ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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The Effects of Combined Trainings on Tennis Serve Speed in Tennis Players

Tenis Sporcularında Kombine Antrenmanların Tenis Servis Hızına Etkisi

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ABSTRACT Objective: In this study, the effects of twelve-week combined training on service speed in elite tennis players were investigated. **Material and Methods:** A total of 24 male tennis players whose ages varied between 12 and 14, who do regular tennis trainings in Tennis Courts of Süleyman Demirel University Western Campus were included in the studuy. The players were separated into two groups as those who did combined training (n=12) and those who did normal tennis training (n=12). In the study the mean age of the students was 13.2±0.5 years, mean height was 154.20±1.09 cm, body weight was 45.87±0.91 kg. and in control group the mean age of the students was 13.3±1.5 years, mean height was 153.0±1.09 cm, body weight was 42.87±0.91 kg. The trainings were planned as 12 weeks, 3 days a week, 90 minutes in each training. Before and after the 12-week training period, the tennis serve speeds of the players were measured by using the Sports Radar. The data obtained were evaluated by two independent groups t test and repeated measurements ANOVA tests. **Result:** According to the results of repeated measures variance analysis group time interaction, a statistically significant change was observed in the combined training group ($p<0.05$). In addition, when the training techniques, pretest and posttest comparisons were compared, statistically significant improvement was detected in both groups ($p<0.05$). **Conclusions:** Combined training can benefit tennis players as a complementary or alternative training method to improve tennis service speeds.

Keywords: Tennis; serve speed; athlete; combined training

ÖZET Amaç: Bu çalışmada elit tenisçilerde on iki haftalık kombine antrenmanların, servis hızına etkileri araştırılmıştır. **Gereç ve Yöntemler:** Araştırmaya Süleyman Demirel Üniversitesi Batı Yerleşkesinde bulunan tenis kortlarında düzenli olarak tenis antrenmanları yapan 12-14 yaşları arası 24 erkek sporcu katıldı. Sporcular, kombine antrenman yapanlar (araştırma grubu, n=12) ve normal tenis antrenmanı yapanlar (kontrol grubu, n=12) olarak ikiye ayrıldı. Araştırma grubu yaş ortalaması 13,2±0,5 yıl, boy uzunluğu ortalaması 154,20±1,09 cm, vücut ağırlığı ortalaması 45,87±0,91 kg ve kontrol grubunun ortalama yaş 13,3±1,5 yıl, boy ortalaması 153,0±1,09 cm vücut ağırlığı ortalaması 42,87±0,91 kg olarak belirlendi. Antrenmanlar on iki hafta ve haftada 3 gün, her birim antrenmanda 90 dk. olarak planlandı. On iki haftalık antrenman periyodu öncesi ve sonrası Sports Radar kullanılarak tenis servis hızları ölçüldü. Elde edilen veriler bağımsız iki grup ortalaması t testi ve tekrarlanan ölçümler ANOVA testleri ile değerlendirildi. **Bulgular:** Tekrarlı ölçümler varyans analizi grup zaman etkileşimi sonuçlarına göre, kombine antrenman grubunda istatistiksel açıdan önemli bir değişim gözlendi ($p<0,05$). Ayrıca, antrenman teknikleri, kendi içinde ön ve son test karşılaştırılması yapıldığında her iki grupta istatistiksel açıdan önemli gelişme saptandı ($p<0,05$). **Sonuç;** Kombine antrenmanları sporcularda tenis servis hızlarını geliştirmede tamamlayıcı veya alternatif bir antrenman yöntemi olarak yarar sağlayabilir.

Anahtar Kelimeler: Tenis; servis hızı; sporcu; kombine antrenman

The teaching and training level of the skill should be analyzed strictly to ensure performance improvement. A systematic analysis is required to determine the level of the athlete according to certain criteria, physically, mentally, technically and tactically, what the deficiencies are, the causes of the failure and the need to train accordingly.[1]

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The "elite athlete" concept is the highest level achieved in sports. Elite athletes are those who have turned professional sports concept into a philosophy, enjoy the work they do, know the responsibility of their work, can absorb without becoming excited in difficult events, who are able to control themselves in all situations. The athletes who achieve a good performance or classification with the individual or national team in the competitions of the Olympic Games, world championships and the national senior sports commission are included in this category.

They move faster when compared with their opponents, think faster, recover after long-lasting scores, become less tired, the risk for them to be hurt is low, and their endurance in force are high. In other words, the difference between winning and losing depends on conditional features.[2]

Condition is very important for tennis players in terms of having fast movement ability in the court and playing during the game without losing the performance. This condition brings endurance, speed, force, flexibility, coordination and workout that are specific for tennis.[3]

The serve in tennis is the most effective shot that can influence the result of the game. It has gathered much attention due to its popularity, which in turn compared to the slice serve. There are several aspects, such as the characteristics of both the racquet and player that may affect one's ability to serve at high speeds. Serves at high speeds and correct directions play a key role in winning a tennis match. Therefore, many studies have focused on speed in serving in tennis.[4-10]

Tennis players try to increase the speed of their balls in serve hits in order to have superiority to their rivals. The speed of the tennis balls reaching 250 km/h in serves of the professional tennis players to have the ball in the game has made the serve in today's world tennis to become an extremely important issue because of its mechanical advantage. The serves with a well-directed serve percentage cause that the player gains extra scores, which increases the probability of winning the tennis game.[11]

Combined training is the training model in which the basic biomotoric and technical-tactical features of players are associated with each other. These features are used in a proportional way in unit training according to their severity values.[12]

The serve ball speed depends on interdependent anthropometric characteristics, biomotor and bio-mechanic factors to act as a complex whole. Among these factors, physical structure, strength, joint movement range of the player and the speed of the racket when serving are considerably important. Moreover, the transfer of strength is provided through the kinetic chain to be produced by the body. The peak racket speed at serve has been reported as 100-116 km/h and ball speeds as 134-250 km/h.[9]

Muscle strength in 12-14-year-old children increases significantly with age. Rapid growth and development occurs intensively in adolescence period. The improvement in engine performance is rapidly emerging at the beginning and at the end of this period. In this period, special performance abilities are learned, aerobic-based basic endurance is improved, and coordination is perfected by developing 32% of physical performance muscle, mass-body weight, motorical learning ability.[13]

Recent research has contributed to sports scientists that regular combined training for tennis players should be performed at an early age in order to improve physical, physiological and biomotoric characteristics in order to achieve high-level performance in tennis. It is thought that the importance of combined training applied at young ages will positively affect the performance of the athlete in the future sports life. It is thought that the combined training carried out in this direction will positively affect the performance of the athlete both during the training period and during the competition period.[14]

In our present day, serve plays an important role in winning tennis games when thrown at high speed in an accurate manner. In tennis, serve has a complex structure and includes 8 stages, i.e. the start, release, loading, establishment, acceleration, contact, deceleration, and finish. Serve is a challenging skill as it involves different movement functions; and the lower extremity-upper extremity and body movements must be coordinated with each other. In addition to these,

physical structure, power, the joint range of motion of the player, and the speed of the racket during serve are also very important. An effective serve movement is achieved by using hip rotation, main muscle groups, and coordinated lower-extremity muscle groups (hamstring, quadriceps, hip rotator muscles) in a synchronized manner.[15]

The purpose of the present study was to determine the beneficial effects of combined trainings as well as regular tennis trainings on the motoric features of tennis players. In this respect, the effects of 12-week combined trainings on the performances of 12-14 age group elite tennis players were examined.

MATERIAL AND METHODS

THE CHARACTERISTICS OF THE PLAYERS

Parental informed consent forms and the voluntary consent forms were filled and signed for each participant in the study. A total of 24 healthy (12 people in the normal training group, 12 in the combined training group) male athletes in the 12-14 age group who regularly trained at least 5 days a week were included in the study. The age, sports age, height, weight and tennis serve speed measurements of the participants were made.

General classification ranking players are between 100 and 400 according to the Tennis Federation of Turkey. At the time athletes set by the Tennis Federation of Turkey they were obtaining degrees in summer and winter cups in the national team camp.

Ethics committee approval was not taken in our study. Parental leave approvals were obtained.

This study was conducted in accordance with the Helsinki Declaration Principles.

BODY WEIGHT MEASUREMENT

The body weight measurements of the tennis players were made with a DESIS (Turkey) brand electronic scale which had a sensitivity of 0.5 kg when the players wore only shorts and t-shirts bare feet according to standard techniques.

HEIGHT MEASUREMENT

For the height measurements, the tennis players stood bare feet, body weight transferred to both legs equally, body in anatomic stance, arms let loose, head in horizontal state, heels showing the wall, the body in vertical stance, the heels, hip, the scapula and the rear part of the head touching the wall. A non-flexible rule was placed on the top of the head and a steel measurement tape was used to measure the height in cm.

TENNIS SERVE SPED MEASUREMENT TEST

In measuring the speeds of the tennis balls, new tennis balls (Wilson US OPEN) were used. To control the effects of the air, all serves were performed in a closed tennis court on a hard surface. Before the presentation test, after running for a certain time in the tennis court, opening and stretching movements were made. Tennis players were allowed to warm up until they reached their maximum service speed (dynamic movements on the shoulders, plus 8 or 12 slow services). Three minutes after the warm-up of the subjects, the test was started, and they were asked to serve at maximal speed. In measuring the speed of the balls, a hand-held radar pistol (Sports Radar, Power Madd), Accuracy: +/- 1 MPH (+/- 2 KPH, Measures from: 25 to 130 MPH (40 to 209 KPH) was used to measure the top ball speed in real time. The radar was placed in the mid-point of the baseline in 4 m rear part, at the same level with the contact height of the ball (~ 2.2 m) and the pointed the center of the tennis court. The serves were asked to meet the conditions of cross serve box backhand return point, which is in agreement with the tennis rules, and when the ball was thrown to the net or to the outside of the serve box (out), it was not taken as having serve value. To encourage maximum effort, the direct feedback of the speeds was ensured. All serves were made to the left serve box (from the right side) for the players who used their right hands; and to the right serve box (from the left side) for those who used their left hands. All tennis players were instructed to use plain serve technique, and it was assessed by the trainer. For data analysis, the fastest of the 5 serves of the players at maximal speed (km/hour) was analyzed as the maximal serve (Vmax).

THE TRAINING METHOD APPLIED TO THE TENNIS PLAYERS

After general information was given to the players prior to the study, the serve speed measurements of the 24 tennis players were taken, and the players were separated into two groups. After the pretests, the study group, which consisted of 12 participants, received training 3 days a week as unit (micro) training, 90-minute combined training in addition to the club trainings throughout 3 months (meso); normal tennis technical trainings continued with club trainings on different days. The control group, which consisted of 12 participants, unit (micro) training was applied throughout 3 months (meso) 5 days a week for 90 minutes. In the training program, which was prepared for the control group, normal tennis trainings which included basic techniques were applied. After the 12-week trainings, the serve speed measurements were made again in the study and control groups; and the last measurements were made. Warm-up, activity and flexibility workouts were applied before all the tests. In order to avoid injuries, the positions which could cause injuries or which would pose risks were eliminated (Table 1, Table 2).

THE ANALYSIS OF THE DATA

The SPSS 24.0 for Windows package program was used in the analysis of the data that were obtained to evaluate the findings of 12-14 age group tennis players. Shapiro-Wilk test was used in order to determine the mormality distribution of the data. The repetitive measurements variance analysis (repeated measure ANOVA), simple effect test, and independent ***t*** tests were used as the statistical analysis methods. The results were evaluated according to $p<0.05$ significance level.

RESULTS

No statistically significant differences were determined between the groups in terms of age, sporting age, height and weight parameters ($p<0.05$) (Table 3).

According to the repetitive measurements variance analysis results, after the 12-week training process, when the differences in the measurement values were compared for the groups, it was determined that there was a significant difference between the groups. There was more improvement in the study group compared to the control group ($p<0.05$).

In the study, the first measurement average of the tennis serve speed in the combined training group was 112.333±1.513; and the last measurement average was 123.000±1.371, which meant that there was a significant difference at ($p<0.05$) level when the statistical data were examined. The first measurement average of the tennis serve speed in the normal tennis training group was 105.000±1.513; and the last measurement average was 109.000±1.371, which meant that there was no difference at $p>0.05$ level when statistical data were examined (Table 4).

According to the simple effect test results, the improvement in both the study and control groups at the end of the 12-week training period was statistically significant ($p<0.05$).

DISCUSSION

The purpose of the present study was to examine the effects of combined training program applied to tennis players on serve performances and on improving the speed of the ball in the serve and developing the physical fitness and biomotoric features of the 12-14 age group tennis players. In this context, 24 players who dealt with sports at Süleyman Demirel University Tennis Center for at least 5 years were included in the study. The study was conducted in Süleyman Demirel University, Tennis Center and Sports Sciences Faculty halls and fields.

Sportive performance is a whole of components. The direction and severity of the mutual interactions of various components included in a whole determine the performance.[16]

Tennis is one of the sports, which requires maximum physical fitness. The age, body height, body weight and sports age of tennis players are very important parameters for their access to a high level sports efficiency. For a tennis player, all physical fitness parameters must be at a high level to make an effective shot. The tennis game, which is an individual sport without contact with the opponent, requires fast directional changes, rapid arm movements, jumps and quick moves.[17] Elite tennis players are ex-

TABLE 1: Detailed view of the 12-week combined training program.

Plan & Periods													
Periods		**Period 1**				**Period 2**				**Period 3**			
Month		**August**				**September**				**October**			
Week		**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Competitions													
Camps													
Performance Tests													
Loading Severities	**100%**												
	90%												
	80%												
	70%												
	60%												
	50%												
	40%												
Weekly Combined Training Planning	**Monday**	D	D	D	D	D	D	D	D	D	D	D	D
	Tuesday	1	1	1	1	Vacation	1	1	1	1	1	1	1
	Wednesday												
	Thursday	1	1	1	1		1	1	1	1	1	1	M
	Friday												
	Saturday	1	1	1	1		1	1	1	1	1	1	M
	Sunday	T	M	M	M		M	M	M	M	M	M	T
Total	**K.A.G. Day Count**	3	3	3	3	Vacation	3	3	3	3	3	3	1
	N.A.G. Day Count	2	2	2	2		2	2	2	2	2	2	0
	Match Count	0	1	1	1		1	1	1	1	1	1	3
	Vacation Count	1	1	1	1		1	1	1	1	1	1	2
	Training Count	5	5	5	5		5	5	5	5	5	5	0
	Training Time	7.5	7.5	7.5	7.5		7.5	7.5	7.5	7.5	7.5	7.5	1.5
Biomotoric Loading Severities	**Force %**	40	30	40	30	40	30	40	30	40	30	40	30
	Speed %	10	10	10	10	10	10	10	10	10	10	10	10
	Endurance %	20	30	20	30	20	30	20	30	20	30	20	30
	Coordination	15	15	15	15	15	15	15	15	15	15	15	15
	Flexibility %	5	5	5	5	5	5	5	5	5	5	5	5
	Technique %	10	10	10	10	10	10	10	10	10	10	10	10

D: Resting T: Test M: Match.

pected to move very quickly in all possible directions. If they do not take position on the tennis court at the correct time, they will not be able to hit the ball. In this context, they must be fast to have the proper position and provide the ball with the desired shot.[14]

Hudson conducted a study and reported that coordination activities are excellent for motor development especially in young children.[18] Coordination of an individual with correct coordinate properties is faster than a weak individual, technical-tactical posi-

TABLE 2: Twelve (12)-week combined training program.

12-Week Combined Tennis Training Program Applied To 12-14 Age Group Tennis Players			
	Tuesday	**Thursday**	**Saturday**
1. **Week**	-15 min introducing the training content and target and explaining what will be done in training to achieve this target -20 min rally (cross-parallel) -30 min working with own body weight	-55 min station workout Paired workout with health ball and theraband -10 min skipping rope 100x4 skipping rope x2	-5 min rally exercise -10 min coordination accompanied by technical workout -55 min combined training (force, speed and ability)
2. Week	-10 min rally exercise -55 min combined training (endurance and ability) -5 min game,	-10 min rally exercise -55 min combined training (plyometric, agility and ability)	-50 min combined training (force, speed, agility and ability) -20 min 4 game 1 set match
3. Week	-55 min combined training (endurance and ability) -10 min skipping rope 200x4 skipping rope	-10 min coordination -55 min combined training (plyometric, agility and ability)	-5 min coordination -55 min combined training (agility-speed -plyometric and ability) -10 min rally workout
4. Week	-5 min coordination -55 min combined training (force, speed, agility and ability) 5 min game	-50 min working with own body weight -Paired force workout ı -15 min rally	-10 min coordination -55 min combined training (jumping and speed workout)
5. Week	Vacation	Vacation	Vacation
6. Week	-5 min coordination -55 min combined training (force, speed, agility and ability) -10 min game	-50 min combined training speed workout 1 specific to tennis (interval) -10 min sense and perception work	-50 min station workout Health ball and paired workout -15 min skipping rope 250x4 skipping rope
7. Week	-50 min combined training (plyometric, agility and ability) -15 min for endurance game (low-severity)	-15 min core training -50 min combined training (force, speed, agility and ability)	-10 min wall workout -55 min combined training (agility-speed -plyometric and ability)
8. Week	-10 min rally workout -55 min combined training (coordination, balance, speed and ability)	-50 min combined training (paired exercises with own body weights) -15 min 4 game 1 set match	-10 min game -30 min speed drill workout specific to tennis 1 -25 min 6 game 1 set match
9. Week	-15 min coordination -55 min combined training (interval workout according to Pyramidal Method)	-55 min station workout Workout with health ball and theraband -10 min skipping rope 200x4 skipping rope	-20 min core training -50 min combined training (coordination, balance, reaction speed and ability)
10. Week	-10 min jumping and climbing -55 min combined training (force, speed, agility and ability)	-10 min coordination -55 min combined training (plyometric, agility and ability)	-50 min station workout Paired workout with health ball and theraband -15 min 400x4 skipping rope
11. Week	-5 min coordination -55 min combined training (Interval workout according to Pyramidal Method)	-20 min core training -50 min combined training (coordination, balance, reaction speed and ability)	-10 min sense and perception work -55 min combined training (jumping, speed and ability workout)
12. Week	-30 min combined training (paired exercises with own body weight) -35 min 4 game 1 set game	Competition & Test	Competition & Test

Before Training 10-15 min warm-up and After Training 10 min recovery.

TABLE 3: Comparison of some variables between the groups.

Parameter	Groups	N	Mean ± SD	t	p
Age (year)	Control	12	12.583 ± 0.669	-1.449	0.161
	Experimental	12	13.000 ± 0.739		
Sporting Age (year)	Control	12	6.417 ± 0.793	-1.350	0.191
	Experimental	12	6.833 ± 0.718		
Height (cm)	Control	12	151.750 ± 2.633	-0.741	0.466
	Experimental	12	152.917 ± 4.776		
Weight (kg)	Control	12	43.083 ± 0.669	-1.277	0.215
	Experimental	12	45.083 ± 5.384		

*p<0.05.

TABLE 4: Evaluation of the tennis serve speed values according to the repeated measure ANOVA group x time interaction.

Parameter	Groups	N	Mean ± SE	F	p
Tennis serve speed (km/h)	Classic training pretest	12	105.000 ± 1.513	22.000	0.000*
	Classic training posttest	12	109.000 ± 1.371		
	Combined training pretest	12	112.333 ± 1.513		
	Combined training posttest	12	123.000 ± 1.371		

*p<0.05

tions and problem solving skills are faster, and children need to have learning capabilities individually at the maximum level.

One of the biggest difficulties in serve is ensuring the body balance.[19] Each extra weight in the body changes the weight center of the body. This may disrupt the balance of the body during serve. An efficient serve is directly related with the body height as a parameter, and training age expresses the experience in serve shots.[20]

Vaverka et al. reported that there are significant relations between the body heights of male tennis players who participated in the 4th Grand Slam Tournaments and the speed at which they served tennis, and between the maximum serve speeds of elite tennis players and their body heights.[21] Body height is an important parameter in making an effective serve shot in tennis. A player who is tall meets the ball at higher point, and this allows him to perform a faster and more efficient serve shot.

In the study we conducted, the first measurement average of the tennis serve speed in the combined training group and the last measurement average which meant that there was a significant difference at level when the statistical data were examined. The first measurement average of the tennis serve speed in the normal tennis training group and the last measurement average which meant that there was no difference at level when statistical data were examined. Fernandez et al. reported that the service speed of young male tennis players was measured.[6] Service speed of tennis players was found higher in training group (150.3±12.3) (km-h) as compared to control group (146.1 ± 10.7) (km-h).

When the combined training program used in our study was considered, we believe that there is a positive relation between the tennis serve shot and the speed of the ball based on the training models that were applied as unit trainings according to loading severities by associating the biomotoric features of the player with technical-tactical skills.

When the linear relation between the first and last measurements of the combined training group was examined, a significant relation was found between the serve shot pretest and serve shot posttest measurements of the tennis players in the combined training group (Table 5). We believe that the reason of the significant relation between the serve speeds of the combined training group was that the training programs we applied improved the serve performances of the tennis players by combining their biomotoric features with technical-tactical skills.

TABLE 5: The result of the simple effect test for the tennis serve speed.

Parameter	Groups	N	Posttest	Pretest	Mean Diff. ± SE	p
Tennis serve speed (km/h)	Classic training	12	109.000	105.000	4.000 ± 1.005	0.001*
	Combined training	12	123.000	112.333	10.667 ± 1.005	0.000*

*p<0.05.

12-week (meso) combined trainings caused positive improvements in the serve performance speeds as well as improving their biomotoric features of the players in 12-14 age group. Tennis requires fast reaction, fast acceleration, fast arm-leg and all body movements and fast direction change skills. Designing and applying the trainings that are suitable for tennis requires that many physiological and physical fitness, technical and tactical variables, which are very important for optimal performance, are understood fully. Trainers may ensure focusing on the points that may be improved by applying technical trainings with the ball in tennis hits instead of focusing only on the points that need correction. Success of the players in shots depends on many factors like technical-tactical, physical conditions and mental features. In the light of these data, both combined trainings and technical training programs may be constructed. The 12-week combined trainings that are based on scientific facts and that would improve the abovementioned features were combined with techniques, which improved the serve performances of the players.

Kara conducted a study on the effect of 6-week specific exercise in tennis program on serve speed and found out that the serve speed change rate of the study group was higher than the control group.[8] Furthermore, the exercise program applied by the exercise group had positive effects on body composition. For this reason, it is recommended that specific exercises intended to increase the serve speed are applied together with traditional strengthening exercises. This study and the present study of ours show parallelism in terms of combined training program we applied.

Hernández et al. reported that different training methods increase the speed of serve by examining the effect of different training methods on serve speed and accuracy.[10] Myers et al. who investigated the effects of different strength training on serve speed, reported that continuous and high intensity special training had a positive effect on serve speed.[22]

Fernandez et al. reported the result of the 8-week pliometric training applied to the upper and lower extremities in the study that they performed. They showed a significant improvement in the serve speed of tennis players and some parameters, which supports our study.[6]

The multiple joint kinetic chain, which is specific for tennis serve, requires that there is optimal force, flexibility, timing and coordination of many parts of the human body. For this reason, the performance of the serve depends on the integrity of many interdependent factors. One of these factors is, no doubt, the muscle force and joint movement extension. A muscle force at a high speed, which is the indispensable part of tennis serve, requires that the force is transferred from the legs and the body to arms at proper level and time.[23]

As it is already known, both upper and lower extremity strengths are very important in tennis and are a key quality in sport performance. Muscle strength and muscle endurance develop during childhood. In this context, it is emphasized that resistance training is more efficient in adaptation process with medium severity. Since there is a disproportinate growth between the muscle strength of children increase and the volume of the muscle and the increase in muscle strength at this age, the increase in muscle strength depends on neurological adaptations (more coordinated operation of muscle groups).[24] Although the development of muscle strength in children may not only depend on strength training, it may be related to age, body structure and sexual maturation.[25] In our study, the reason why there was a positive increase in the serve rates of tennis players was that force training that was made with the biomotoric characteristics of combined training, and muscle hypertrophy on the development of muscle strength in children, and the increase in the number of motor units activated and the neurological adaptation and improvements in motor skills coordination.

Davey et al. reported that the most important finding about the weariness during Loughborough Intermittent Tennis Test was that there was a deterioration in the success of the hits at a rate of 69% and the success in the serve hits with the right hand decreased at a rate of 30%.[26] It is considered that the reason for this negation is the lateral lower extremity movement of the players to meet the ball or to hit it. Such movements cause weariness in the player, decreases are ob-

served in running speeds, the hits are delayed and hit success rates are reduced.

It was shown that applying force trainings by using different methods increased the hit speed at a significant level.[27-29] In a study which investigated the maximal force training on hit speed and muscle force, it was determined that the standing and running hit speed was improved at a significant level after 9-week duration.[30]

In order to apply techniques in tennis in an efficient manner, it is necessary to hold the handles of the racket strong. In order to ensure the stability of the hand and the racket, it is necessary that the forearm and finger muscles are strong. The basic idea in serve technique is applying the movement in a certain coordination. For an efficient serve, the important thing is to ensure the coordination between the optimal racket position, its orbit and speed and the body segments during the hit. For a better serve hit, the best way is to coordinate the formation of the movement, in other words, to produce the kinetic chain that ensures the ideal racket position in the hit. With the help of the kinetic chain, the force transferred to the racket and the speed caused by the segments affect each other.[31] It is necessary that the segments of the player are sped up and all elements like physical, biomotoric, physiological, psychological and technical-tactical are improved for a fast and efficient serve hit.

■ As a conclusion, it was observed that the physical fitness and biomotoric features used intensely in tennis determine the serve hit speed.

■ We believe that trainers may improve these features and increase the speed of the ball in serve throw with trainings.

■ We believe that if exercises related with the ball are included in combined trainings when preparing tennis training programs, more advantages will be obtained.

■ Based on the obtained data, it was observed that the meso combined training programs applied to 12-14 age group elite tennis players improved the serve performance and speeds.

■ It may be considered that the applied combined trainings become a model for similar workout programs that will be implemented in the future.

■ The required workout that will increase the success of the players, ensure that the serves are used efficiently and increase the speed of the ball must be performed in training programs that will be prepared in the future.

■ It is recommended for future similar studies that the workouts are evaluated between the tournaments and during competitions, the serves in games are compared in addition to the general serve evaluation, and the effect of these on winning games are investigated.

Source of Finance

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Sinan Akın;* ***Design:*** *Aydın Şentürk, Sinan Akın;* ***Control/Supervision:*** *Berat Koçyiğit;* ***Data Collection and/or Processing:*** *Berat Koçyiğit;* ***Analysis and/or Interpretation:*** *Sinan Akın;****Literature Review:*** *Berat Koçyiğit;* ***Writing the Article:*** *Aydın Şentürk, Sinan Akın, Berat Koçyiğit;* ***Critical Review:*** *Sinan Akın;* ***References and Fundings:*** *Berat Koçyiğit.*

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