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The Effect of Core Training on Agility, Strength Performance and Tennis Skills on 10-14 Year Old Tennis Players

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ORIJINAL ARTICLE

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Öz

This study aims to determine the effect of 8-week core training on agility, strength performance and tennis skills in tennis players aged 10-14. 25 tennis players studying tennis at EA Tennis Academy participated in the study voluntarily. First of all, vertical jump, pro-agility agility and ITN Tennis skill tests were applied to all participants, then, in addition to tennis training, the experimental group of 11 people was given core training 3 times a week for 8 weeks in a row in line with the literature. The tennis players in the control group continued only their tennis trainings. In order to examine the effect of core training on strength, agility and tennis skills, the tests applied in the pre-tests were applied to all participants again at the end of 8 weeks as post-test. According to the results, a statistically significant improvement was observed in the ITN numbers, ITN scores, agility of the tennis players in the experimental group. Also, within limited aspects, a statistically significant difference was found in ITN numbers, ITN scores in the control group. On the other hand, there was no statistically significant difference in vertical jump and counter movement jump test scores in both groups. As a result, it has been concluded that core training has positive contributions to agility and tennis performance in tennis players aged 10-14. It is thought that core training to be applied in addition to tennis training in training programs will contribute to the development of athletes.

Keywords: Training, Core, Tennis, ITN

10-14 Yaş Tenisçilerde Core Antrenmanlarının Çeviklik, Kuvvet Performansına ve Tenis Becerilerine Etkisi

Bu çalışma 10-14 yaş tenisçilerde 8 haftalık core antrenmanlarının kuvvet ve çeviklik performansları ile tenis becerilerine etkisini belirlemeyi amaçlamaktadır. Çalışmaya EA Tenis Akademisi'nde tenis eğitimi gören 25 tenisçi gönüllü olarak katılmıştır. Tüm katılımcılara öncelikle sıçrama testleri, pro-agility çeviklik ile ITN Tenis beceri testi uygulanmış, ardından 11 kişilik deney grubuna tenis antrenmanlarına ek olarak 8 hafta süresince haftada 3 kez core antrenmanları yaptırılmıştır. Kontrol gurubunu oluşturan tenisçiler yalnızca tenis antrenmanlarına devam etmişlerdir. Core antrenmanlarının kuvvet ve çeviklik performansı ile tenis becerilerine etkisinin incelenmesi için 8 hafta sonunda ön testlerde uygulanan testler tekrar tüm katılımcılara uygulanmıştır. İstatistiksel analiz sonuçlarına göre core antrenmanlarının deney grubundaki tenisçilerin ITN numaraları, ITN puanları ve çeviklik performansında istatistiksel olarak anlamlı bir ilerleme görülmüştür. Ayrıca kontrol grubunda ITN numaraları, ITN puanlarında istatistiksel olarak anlamlı bir farka rastlanmıştır. Buna karşılık dikey sıçrama ve yaylanarak sıçrama test skorlarında her iki grupta da istatistiksel olarak anlamlı farka rastlanmamıştır. Sonuç olarak core antrenmanlarının 10-14 yaş tenisçilerde çeviklik ve tenis performansına olumlu yönde katkılarının olduğu sonucuna ulaşılmıştır. Antrenman programlarında tenis antrenmanlarına ek olarak uygulanacak core antrenmanlarının sporcuların gelişimine katkı sağlayacağı düşünülmektedir.

Anahtar kelimeler: Antrenman, Core, Tenis, ITN

Introduction

Tennis is a sports branch in which rapid changes of direction, quick arm and racket movements, jumps and moves are frequently used (Gullikson, 2003). Tennis achievement involves a combination of velocity, static and dynamic balance, strength, reaction time and coordination together with several physical, technical/tactical and psychological factors as well as the abilities of agility, speed and force (Egesoy et al., 2021). Muscle strength plays an important role in successfully spreading tennis performance into the competition (Demirci et al., 2019).In addition to stabilizing the spine and the body during lower and upper extremity movements like jumping, running and throwing (Özmen and Aydoğmuş, 2016), core muscles are an important component in maximizing balance and athletic performance in the movements of the lower extremity (Kibler, 2006). In such branches as tennis, which typically involve direction changes, accelerations, turns, jumps and the sequencing of the kinetic chain frequently changes, the importance of the core area increases. In a branch that includes often changes of direction, mobility and imbalance, core strength is considerably important in terms of being the starting point of strength and balance (Egesoy et al., 2021). Allowing for strength transfer from the lower body to the upper body spending the least amount of energy, a strong core area serves as a critical component in the sum of the forces generated from the ground at the beginning and transferred to the racket and ball from the other parts of the body (Roetert and Kovasc, 2011). In modern tennis, particularly rotational motion has become more common and tennis players must see the training in three dimensions in order to develop a balanced program. For the core, tennis specific exercise should focus on stability, balance, stance, performance improvement and injury prevention. The body and the core are involved in each tennis stroke; therefore, they must be exercised in a programmed way (Roetert and Kovasc, 2011).

Long-term core training programs in child and young athletes should not focus solely on arms and legs, but they must also include the abdominal, back and spinal muscles. In short, in training programs for young athletes, especially before and during adolescence, exercises should start from the core area of the body and performed towards the extremities. In other words, before strengthening legs and arms, the focus should be placed on core muscle groups concentrating on developing the connection among them (Bompa and Carrera, 2015). Core training for young tennis players can improve the shoulder external/internal rotation range of motion as well as increasing tennis performance (serve speed) and decreasing the risk of a possible overuse injury (Fernanadez-Fernanadez et al., 2013). Sever et al. (2017) found that core training practices positively affected accurate serve speed in young tennis players. The literature includes many studies on the effects of core training on performance components. Manchado et al. (2017) found that the core training program they applied to handball players for 10 weeks improved their throwing speeds; Watson and

colleagues observed increases in the pivot turn ability, static and dynamic balance and muscle performance test scores of dancers as a result of a 9-week core stabilization program. While Afyon et al. (2017) report that core training improves velocity and agility performance in footballers, Sever and Zorba (2016) and Prieske et al. (2016) state that core training has no effect on agility skills as a result of their studies conducted with footballers.

While studies on core strength and performance are more diverse in other fields, those carried out on core training among adolescent tennis players are scarce. As mentioned above, agility and strength have an important place in the physical and physiological requirements of tennis. The development of agility and strength, and accordingly the development of technical characteristics are important for the performance of adolescent tennis players. The connection between core training and these developments is important in terms of planning and structuring tennis training. Therefore, the aim of the present study was to examine the effect of an 8-week core training program on agility, strength performance and tennis skills of tennis players aged 10-14.

Method

The present study aiming to examine the effect of 8-week core training on strength, agility performance and tennis skills among 10-14 year-old tennis players was participated by 28 tennis players playing at the EA Tennis Academy. The control group consisted of 14 of these participants (11,98±1,38 years, 152,35±7,89 cm., 43,78±10,16 kg.) who were chosen at random by "drawing from a hat" and continued tennis training only. Another 14 individuals formed the experimental group of the study performing core training 3 times a week for 8 weeks in addition to their tennis training. However, 3 athletes were excluded from the study due to lack of regular attendance in training and the experimental group was included in the data analyses with 11 athletes (12,90±0,94 years, 161,63±6,90 cm., 49,27±7,95 kg.) and the study was finalized.

First vertical and countermovement jump, pro-agility and ITN Tennis Skills Tests were applied to all participants, and the experimental group was given sore training in addition to their tennis training afterwards. The control group, on the other hand, continues regular tennis training only for 8 weeks. All the tests given in as pre-test were repeated at the end of the 8 weeks. Core training sessions were held three times a week during the 8 weeks.

Jump Tests

Squat jump and counter movement jump tests were applied in order to evaluate10-14-year-old tennis players' strength. Vertical jump and counter movement jump tests of the athletes were performed using My Jump 2 (IOS app) application on Apple Iphone 8 Plus (IOS (Balsalobre et al., 2015). The athletes repeated all the jump tests twice and the highest values were recorded. For the squat jump test, the participants were asked to be ready on the "jump mat" on both feet with their

hands on their waist and their knees at 90º squat position (bent at 90º). Later, they were instructed to jump as high as they could from the position they were standing. For the counter movement jump test, the participants were told to be ready on the "jump mat" on both feet at hands-free position. Afterwards, they were asked to bring their knees to 90º squat position (bent at 90º) and jump quickly as high as they could with an arm swing.

Pro-Agility Test

Pro-agility test was employed to assess the participants' agility skills. The participants started the test on a field of 10 yards (9.14m) in length in front of a photocell placed at an equal distance between two cones. After moving to the cone they selected, they made a 180 º turn around the cone, ran to the other cone (9.14 m), made another 180 º turn and completed the test by running past the photocell at the starting point at 5-yard (4.57m) distance (Vescovi & VanHeest, 2010).

Tennis Skills Tests

It is a practice with a standard test protocol initiated by the International Tennis Federation (ITF) to determine tennis players' levels worldwide. Rather than the technical qualities of individuals' tennis strokes, this test looks at the factors of stability, depth and force in Serves, Groundstrokes and Volleys among the 5 game situations together with their abilities of physical mobility. There is an assessment sheet to determine the athletes' ITN tennis numbers; the sum of the scores obtained from the 5 tests gives the athlete's score and the ITN rating is obtained (www.internationaltennisnumber.com) (Fernanadez- Fernanadez et al. 2009).

Core training Program

The content of the core training program applied to the tennis players in the experimental group 3 times a week for 8 weeks is presented in Table 1.

Table 1

8-week Core Training Content

	Monday	**Wednesday**	**Friday**
Weeks 1-4	2 sets on the mat 3x15 Sit-ups 3x15 Cross Sit-ups 3x20 Bicycle Exercise on the Floor 3x30sec Plank	2 sets on the mat 3x12 Jack-knife Exercise 3x15 Scissors Exercise 3x15 Criss Cross-scissors exercise 3x30sn Plank	2 sets on the mat 3x20 Seated Twist 3x20 Heel Touch 3x12 Side Sit-ups 3x30sn Side Plank
Weeks 5-8	2 sets on the mat 3x12 Sit-ups with Med Ball 3x12 Seated Knee Raise 3x10 Hanging Knee Raise	2 sets on the mat 3x15 Seated Twist with med Ball 3x12 Side Sit-ups right, left on Pilates Ball	2 sets on the mat 3x15 Sit-ups 3x15 Cross Sit-ups 3x20 Bicycle Exercise on the Floor

	3x15 Sit-ups on Pilates Ball	3x30sec Plank

Statistical Analysis

Statistical analyses of the study were conducted on SPSS 22.0 package program. Depending on the normal distribution of the data; paired T test, Wilcoxon or independent two samples T test and Mann-Whitney U test were used for within-group and between-group comparisons. Level of statistical significance was accepted as $p<0,05$.

Ethics

The study was initiated upon the approval of the Ethical Committee of Aydın Adnan Menderes University (protocol no: 2019/36, dated 21.02.2019, numbered 3) and was performed according to the Declaration of Helsinki. All the participants were included in the study after receiving parent consent and signing the voluntary consent form which shows that they participated in the study voluntarily.

Findings

The present study aimed to determine the effect of 8-week core training exercises on 10-14 year-old tennis players' agility, strength performance and tennis skills. The results of the Student T test are shown in Table 2 displaying the ITN, Pro-Agility, vertical jump and counter movement jump pre and post tests means and standard deviation values of the tennis players in the control and experimental groups along with the differences between them.

Table 2

ITN Numbers and Scores, Pro-Agility and Jump Pre/Post-Test Means and Standard Deviations of The Control and Experimental Group Tennis Players and the Differences Between Them

	Experimental Group (n=11)	Control Group (n=14)	*p*
ITN No Pre Test	8,27±0,90	9,57±0,93	,002*
ITN No Post Test	7,09±0,83	9,28±1,13	,000*
ITN Score Pre Test	140,81±20,84	91,07±35,82	,000*
ITN Score Post Test	173,00±24,88	105,50±34,98	,000*
Pro-Agility Pre Test (Sn.)	5,75±0,41	6,00±0,45	,163
Pro-Agility Post Test (Sn.)	5,52±0,39	6,05±0,49	,008*

Static Vertical Jump Pre Test (Cm.)	27,10±2,75	20,75±3,16	,000*
Static Vertical Jump Post Test (Cm.)	27,17±3,19	20,75±3,67	,000*
Counter movement Jump Pre Test (Cm.)	30,32±2,27	23,10±3,60	,000*
Counter movement Jump Post Test (Cm.)	30,04±2,81	23,12±4,01	,000*

*$p<0,05$

As seen in Table 2, statistically significant differences were found among the control and experimental group tennis players' ITN number pre-tests, ITN number post-tests, pro-agility post-tests, static vertical jump pre and post-tests and counter movement jump pre and post-tests. Performance and tennis skills test scores of the participants composing the experimental group are seen to be better compared with the control group except for pro-agility pre-test scores.

Table 3 presents the results of the Paired Samples T test, which was used to reveal the statistical differences between the ITN, Pro-Agility, Jump and star excursion balance pre-test and post-test scores of the control group participants.

Table 3

ITN Numbers and Scores, Pro-Agility, Jump Test Pre/Post-Test Means and Standard Deviation Values of the Control Group Tennis Players and the Differences Between Them

	Pre-Test	Post-Test	*p*
ITN No	9,57±0,93	9,28±1,13	,040*
ITN Score	91,07±35,82	105,50±34,98	,000*
Pro-Agility (Sec.)	6,00±0,45	6,05±0,49	,580
Static Vertical Jump (Cm.)	20,75±3,16	20,75±3,67	,988
Counter movement Jump Pre-test (Cm.)	23,10±3,60	23,12±4,01	,948

*$p<0,05$

As shown in Table 3, while a statistically significant progress is observed in the ITN numbers and ITN test scores together with the test results of the tennis players in the control group in pre and post-tests; no statistically significant difference was found in the Pro-Agility test and jump test results.

The results of the Paired Samples T test, which was used to find out the statistical difference between the ITN, Pro-Agility, jump and star excursion test pre and post test results of the experimental group, are shown in Table 4.

Table 4

ITN Numbers and Scores, Pro-Agility, Jump tests pre/post-test Means and Standard Deviation Values of the Experimental Group Tennis Players and the Differences Between Them

	Pre Test	Post Test	*p*
ITN No	8,27±0,90	7,09±0,83	,000*
ITN Score	140,81±20,84	173,00±24,88	,001*
Pro-Agility (Sec.)	5,75±0,41	5,52±0,39	,004*
Static Vertical Jump (Cm.)	27,10±2,75	27,17±3,19	,855
Counter movement jump (Cm.)	30,32±2,27	30,04±2,81	,481

*$p<0,05$

As seen in Table 4, while a statistically significant progress is observed in the ITN numbers and ITN test scores together with the Pro-Agility test results of the experimental group tennis players in pre and post-tests; no statistically significant difference was found in the jump tests.

Discussion

Core training has been among the most commonly practiced training methods recently with their contribution to performance improvement as well as preventing injuries and has been examined by many studies. In tennis, increased core strength can contribute both to quick change of direction skills and compound movement skills as well as tennis skills by enabling strength transfer. In this regard, the present study, which aimed to determine the effect of core training on agility, strength performance and tennis skills in tennis players aged 10-14, found that core training led to a statistically significant progress in the ITN numbers, ITN scores and agility skills of the tennis players in the experimental group. In addition, a statistically significant difference was found in the ITN numbers and ITN scores of the control group. On the other hand, no statistical difference was observed in the vertical jump and counter movement jump scores of both groups. Several studies in the related literature have reported similar results to the present study.

Eren (2019) found a statistically significant difference in the forehand and backhand groundstroke speeds, static balance and throwing performances of 12-14-year-old female and male tennis players as a result of an 8-week core training program ($p<0.05$), but no statistically significant difference was observed between the groups in terms of vertical jump and flexibility performances ($p<0.05$). Yapıcı (2019) examined the effect of 6-week core training on balance, strength and serving performance in volleyball players and found a significant difference between the pre-test and post-test results of the study group in terms of right-left dynamic balance, core strength, serve accuracy, serve speed performances ($p<0.05$).

In the study titled "Examining the effect of 8-week core training on groundstroke speeds and certain motoric characteristics in 12-14 year-old tennis players", Eren (2019) found a significant difference between the pre-test and post-test means of static balance in the experimental group ($p<0,012$). Axel (2013) studied the effect of 8-week core training programs on strength, balance and agility parameters among surfers and observed statistically significant differences in all results. The progress seen in the ITN numbers and ITN scores in both groups in the present study is considered to result from the regular tennis training attendance of all athletes in both the experimental group and control group independently of core training.

When the related literature was reviewed, it was seen that several studies reported different findings from the present study. In the study in which Kır (2017) examined the effect of a core training program on strength, speed, agility and balance among tennis players aged 11-15, tennis players performed core training 3 days a week during 10 weeks and it was found that no statistical difference occurred in the tennis players' agility as a result of the training. Arı and Çolakoğlu (2021) looked into the effect of core training on the standing long jump, handgrip strength, flamingo balance, sit and reach flexibility and sit-up test performances of 31 tennis players aged 13-16 years and found a statistically significant improvement in the standing long jump, handgrip strength sit and reach flexibility and sit-up parameters, but no significant difference in balance performance. Baş (2018) examined the effect of a 10-week core training program on certain motor parameters of 11-13-year old footballers and found a significant difference ($p<0,049$) between the vertical jump pre-test and post-test scores obtained from the individuals in the core training group. In the study where they examined the effect of core training on physical performance in children, Boyacı and Afyon (2017) observed a significant difference ($p<0,000$) in the vertical jump pre-test and post-test results of the experimental group. Tortum (2017) carried out a study with female volleyball players examining the effect of a stabilization exercise program on balance and aerobic performance and found a significant difference ($p<0,000$) between the 1^{st} and 2^{nd} measurements in the vertical jump test results of the athletes in balance training. Göktepe et al. (2019) looked at the effect of core strength training performed by female footballers on their vertical jump methods and reported that core training had positive effects on the athletes' jump strength. In these differences found in the studies, increases in jumping performance are particularly noteworthy. Each branch specializes with its own physical and physiological requirements. Tennis is a branch typically involving sudden changes of direction on the horizontal axis rather than vertical movements. Thus, the fact that jumping performance is not developed among tennis players may be associated with the training content of the branch.

Conclusion and Recommendations

In conclusion, in the present study conducted with tennis players, a statistically significant improvement was observed in the core training ITN numbers and ITN scores as well as the Pro-

Agility test results. As mentioned earlier, core training programs have been observed to have positive effects on different parameters in studies conducted both with tennis players and in other branches or different sample groups in the literature.

In this respect, especially for athletes with maximal development levels and for performance athletes, core training programs should be integrated and performed in the training program of the athlete.

Author Contributions

Idea/Concept: Esin Ergin, Engin Arslan; Design: Esin Ergin, Engin Arslan; Supervision/Consultancy: Esin Ergin; Data Collection and/or Processing, Source Search: Engin Arslan; Writing the Article: Esin Ergin, Engin Arslan; Critical Review: Esin Ergin.

Conflict of Interests

The authors declare no conflict of interest.

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