak haftada üç kez core antrenman seansları alırken, kontrol grubu sadece standart tenis antrenman programını takip etmiştir. Müdahale dönemi altı hafta sürmüştür. İstatistiksel analiz, grup içi karşılaştırmalar için eşleştirilmiş örneklem t-testleri ve gruplar arası karşılaştırmalar için bağımsız örneklem t-testleri kullanılarak gerçekleştirilmiştir. Sonuçlar, deney grubunun müdahaleden sonra denge ($p<0.05$), dikey sıçrama yüksekliği ($p<0.01$), çeviklik ($p<0.01$) ve çekirdek kuvvetinde ($p<0.001$) istatistiksel olarak anlamlı gelişmeler gösterdiğini ortaya koymuştur. Kontrol grubu, muhtemelen tutarlı tenis eğitiminin genel faydalarından dolayı çeviklik ve dikey sıçramada küçük ama önemli gelişmeler göstermiştir ($p<0.05$). Her iki grupta da vücut ağırlığı veya boy uzunluğunda önemli bir değişiklik gözlenmemiştir. Sonuç olarak, bulgular tenis oyuncularının rutin kondisyon programlarına core antrenmanının entegre edilmesinin özellikle denge, çeviklik ve anaerobik kapasite açısından fiziksel performansı önemli ölçüde artırabileceğini göstermektedir. Bu nedenle antrenörler ve koçlar, sporcu gelişimini ve uzun vadeli performans kazanımlarını optimize etmek için yapılandırılmış core odaklı egzersizleri yıllık antrenman planlarına dahil etmeye teşvik edilmektedir.

Anahtar Kelimeler: Core Antrenmanı, Tenis, Çeviklik, Denge, Fiziksel Performans.

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INTRODUCTION

Tennis is an entertaining sport that is popular around the world and played by nearly 75 million people (Chen et al., 2023). In addition, it is also an enjoyable sport to watch and one of the competitive sport branches attracting many followers

(Fernandez et al., 2013). Since there is no time limitation in tennis, the matches can last over 5 hours (Kilit and Arslan, 2017). Tennis is a sport that combines anaerobic and aerobic capacity, speed, agility, balance, and strength (Bashir et al., 2019). Athletes with high aerobic and anaerobic capacity are able to sustain their technical and tactical abilities over prolonged matches, recover faster, and be more prepared for subsequent sets or matches (Sandford et al., 2021).

Alongside its entertaining nature, tennis involves high-intensity actions with rapid and sudden directional changes, which increase the risk of lower and upper extremity injuries (da Silva et al., 2025). One of the key preventive strategies for reducing such injuries and enhancing recovery is strengthening the core muscles through systematic core training. Core muscles serve as a bridge between the lower and upper extremities (Ceylan et al., 2022; Karababa and Kilinc-Boz, 2023; Pancar, 2023), enabling efficient force transfer and overall coordination. These exercises also contribute to the improvement of athletes' balance and stability (Yüksel et al., 2016; Soyler and Cingoz, 2023). Furthermore, research shows that injury risk has not only physical but also cognitive and emotional consequences (Özkan et al., 2025). Research has demonstrated that inadequate physical preparation and insufficient muscular stability increase athletes' vulnerability to both physiological and psychological stressors, highlighting the importance of structured conditioning practices across sports disciplines (Çağlar et al., 2025).

Core training enhances trunk strength and neuromuscular control, leading to improved performance outcomes in many sports (Hsu et al., 2018). Moreover, a well-developed core structure provides essential spinal support, contributing to injury prevention and optimal posture during prolonged activity (Bozlak, 2019). Long-duration exertion can impair balance and motor output, and core stability plays a protective and performance-enhancing role in such contexts (Berger et al., 2024). Core training, often based on bodyweight exercises, aims to strengthen abdominal and spinal muscles and is widely used to improve flexibility, stability, and anatomical function across various sports (Akuthota et al., 2008; Sun et al., 2016).

Studies in the literature have reported that core training improves psychomotor skills, muscular strength, respiratory endurance, and athletic performance (He et al., 2019; Luo et al., 2022; Luo et al., 2023). A strong core has been shown to enhance stroke response time and power in racket sports such as tennis (Bompa et al., 2014; Huang et al., 2023). Core-based interventions have been positively associated with improvements in physical fitness, serve accuracy, and general performance in tennis players (Gür and Ersöz, 2017; Sever et al., 2017; Abdioglu et al., 2025).

The aim of this study is to examine the effects of a six-week core training program on selected performance parameters (balance, agility, vertical jump) in male university-level tennis players. It is hypothesized that the tennis players who perform core training in addition to their regular tennis sessions will show greater improvements in balance, agility, and anaerobic power compared to players who only participate in standard tennis training.

METHOD

Research Model

This study was designed as a quasi-experimental study with a pre-test-post-test control group. Before the study was conducted, participants were given detailed information about the content and implementation of the basic training programme during the initial information session. The study was conducted on hard courts at the indoor tennis courts of the Faculty of Sports Sciences at Sivas Cumhuriyet University under the supervision of an expert trainer. A total of 30 male tennis players volunteered to participate in the study. Participants were randomly assigned to two groups: the experimental group (n = 15) and the control group (n = 15). The study was conducted over a six-week period. During the intervention, the experimental group participated in a core strengthening training programme in addition to regular tennis training three times a week. In contrast, the control group continued with the specified tennis training only and did not perform any core-specific exercises. Pre-test measurements were taken from all participants on 3 April 2023, and post-test measurements were conducted under the supervision of a specialist coach on 16 May 2023, at the end of the six-week training period. Each abdominal muscle training session was conducted three times a week, each session lasted approximately 30 minutes, and was designed to gradually increase abdominal muscle strength and balance.

Study Group

The study included 30 male students enrolled at the Faculty of Sports Sciences, Sivas Cumhuriyet University, aged 20.93 ± 2.28 (experimental group) and 20.00 ± 1.77 (control group). The groups were randomly divided into two groups. Individuals with any known medical conditions were excluded from the sample. Prior to data collection, participants were informed about the purpose and procedures of the study, and those who voluntarily agreed to participate signed a written informed consent form. The study protocol was designed and implemented in accordance with the ethical principles outlined in the Helsinki Declaration (World Medical Association, 2013).

Warming Protocol

Prior to the administration of the physical measurement tests, athletes were adjusted to a standardized relative intensity of 65% maximum heart rate at the cardiovascular stage for the warm-up protocol. For the protocol-specific activity prior to the tests, it consisted of two 40 m sprints and one maximum 40 m sprint at 50% and 75% of the participants' perceived maximum effort, respectively (Taylor et al., 2013; Ceylan et al., 2024).

Data Collection Tools

Data were collected using five field-based physical performance tests with established validity and reliability in athletic populations:

1. **Abdominal Curl-Up Test:** Participants lay in a supine position with knees flexed at 90°, feet flat on the floor, and hands placed behind the head. Within 30 seconds, they were instructed to perform as many trunk flexions as possible, touching their elbows to their knees without lifting the lower back off the floor. Only repetitions performed with correct form were counted (Mackenzie, 2005).

2. **Flamingo Balance Test:** The test was conducted on a standardized balance beam (50 cm in length and 4 cm in width). Participants stood on their dominant leg, while the other leg was flexed and held at the hip level. Balance was assessed over a 60-second period; the total number of falls or corrections was recorded. A lower number of errors indicated better balance (Jakobsen et al., 2011).

3. **Vertical Jump Test:** Participants started from an upright stance with feet shoulder-width apart and performed a rapid countermovement jump, ensuring a 90° knee flexion during the preparation phase. The best result from two valid attempts was recorded using a digital jump mat (Wehbe et al., 2015). Trials in which the knees were excessively flexed or arms were swung were disqualified.

4. **Standing Long Jump Test:** Participants performed a maximal forward jump from a standing position with both feet aligned. The test was repeated three times, and the best distance (in centimeters) was recorded using a marked measuring tape (Bostancı et al., 2019).

5. **Pro-Agility Shuttle Test (5-10-5 drill):** Three cones were placed in a straight line with 4.57 meters (5 yards) between each. Athletes sprinted from the center cone to the right, then to the far left cone, and finally back to the center. The fastest time out of three trials was recorded with a digital stopwatch (Bayraktar, 2013).

Training Schedule:

The experimental group underwent a six-week core training program, conducted three times per week in addition to their regular tennis training. Each session consisted of 10 distinct core-focused exercises (e.g., front plank, side plank, Russian twist, bridge, bird-dog, dead bug), performed in 2 sets of 8 repetitions per exercise. Participants rested 5 seconds between repetitions, and a full recovery period was given between sets. The control group continued with their regular tennis sessions and did not participate in any additional training. All training sessions were supervised by certified fitness instructors to ensure proper technique and adherence to the protocol.

Table 1. Core exercise protocol: targeted muscles, descriptions, and application details (Willardson, 2018)

Exercise	Target Muscles	Description	Sets x Reps	Equipment
Crunch	Rectus abdominis	Lying supine with knees bent, hands beside head; upper shoulders lifted off floor.	2 x 8	None
Reverse Crunch	Lower rectus abdominis, hip flexors	Supine position with knees and hips flexed; hips slightly lifted.	2 x 8	None
Bird Dog	Erector spinae, gluteus maximus, deltoid	On hands and knees; opposite arm and leg extended parallel to floor.	2 x 8	None
Prone Plank	Transversus abdominis, rectus abdominis	Body lifted off floor by forearms and toes in a straight line.	2 x 30 sec	None
Superman	Erector spinae, gluteus maximus, deltoids	Lying face down; arms and legs lifted simultaneously.	2 x 10	None
Leg Lower	Rectus abdominis, hip flexors	Supine position; legs raised to 45°, then lowered slowly.	2 x 10	None
Sit-Up	Rectus abdominis, obliques	Cross arms over chest; lift torso to seated position and return.	2 x 8	None
Slide Board Mountain Climber	Rectus abdominis, hip flexors, shoulders	Push-up position on slide board; alternate knee drives with hold.	2 x 8 (each leg)	Slide board
Jackknife	Obliques, rectus abdominis	Supine; opposite leg and arm lifted with rotation and contraction.	2 x 8	None
Plate V-Up	Rectus abdominis, hip flexors	Supine holding weight; V-shape formed by simultaneous leg and torso raise.	2 x 8	Plate or medicine ball

Data Analysis

The data collected in the study were analyzed using IBM SPSS Statistics (version 24) software. Descriptive statistics (mean ± standard deviation) were used to summarize the demographic characteristics and physical performance parameters of the participants. To examine the normality of the data distributions, Shapiro–Wilk test was applied. As the data were found to be normally distributed, parametric tests were used for further analyses. For the comparison of pre-test and post-test results within the same group, paired samples t-tests were conducted. The magnitude of the effects was interpreted using Cohen's d, where values of 0.2, 0.5, and 0.8 were considered as small, medium, and large effects, respectively (Cohen, 1988; Field, 2013; Tabachnick and Fidell, 2013; Lakens, 2013; Yagin ve ark., 2024). The level of statistical significance was set at $p < 0.05$ for all analyses. Additionally, effect size interpretations were provided alongside p-values to offer a more comprehensive understanding of the practical impact of the intervention.

RESULTS

Table 2. The Comparison of the physical characteristics of the tennis players

Variables	Groups	n	Mean	Standard Deviation (Sd)
Age (years)	Experimental	15	20.93	2.28
	Control	15	20.00	1.77
Height (cm)	Experimental	15	173.86	9.28
	Control	15	170.40	10.97
Body Weight (kg)	Experimental	15	67.07	9.98
	Control	15	61.13	9.97

Table 2 shows that the average age of the tennis players was 20.93±2.28 in the experimental group and 20.00±1.77 in the control group, the average height was 173.86±9.28 in the experimental group and 170.40±10.97 in the control group, and the average body weight was 67.07±9.98 in the experimental group and 61.13±9.97 in the control group.

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Table 3. Within-group comparisons of physical performance parameters

Variable		Experimental (n:15)				Control (n:15)			
		X ± Sd	t	p	Cohen's d	X ± Sd	t	p	Cohen's d
Crunch (number)	Pre-test	15.07±3.19	-4.620	**0.001**	1.193	15.53±3.68	-4.620	**0.001**	**1.193**
	Post-test	18.40±4.38				16.40±3.20			
Balance (number)	Pre-test	4.93±2.89	2.591	**0.021**	0.669	2.13±0.35	-1.852	0.085	0.478
	Post-test	3.00±1.73				4.07±4.16			
Vertical jump (cm)	Pre-test	41.53±8.89	-3.780	**0.002**	0.976	44.00±9.05	-3.780	**0.002**	**0.976**
	Post-test	44.87±7.68				45.47 ±9.10			
Standing long jump (cm)	Pre-test	2.24±0.29	-1.589	0.134	-0.410	2.19±.0.23	-0.824	0.424	0.213
	Post-test	2.29±0.29				28.15±68.39			
Agility test (sec)	Pre-test	6.37±0.41	3.879	**0.002**	1.002	6.98±0.59	4.003	**0.001**	**1.034**
	Post-test	6.20±0.35				6.64±0.61			

When Table 3 was examined, significant differences were found in the values for crunch (p = 0.001, d = 1.19), balance (p = 0.021, d = 0.67), vertical jump (p = 0.002, d = 0.98) and agility (p = 0.002, d = 1.00) of the tennis players in the experimental group, but the values for the standing long jump showed no significant difference (p = 0.134, d = 0.41). While in the control group there was a significant difference in the values for crunch (p = 0.001, d = 1.19), vertical jump (p = 0.002, d = 0.98) and agility (p = 0.001, d = 1.03), no significant differences were found in the values for balance (p = 0.085, d = 0.48) and standing long jump (p = 0.424, d = 0.21).

Table 4. Between-group comparisons of physical performance parameters in Pre-Test and Post-Test

Variable		Pre-test (n:15)				Post-test (n:15)			
		X ± Sd	t	p	Cohen's d	X ± Sd	t	p	Cohen's d
Crunch (number)	Experimental	15.07±3.19	-0.371	0.714	0.135	18.40±4.38	1.426	0.165	0.521
	Control	15.53±3.68				16.40±3.20			
Balance (number)	Experimental	4.93±2.89	3.725	**0.002**	1.36	3.00±1.73	-0.916	0.371	0.334
	Control	2.13±0.35				4.07±4.16			
Vertical jump (cm)	Experimental	41.53±8.89	-0.753	0.458	0.275	44.87±7.68	-0.195	0.847	0.071
	Control	44.00±9.05				45.47 ±9.10			
Standing long jump (cm)	Experimental	2.24±0.29	0.559	0.581	0.204	2.29±0.29	0.622	0.539	0.227
	Control	2.19±.0.23				2.23±0.26			
Agility test (sec)	Experimental	6.37±0.41	3.296	**0.003**	1.204	6.20±0.35	-2.370	**0.025**	0.865
	Control	6.98±0.59				6.64±0.61			

When table 4 was examined, a significant difference was observed in the pre-test measurements of balance (p = 0.002, d = 1.36) and agility (p = 0.003, d = 1.20) between the experimental and control groups, while no significant differences were found in crunch (p = 0.714, d = 0.14), vertical jump (p = 0.458, d = 0.28), and standing long jump (p = 0.581, d = 0.20) values. ın the post-test comparisons, a statistically significant difference was observed only in agility performance (p = 0.025, d = 0.87), whereas no significant differences were found in crunch (p = 0.165, d = 0.52), balance (p = 0.371, d = 0.33), vertical jump (p = 0.847, d = 0.07), and standing long jump (p = 0.539, d = 0.23) values.

DISCUSSION AND CONCLUSION

This study demonstrated that a structured 6 week core training program, when integrated with regular tennis practice, led to significant improvements in neuromuscular control, abdominal endurance, and agility among young male tennis players. Notably, the experimental group exhibited large effect sizes in crunch (d

= 1.19), vertical jump (d = 0.98), and agility (d = 1.00) performance, underscoring the transferability of core strength to explosive and sport-specific movements (Table 3-4). These findings align with the growing body of evidence suggesting that core stability serves as a biomechanical foundation for dynamic athletic tasks, particularly in sports like tennis that demand multidirectional speed, postural control, and repeated power output. When the literature is examined Savaş and Uğraş stated that a significant difference was found in vertical jump figures in the research they conducted (Savaş and Uğraş, 2004). Furthermore, in another study, core training was performed for 25-30 minutes three days a week in a time span of 10 weeks. After the study, a significant difference was revealed in the vertical jump values of the football players (Boyacı and Bıyıklı, 2018). Göktepe et al. stated that although there was an increase in the vertical jump values after 2 days a week core training for 8 weeks, this increase was not significant (Göktepe et al., 2019). Core training can cause an increase in muscle strength and vertical jump values due to strengthening the body and lower extremity muscle groups. We believe that the significant difference revealed in vertical jump values in our study was because of the core training the experimental group performed and the participation of the control group actively in other sport branches along with tennis.

In the data obtained, a significant difference was observed in the balance values of tennis players (Table 3). The improvement of balance ability is necessary for succeeding in sports. The decrease of balance performance can also reduce the performance of athletes by increasing the risk of injury (Ateş et al. 2017). The improvement of balance performance also contributes in other performances (Okudur and Sanioğlu, 2012). No statistically significant difference was revealed in the pretest and posttest results after 12 weeks of core training performed by female badminton athletes (Eriş, 2018). Lengkana et al. declared that the core training performed by the students in the age group of 10-11 resulted in a significant difference in their static balance (Lengkana and Tangkudung, 2019). A 12 week core training performed by tennis players showed no significant difference in their balance performance (Gür and Ersöz, 2017). We can claim that the training we applied had a positive contribution to the balance performances of the athletes. Our study is observed to have similarities to and differences from the other studies conducted in this field.

In our study, a significant difference was observed in crunch values in favor of both groups (Table 3). The areas core area affects in our body are listed as abdominal muscles, paraspinal muscles, gluteal muscles, oblique muscles, pelvic hip muscles and the diaphragm muscle (Shinkle et al., 2012). Study results parallel to our study can be observed in other studies conducted in this field. In their study on tennis players, Arı and Çolakoğlu stated that the group that performed core training had a significant increase in their crunch figures (Arı and Çolakoğlu, 2021). Similarly, it was expressed that core training performed with the help of swissball resulted in a significant increase in the strength and the activation rate of m. rectus abdominis and m. obliques internus/externus muscles (Escamilla et al., 2010). Cosio-Lima et al. reported increases in the abdominal muscle stability and strength levels of athletes after core training (Cosio et al., 2003). It is explained that core training results in a strength increase in m. rectus abdominis muscle and corresponding to this, it caused an increase in crunch values by transferring the strength to upper extremities with the help of its own connective tissue (Akuthota and Nadler, 2004). We can state that the reason of that our study showed significant difference is that core training specifically strengthens the abdominal muscles and increase their stability.

A significant difference was observed in agility values after the core trainings performed by the tennis players (Table 3). Tennis is a branch of sport that has sudden and quick direction changes and requires being active during the game. Core training can especially contribute to strengthening lower extremities and increasing explosive strength. The reason of the significant difference in the agility values of both experimental and control groups might be that both groups actively participated in tennis and other sports branches alongside it. In their study on core training, Shaikh et al. stated a significant difference in the agility figures of individuals participating in the study (Shaikh et al., 2019). In a study performed on basketball players, core training was revealed to increase muscular endurance and thus, improve the agility performance (Aksen et al., 2019). Similarly, in another study, a 6 week core training performed by adolescent basketball players resulted in a positive contribution to the agility values of the athletes and decreased agility time (Kafa et al., 2020). Our study is observed to be similar to the studies conducted in this field.

Consequently, it can be observed that the core training applied in our study contributed to the tennis players' scores for balance, crunch, vertical jump and agility. In particular, the use of core exercises as part of the defined program ensures the strengthening of the lower and upper extremities. Core training not only helps to strengthen, but also allows athletes to train longer and prevent injuries. The fact that coaches and athletes are incorporating core training into their annual plans for sports that require strong lower and upper extremities will enhance athletes' performance and help maintain existing performance. We believe that increasing the weekly training time and the number of repetitions of core exercises will help to increase performance levels.

Limitations of the Study

Although this study provides valuable insights into the effects of core training on tennis-specific performance metrics, several limitations must be acknowledged. First, the relatively small sample size (n = 30) and the fact that only male college athletes were included may limit the generalizability of the results to broader populations such as female athletes or other age groups. Secondly, the duration of the intervention was limited to six weeks; although significant improvements were observed, longer-term effects and sustainability of performance could not be assessed. Third, although participants were asked to maintain a consistent level of activity outside of the intervention, their participation in other physical activities (e.g., recreational sports, gym) could not be strictly controlled, potentially introducing confounding variables. Finally, psychological factors such as motivation, fatigue or perceived exertion were not measured, which may have influenced the performance results during the tests.

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Conflict of Interest

There is no conflict in the this study.

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