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Balance control, agility, eye-hand coordination for the sportive performance of amateur tennis players: A pilot study

Mehmet SÖYLER[1], Yunus Emre ÇİNGÖZ[2]

[1]Çankırı Karatekin University, Vocational School of Social Sciences, Türkiye
[2] Bayburt University, Faculty of Sport Sciences, Türkiye

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Abstract

This study aimed to compare balance performance, agility, eye-hand coordination between amateur tennis players and individuals doing recreational sports. In the research, an amateur tennis club, who has been playing tennis for at least 3 years and playing active tennis; ten male tennis players with an average age of 18.40±0.50 years, an average height of 175.30±3.56 cm, an average body weight of 70.00±3.57 kg, and an average body fat percentage of 22.10±1.25%, participated in recreational and recreational physical activities; Ten male university students with an average age of 18.80±0.63 years, an average height of 163.0±33.8 cm, an average body weight of 69.8±2.62 kg, and an average body fat percentage of 22.60±1.17% participated voluntarily. In the study, Y Balance test, Hexagonal test, Eye-hand coordination test were applied. In the analysis, the differences between the normally distributed variables were analyzed using the independent sample t-test, and the differences between the non-normally distributed variables were analyzed with the Mann-Whitney U test. Statistical significance level was accepted as $p<0.05$. The effect sizes of the differences were calculated according to Cohen's d. Obtained results; no significant difference was found between the balance values between the groups ($p>0.05$), it was determined that there was a significant difference in agility and eye-hand coordination reaction time between the groups ($p<0.05$). Among the factors affecting the sportive performance of amateur tennis players, it is seen that agility and eye-hand coordination values are effective compared to the recreational group, while balance is not. In summary, amateur tennis players should be compared with more performance tests.

Keywords: Physical performance, visual skill, postural control, tennis

Amatör tenis oyuncularının sportif performansına yönelik denge kontrolü, çeviklik, göz-el koordinasyonu: Bir pilot çalışma

Özet

Bu çalışma, amatör tenisçiler ve rekreatif amaçlı spor yapan bireyler arasında denge performansı, çeviklik, göz-el koordinasyonu karşılaştırılmasını amaçlamıştır. Araştırmaya amatör bir tenis kulübünün, en az 3 yıl tenis sporu yapan ve aktif tenis oynayan; yaş ortalamaları 18,40±0,50 yıl, boy uzunluğu ortalamaları 175,30±3,56 cm, vücut ağırlığı ortalamaları 70,00±3,57 kg, vücut yağ oranı ortalamaları 22,10±1,25% olan 10 erkek tenisçi ile rekreatif amaçlı, rekreasyonel amaçlı fiziksel aktivitelere katılan; yaş ortalamaları 18,80±0,63 yıl, boy uzunluğu ortalamaları 163,0±33,8 cm, vücut ağırlığı ortalamaları 69,8±2,62 kg, vücut yağ oranı ortalamaları 22,60±1,17% olan 10 erkek üniversite öğrencisi gönüllü katılmıştır. Çalışmada Y Balance testi, Hexagonal test, Göz-el koordinasyon testi uygulanmıştır. Yapılan analizde normal dağılan değişkenler arasındaki farklılıklar bağımsız örneklem t testi kullanılarak, Normal dağılmayan değişkenler arasındaki farklılıklar Mann-Whitney U testi ile analiz edilmiştir. İstatistiksel anlamlılık düzeyi $p<0,05$ olarak kabul edilmiştir. Farklılıkların etki büyüklükleri Cohen's d'ye göre hesaplanmıştır. Elde edilen sonuçlar; gruplar arası denge değeri arasında anlamlı farklılık tespit edilmediği ($p>0,05$) gruplar arası çeviklik ve göz-el koordinasyonu reaksiyon zamanında anlamlılık olduğu tespit edilmiştir($p<0,05$). Amatör tenis oyuncularının sportif performansına etki eden faktörler arasında çeviklik ve göz-el koordinasyon değerlerinin rekreatif gruba göre etkili olurken, dengenin ise etkili olmadığı görülmektedir. Özetle amatör tenis oyuncularının daha fazla performans testleriyle karşılaştırma çalışmaları yapılmalıdır.

Anahtar Kelimeler: *Fiziksel performans, görsel motor, postural kontrol, tenis*

Sorumlu Yazar/Corresponded Author: Mehmet SÖYLER, **E-posta/e-mail:** mehmetsoyler@karatekin.edu.tr

Genişletilmiş Türkçe Özet makalenin sonunda yer almaktadır.

INTRODUCTION

Tennis, which originated in England in the 19th century, has become a global sport. Today, it is a sports branch that is especially popular all over the world (Munroe, 2010). Tennis is a sport played as singles or doubles. Players make hard and low-level hits using tennis rackets and ball, applying winning strategies by sending the ball to the other player mutually (Selby, 2017). Players develop strategies to win the game by hitting low and hard and changing positions to send the ball to the other player.

The tennis branch should develop strategies that require high physical and mental effort, concentration and self-confidence (Bass, 2016). Tennis has changed from being a technical sport, where athletic technical skills (such as stroke skills) are in demand, to a more explosive activity with increased serve and stroke speed and significantly increased physical requirements.

Tennis is also an activity that encourages the individual's mastery and personal success (Santos et al., 2018). In addition to its positive effects on personal development, tennis has also been observed to help develop important skills such as strong strategic thinking, problem solving and creativity (Schenk, 2014). As the individual's level of success in tennis increases, his/her self-confidence will increase as well as his/her discipline and responsibilities (Hudson, 2013).

Tennis includes a combination of various cardiovascular exercises, strength training and coordination actions to support the physiological development of individuals (Zivin et al., 2018). In addition, it has been observed that exercises play an important role in increasing the effects on individuals' strength, condition and flexibility (Bauman, 2009). Tennis players play a significant role physically, mentally, and sociologically, according to the explanations (Gorman et al., 2013; Zivin et al., 2018; Bauman, 2009).

It is seen that tennis education crucial for the development of reaction and balance skills. In the study by Jones et al. (2019), on evaluating the reaction and balance abilities of tennis players, a significant increase was observed in the indicators of standing in a balanced state, stable running and reaction time compared the individuals who received tennis training with the control group. In another study, it was shown that tennis players exhibit better reaction time and coordination skills compared to other athletes (Krane et al., 2001). Studies have shown that tennis is an effective tool to increase reaction time through these skills by helping individuals develop their coordinative skills (Zivin et al., 2018).

Tennis training is thought to be an effective tool for tennis players to improve their balance, agility and coordination skills. In this direction, the performances of tennis players during tennis competitions vary in terms of technique and tactics. Balance skills, agility and coordination skills should be developed in order for tennis players to achieve the best result in terms of performance. For this reason, it was aimed to carry out this study, and compared to other sports branches, tennis training helped individuals to develop their agility, coordination and balance skills at an advanced level. In addition, tennis training

requires more movement and coordination, which leads to a significant increase in reaction time indicators, especially in standing balance, stable running and coordination. In line with all these, this study aimed to compare balance performance, agility, eye-hand coordination between amateur tennis players and individuals doing recreational sports.

METHOD

Research model

In the study, the comparison model used in quantitative research was used. This model is applied to determine the causes or affecting factors of an existing phenomenon and the aim is to reveal the correlation between the variables by comparing the groups that change according to different variables (Sayım, 2017).

Participants

The research was conducted through voluntary participation of the tennis group aged 18-20 years, which consists of ten male athletes who played tennis for at least three years and, in this process, did aerobic and general strength-based and licensed tennis sports for a minimum of three days a week and one hundred eighty minutes (age, mean height and body weight 18.4±0.5 years, 175±3.56 cm, 70.0±3.57 kg, respectively) and of a recreational group consisting of ten randomly selected male students from the university student sports community (participating in different weekly physical activities for recreational purposes) who are healthy and actively engaged in sports (age, mean height and body weight 18.8±0.63 years, 163±33.8 cm, 69.8±2.62 kg, respectively). All participants were informed verbally and in writing about the purpose of the study, possible risks and the process to be carried out, and they received all the information they needed and were reassured that participants may leave the study at any time. The study's participants each signed a participation form. The Declaration of Helsinki was followed during the study's execution. Researchers scanned and identified every volunteer participant.

The criteria for participation in the research were determined as follows; Being between 18 and 20 years old (for both groups), having played singles or doubles tennis for at least three years and frequently participating in tennis training (>three hours/week) (for tennis group), having no formal tennis training (for the control group), the general criteria for participating in the study are that the participants do not have any health problems, do not use tobacco products such as cigarettes, and do not use drugs constantly.

Exclusion criteria from the study were determined as; any recent or active injury that needs medical attention; existence of severe neurological, musculoskeletal, visual, vestibular, cardiorespiratory, or cognitive deficits pregnancy,

Data collection tools

The research consists of male tennis players who are athletes in the private sports club of Cankiri province and randomly selected students from the university. Before starting the tests, information was given about the tests and informed that it was on a voluntary basis, information about the test applications and voluntary participation consent forms were signed among the individuals who agreed to participate. Athletes and recreational groups participating in the study warmed up for twenty minutes with the same warm-up procedures accompanied by trainers before the tests were applied. The study participants were requested to have their toilet needs met thirty minutes before the test, not to consume solid and heavy foods for three hours before the test, and not to do an intense training for twelve hours before the test. Height, body composition analysis, Y balance test, hexagon test and eye coordination tests were applied to the participants, respectively.

Warm-up protocol

Participants jogged for 5 minutes at a heart rate of 120 beats/min of average heart rate (mean heart rate was determined by the telemetric heart rate monitor PolarR800 / Finland, chest signaling and polar watch). He did exercises based on physical condition for twenty minutes. In these exercises consisting of 5 different movements, 1 movement took 2 minutes. The movement started at the beginning of the 20-meter line, the movement continued for 50 seconds, meanwhile, the end of the line was reached and after resting on the line for 10 seconds, it was returned and the same movement was repeated. When returning to the starting line, after resting for 10 seconds, the second movement was started and 5 different movements were applied in this way. After the participants rested at the end of walking for 1 minute, performance tests were started (Creekmur et al., 2017).

Study procedure

The study was completed in four successive stages.

Information and Evaluation in Stage 1; the registration, information and pre-evaluation processes of the participants have been completed. The tennis group (n=2) and the study's recreational group (n=2) was excluded because they failed to meet the inclusion requirements.

Physical Performance Measurement in Stage 2; Anthropometric and body composition measurements, which constitute the physical characteristics of the participants, were made. The subjects' height, weight, and body fat percentages were calculated at this point. A Seca brand (Germany) stadiometer was used to gauge the participants' heights. Foot-to-foot bioelectrical impedance analysis (Inbody 270, Biospace, California, USA) was used to evaluate body weight and body fat percentage before breakfast, between the hours of 9:00 and 11:00, following an overnight fast with no hydration or food intake, and after meeting all toilet needs.

Body height measurement

The participants' height was ascertained by gauging the distance between the top of the head and the sole of the feet in meters (m) using an electronic measuring device in an anatomical position, without shoes, and in a position where the body weight was evenly distributed on both feet and measured with the Seca (Germany) brand height scale, which has an accuracy of 0.1 mm (Kagawa, 2021).

Body composition analysis

The participants' heights were pre-recorded, and those whose heights were measured were chosen to have their body compositions measured. Body composition measurements were performed using participants' body weight (kg), body fat percentage-VYY (%), and bioelectrical impedance (BIA) analysis. This analysis made use of the Plus 270 model from the Inbody 270 Body Composition Analyzer (İnbody 270, Biospace, California, USA). BIA is a technique for analysis that relies on the differential in electrical permeability of body fat percentage and body weight (Lukaski, 2003). Body composition measurements were carried out between 09:00 and 11:00 on the day before the performance tests. Participants were measured on an empty stomach and without liquid/food intake, and their bathroom requirements were satisfied. The volunteers were stripped of their jewelry and metal before the measurement, and the subject to be measured stood vertically while donning light clothing and putting his or her bare feet against the aluminum soles of the analysis device. The participants were also instructed to hold the hand electrodes. The computer to which the body composition analyzer was linked was used to help record the data (Zileli & Söyler, 2022).Motor performance measurement in stage 3; motor performance measurements of the participants were carried out. The Hand-Eye coordination tests in the Coordination parameter and the Y balance and Hexagon tests in the Agility parameter were used to assess the participants' physical performance.

Y balance test

Using the Y balance test, dynamic balance measurement was assessed. The test requires participants to use the other leg to reach the furthest distance along the marked lines while keeping the standing leg stationary at the marked starting center, and then return the reaching leg back to the starting

center without losing balance. Participants were lying with their feet in Y-shaped Anterior (ANT), Posteromedial (PM), Posterolateral (PL) directions and the distance they reached was recorded in cm. The angle of extension, Posteromedial and posterolateral, is 45 degrees, and the angle of posteromedial and posterolateral to the anterior extension direction is 135 degrees. If the participant loses his/her balance, removes the standing foot from the measuring platform, steps the distance he has reached, or fails to bring the reaching foot to the starting position, the test is repeated (Ödemiş et al., 2023).

Hexagonal agility test

The agility values of the athletes were measured by jumping 3 laps (18 jumps) from the center of the hexagon drawn on a non-slip surface, with a side length of 61 cm and drawn at an angle of 120°, to each side of the hexagon, and recording their arrival to the starting point in seconds. The participants in the test were instructed to look in the same direction and refrain from stepping outside the hexagon's edge. Participants were tested three times and their best scores were taken into account in the research (Orhan et al., 2008).

Eye-hand coordination test

Eye-hand coordination is an essential test of the visual motor function with controlled, accurate and fast movements of arms, hands and fingers to facilitate targeted use in sports activities such as badminton, tennis, and volleyball (Crawford et al., 2004). A computer-based eye-hand coordination test called the finger pointing test, which is a valid and reliable test, is used to measure eye-hand coordination in both adults and children. Test-retest reliability was discovered to be moderate in kids and adults, according the study by Kwok et al. (2010), meaning that the intraclass correlation coefficients varied from 0.68 to 0.71. The top border of the computer screen was at eye level for each participant when they sat in their chairs. Participants stood with their feet flat on the ground with their hips, knees, and ankles bent at 90-degree angles. The participant's dominant hand the one used for writing was placed on a touchpad at the start of the test. Visual targets in the form of balls emerged at random on the left, right, or center of the screen. Participants were told to point to the visual targets as quickly and accurately as they could after seeing them five times in each location. Participants quickly put their hand back in the assigned starting position (touchpad) after contacting the target. Each participant completed this finger-pointing activity 15 times, yielding a total of 15 targets (Fong et al., 2016). The outcomes were recorded and used to do analysis. The absolute value of the participant's touch position's divergence from the center of the visual target is the endpoint accuracy. Reaction time is the amount of time that passes between the visual target appearing and the moment the hand is taken off the touchpad. The period of time between the hand leaving the touchpad and the index finger touching the visible target is known as the "movement time."

From 15 trials, mean values were calculated and produced. Shorter reaction and movement durations reflect better eye-hand synchronization, while a lower value for endpoint accuracy indicates less variation and hence higher accuracy.

Measurement Evaluation and Interpretation in Stage 4; the functionality of the physical and motor performance measurement results obtained from the tennis group (TG) and the recreational group (RG) groups were evaluated and the reliability of the results was tested and the statistical discrepancies between the body composition and physical performance assessment results of the subjects in the TG and RG group were analyzed and evaluated at the conclusion of the study.

Ethical aspect of research

The study was started after the approval (2023/07) from the Non-Interventional Research Ethics Committee of Çankırı Karatekin University. The Helsinki Declaration's guiding principles were followed during the study's execution. A form requesting volunteers' informed consent was signed after participants received thorough information about the study's protocol.

Data analysis

Using the SPSS 21.0 program (SPSS Inc., Chicago, USA), the findings were examined. The Shapiro-Wilk test was used to assess the data's conformance to the normal distribution. The Mann-Whitney U test was used to evaluate the differences between the variables for those that were not normally distributed and the independent sample t-test for those that were. The accepted statistical significance level was $p<0.05$. Using Cohen's d, the effect size of the differences was determined. This calculation determined that values less than 0.2 were considered insignificant, values between 0.2 and 0.5 were considered low, values between 0.5 and 0.8 were considered moderate, and values greater than 0.8 were considered large effects.

FINDINGS

Table 1. Descriptive statistics of tennis and sedentary groups

Variables	**Tennis**	**Recreational**	**P value**	**Effect Size**
Age (year)	18.4±0.51	18.8±0.63	1.0	0.01
Height (cm)	175±3.56	163±33.8	0.246	0.27
Body weight (kg)	70.0±3.57	69.8±2.62	0.883	0.033
Body Fat Percentage (%)	22.1±1.25	22.6±1.17	0.244	0.270

* p<0.05

Table 1 shows the descriptive statistics of tennis and recreational groups. Statistical significance was accepted as p<0.05. Effect size (ES) classification was evaluated as <0.2 insignificant, 0.2-0.5 low, 0.5-0.8 moderate, and >0.8 great effect.

Table 2. Agility, balance and eye-hand coordination test results and statistics of the tennis and recreational groups

Variables	**Tennis**	**Recreational**	**P value**	**Effect Size**
Y Balance Test (cm)(Right)	90.7±1.34	90.4±1.51	0.667	0.098
Y Balance Test (cm)(Left)	90.6±1,98	90.8±0.59	0.649	0.10*
Hexagon Agility Clockwise Test (s)	24.3±1.83	25.7±0.83	**0.044**	0.485**
Hexagon Agility Anti Clockwise Test (s)	24.1±1.24	24.9±0.91	**0.028**	0.49**
Coordination Reaction Time (ms)	3.18±0.00	3.21±0.02	**0.002**	**0.834******
Coordination Movement Time (ms)	4.14±0.28	4.13±0.01	0.053	0.432**

* p<0.05

Looking at Table 2, agility, balance and eye coordination test results and statistics of the tennis group and the recreational group are given. Statistical significance was accepted as p<0.05. Effect size (ES) classification was evaluated as **<0.2 insignificant, **0.2-0.5 low, , ***0.5-0.8** moderate, ****>0.8 great effect.*

DISCUSSION

In the research, when the literature is examined, it has been determined that there are limited studies on the comparison of physical performance characteristics in racquet sports. In this direction, it is aimed to compare valid and reliable physical performance tests that can measure the sportive performance of amateur tennis players with the performance

characteristics of individuals who actively do sports. This study emphasizes the importance of tennis training individuals in improving their reaction and balance abilities compared to sedentary individuals. In this study, height, body weight, body fat percentage and balance, agility and coordination tests were used to compare the anthropometric characteristics and motor performance parameters of amateur tennis players and individuals doing regressive sports, respectively.

Anthropometric measurement and body composition evaluation

In the light of the data obtained from the physical performance measurements of the study, the mean body weight of the amateur tennis players was 70.0±3.57 kg, the mean height was 175.0±3.56 cm, and the mean fat percentage was 22.1±1.25%, while the mean body weight was 69.8±2.62 kg, the mean height was 163.0±33.8 cm, and the mean fat percentage was 22.6±1.25 % in the group doing recreational sports. In the study, when the differences between the groups were examined, no significant difference was found in Table 1 when the groups were compared in terms of height, body weight, and body fat percentage (see Table 1). When examining the literature, Aktaş et al. (2011), compared the effects of 8-week strength training applied to male tennis experimental and control groups on motoric characteristics. They stated that there was no change in body composition in both groups (Aktaş et al., 2011). Kraemer et al. (2003), found no significant difference in body fat percentages and body weights in their study on college tennis players (Kramer et al., 2003). Similar results were found in the study conducted by Naderi et al. (2017), Fernandez et al. (2016), stated that there was no significant change in body composition results obtained after 8 weeks of plyometric training applied on young tennis players (Fernandez et al., 2016). When we look at the literature, it shows parallelism with this study, and it can be concluded that there is no significant difference between the anthropometric and body composition values we obtained in our study, the age groups of the participants are close, the nutritional habits of this age group are similar, and they may have similar body characteristics depending on genetics and other factors.

Evaluation of balance performance

In the light of the data obtained from the dynamic balance test measurements from the motor performance values of the research, while the mean Y balance test of amateur tennis players was 90.07±1.34 (left) 90.06±1.98 (right), respectively, the mean Y balance test of the recreational sports group was 90.04±1.51 (left) 90.08±0.59 (right). In the study, when the differences between the groups were examined, no significant difference was found in Table 2 when the groups were compared in terms of dynamic postural balance values (see Table 2).

When the literature is examined, Malliou et al., (2010), investigated the effects of tennis technical training on balance performance on 36 male tennis players. The results obtained showed that the balance performance examined did not make any difference on the athletes. It is thought that balance-specific movements should be added to training programs in order to improve balance performance (Malliou et al., 2010). Shaffer et al. (2013), found the dynamic balance scores to be high (in the range of 80-91) in a study in which they examined the reliability of the Y dynamic balance test (Shaffer et al., 2013). In the study of Whiteside et al., (2015), in which physical and physiological coordinative abilities were examined, they stated that there was no significant change between balance parameters in tennis performance (Whiteside et al., 2015). When we look at the literature, it shows parallelism with the study, and the fact that there is no significant difference between the dynamic posture control balance values we obtained in our research is that the balance parameter is a coordinative ability, unlike other parameters, and it is also thought that it should be included in the training unit as a specific training in tennis training.

Evaluation of agility performance

In the light of the data obtained from the hexagonal agility test measurements, one of the motor performance values of the research, the mean agility clokwise test of amateur tennis players was 24.3±1.83 (s) and the mean anti-clockwise test was 24.1±1.24(s), respectively, while the mean agility clokwise test of the rekreatif sports group was 25.7±0.83 (s), and the mean anti-clockwise test was 24.9±0.91 (s). In the study, when the differences between the groups were examined, a significant difference was found in the direction of tennis players when the groups were compared in terms of hexagonal agility values (see Table 2). When the literature is examined, the measurement and evaluation of agility, which is very important for tennis in terms of both technical and physical factors, is still a matter of debate today. Armstrong and Greig (2008), stated in their study that agility, which is generally associated with changing direction, also includes cognitive features such as perception, decision making and visual scanning (Armstrong & Greig, 2018). In their study, Nikolic et al. (2014), obtained a significant change in the direction of young tennis players among the physical performance parameters of a different branch of the young tennis group (Nikolic et al., 2014). Tomas et al. (2014), found a significant difference in agility parameter in a study conducted with male lacrosse athletes (Thomas et al., 2014). When we look at the literature, it shows parallelism with the study, and the significant difference between the hexagonal agility values we obtained in our research is thought to have a positive effect on the agility performance of the agility parameter, regardless

of the other physical characteristics of tennis athletes. During the study period, the significant increase in agility performance created by only tennis technical training without any other strength training suggested that tennis-specific movements were effective on agility.

Eye-hand coordination evaluation

In the light of the data obtained from the eye-hand coordination test measurements, one of the motor performance values of the research, the mean reaction time of amateur tennis players was 3.18±0.00 (ms) and the mean movement time was 4.14±0.28 (ms), respectively, while the mean reaction time of the regressive sports group was 3.21±0.02 (ms), and the mean anti-movement time was 4.13±0.01 (ms). When the differences between the groups were examined in the study, Table 2 showed that when the groups were compared in terms of eye-hand coordination values, there was a significant difference in the reaction time parameter for tennis players, while no significant difference was found in the movement time parameter (see Table 2). When the literature is examined, reaction time is an important performance criterion that shows the speed and decision-making process, and at the same time, it is the main part of the movements in sports branches (Bańkosz et al., 2013). One of the skill types that affect success in tennis is reaction time (Qiang et al., 2011). Correa et al. (2013), reported in their study that the reaction times and performances of the athletes differed (Correa et al., 2013). Ando et al. (2001), examined the visual pre-motor time, which is the complement of the reaction time, with EMG for their study on football players at Kyoto University and found that the reaction time of the experimental group was much shorter than the control group (Ando et al., 2001). Kwok et al. (2010), stated that in sedentary individuals who do sports and have never done sports before, the reaction time is shorter in favor of the group that does sports compared to the group that does not do sports (Kwok et al., 2010). When we look at the literature, it shows parallelism with the study, and the significant difference between the reaction time values we obtained in our research, the importance of reaction time in sports is increasing. Athletes with the same conditional and technical capacities will be more successful with shorter reaction times. The time factor is very important for athletes. A tennis player hitting the incoming ball at the right time is very important in evaluating the performance. Considering these features, it is also significant that the reaction time of the tennis group differs from the regressive group, if we consider that training programs that develop speed and reaction time, which is the component of speed, are necessarily included in the training programs. On the other hand, in this study, although the control group was not subjected to any training, it was seen that the movement time durations were the same as the tennis group. The time of movement changes

with age. This period does not fall below a certain limit value (0.10s) according to the rules of sensory physiology. This can be explained by the fact that there is no difference in both groups due to the similarity in the same age group.

As a result, while amateur tennis players differ in reaction time parameters involved in agility and coordination ability according to the regressive group, there is no significant change in body composition, balance and movement time parameters for dynamic posture control. This study for amateur tennis players is important in order to create a design model for studies that will be designed in a comprehensive way. The determination of the basic training modules for the tennis branch emerges with the study in order to reveal the deficiencies in the comparison of amateur tennis education with individuals who do sports for regressive purposes. According to the data obtained, it also reveals the importance of specific training applied in amateur tennis training. It was also supported by the study that the balance parameter should be studied in a separate unit.

Suggestions

In order to achieve the desired performance by benefiting from such studies, trainers and athletes can apply exercises that improve their deficient physical performance, especially reaction time. In parallel with such studies, more physical and physiological parameters of amateur tennis players can be measured. Increasing the number of such studies is important in terms of population formation. It may be recommended to conduct similar studies in different regions with different socio-economic levels. We think that the data obtained in this study will make important contributions to the coaches, athletes and sports science interested in tennis.

GENİŞLETİLMİŞ ÖZET

GİRİŞ

Tenis, günümüzde özellikle bütün dünyada popüler olan bir spor branşıdır. (Munroe, 2010). Tenis oynamanın, bireylerin üstün hareket kontrolü, duyusal keskinliği ve konsantrasyonu geliştirmelerine yardımcı olduğu ve hafızalarının artmasına katkıda bulunduğu gösterilmiştir (Gorman ve ark., 2013). Buna ek olarak, tenis oyuncularının fiziksel durumları, kazanan-kaybedeni belirlemek için kritik önem taşır, özellikle çok yakın rekabet seviyelerindeki tenis oyuncuları için, ileri seviyeli vuruşlar yapabilmek ve giderek daha yetenekli rakipleriyle başa çıkabilmek için çeviklik, hız, güç, aerobik kapasite ve diğer fiziksel form komponentlerinin bir kombinasyonunu kazanmalıdır (Fernandez ve ark., 2009). Çalışmalar, tenisin koordinasyon becerilerini geliştirme potansiyeline sahip olduğunu ve bu becerileri kullanarak reaksiyon zamanını arttırmak için etkili bir araç olduğunu göstermiştir. Tenis, uygun ve düzenli antrenman programları ile kas gücünü, esnekliği ve dengeleri geliştirmek için mükemmel bir araç olarak görülmektedir (Mujika, 2010). Bu sonuç, tenis eğitiminin reaksiyon ve denge

yeteneklerinin gelişiminde etkin bir araç olduğunu desteklemektedir. Bu çalışmada, amatör tenisçiler ve regreatif amaçlı spor yapan bireyler arasında denge performansı, çeviklik, göz-el koordinasyonu karşılaştırılmasını amaçlamıştır.

YÖNTEM

Bu çalışma, tenis eğitimi alan bireylerin tepki ve denge yeteneklerinin sedanter bireylere kıyasla geliştirilmesinin önemini vurgulamaktadır. Çalışma; yaşları 18-20 yaş aralığında olan; tenis grubu, en az 3 yıl tenis sporu ve bu süreçte minimum haftada 3 gün ve 180 dk. aerobik ve genel kuvvet temelli ve lisanslı tenis sporu yapan 10 erkek sporcunun (yaş, boy ortalaması ve vücut ağırlığı sırasıyla, 18.4±0.5 yıl, 175±3.56 cm, 70.0±3.57 kg) ve rekreatif grubu ise sağlıklı ve aktif olarak spor yapan üniversitede öğrenim gören öğrenci spor topluluğundan (rekreatif amaçlı, haftalık farklı fiziksel aktivitelere katılım sağlayan) rasgele seçilmiş 10 erkek öğrencinin (yaş, boy ortalaması ve vücut ağırlığı sırasıyla 18.8±0.63 yıl, 163±33.8 cm, 69.8±2.62 kg) gönüllü katılımı ile yürütülmüştür.

Verilerin analizi

Sonuçlar SPSS 21.0 kullanılarak değerlendirilmiştir (SPSS Inc., Chicago, ABD). Verilerin normal dağılıma uygunlukları Shapiro-Wilk testi ile değerlendirilmiştir. Normal dağılan değişkenler arasındaki farklılıklar bağımsız örneklem t testi kullanılarak analiz edilmiştir. Normal dağılmayan değişkenler arasındaki farklılıklar Mann-Whitney U testi ile analiz edilmiştir. İstatistiksel anlamlılık düzeyi $p<0,05$ olarak kabul edilmiştir. Farklılıkların etki büyüklükleri cohen'in d'sine göre hesaplanmıştır. <0.2 değeri önemsiz, 0.2-0.5 düşük, 0.5-0.8 orta ve >0.8 değeri geniş etki olarak değerlendirilmiştir.

BULGULAR

Tenis grubu ve rekreatif gruba ait çeviklik, denge ve göz koordinasyon test sonuçları ve istatistikleri görülmektedir. İstatistiksel olarak anlamlılık $p<0,05$ olarak kabul edilmiştir. Etki büyüklükleri (EB) sınıflandırılması; **<0,2 değeri önemsiz, **0,2-0,5 düşük, ***0,5-0,8** orta, ****>0,8* değeri geniş etki olarak değerlendirilmiştir. Araştırmanın fiziksel performans ölçümlerinden elde edilen veriler ışığında amatör tenisçilerin vücut ağırlığı ortalamaları 70,0±3,57 kg; boy ortalamaları 175,0±3,56 cm; yağ yüzdesi ortalamaları 22,1±1,25% olarak bulunurken rekreatif spor yapan grup vücut ağırlığı ortalamaları 69,8±2,62 kg, boy ortalamaları 163,0±33,8 cm, yağ yüzdesi ortalamaları 22,6±1,25 % olarak bulunmuştur. Araştırmanın motor performans değerlerinden dinamik denge testi ölçümlerinde elde edilen veriler ışığında amatör tenisçilerin sırasıyla Y balance testi ortalamaları 90,07±1,34 (sol) 90,06±1,98 (sağ) olarak bulunurken rekreatif spor yapan grup Y balance testi ortalamaları 90,04±1,51 (sol) 90,08±0,59 (sağ) olarak bulunmuştur. Araştırmanın motor performans değerlerinden hexagonal çeviklik testi ölçümlerinde elde edilen veriler ışığında amatör tenisçilerin sırasıyla çeviklik clokwise testi ortalamaları 25,07±0,83 (s), anti clockwise test ortalamaları 24,09±0,91(s) olarak bulunurken rekreatif spor yapan grup çeviklik clokwise testi ortalamaları 24,3±1,83 (s), anti clockwise test

ortalamaları 24,1±1,24 (s) olarak bulunmuştur. Araştırmanın motor performans değerlerinden göz-el koordinasyon testi ölçümlerinde elde edilen veriler ışığında amatör tenisçilerin sırasıyla reaksiyon zaman ortalamaları 3,18±0,00 (ms), hareket zamanı ortalamaları 4,14±0,28 (ms) olarak bulunurken rekreatif spor yapan grup reaksiyon zaman ortalamaları 3,21±0,02 (ms), anti hareket zaman ortalamaları 4,13±0,01 (ms) olarak bulunmuştur.

TARTIŞMA VE SONUÇ

Yapılan araştırmada, literatür incelendiğinde raketli sporlarda fiziksel performans özelliklerinin karşılaştırmasına yönelik çalışmaların kısıtlı olduğu tespit edilmiştir. Yapılan çalışma, amatör tenis oyuncularının sportif performansını ölçümleyebilen geçerli ve güvenilir fiziksel performans testlerinin, aktif olarak spor yapan bireylerin performans özellikleriyle karşılaştırılmasını amaçlamıştır. Literatür incelediğinde; Aktaş ve arkadaşları (2011), erkek tenis deney ve kontrol gruplarına uyguladıkları 8 haftalık kuvvet antrenmanlarının motorik özellikler üzerine etkisini karşılaştırmışlardır. Her iki grubunda vücut kompozisyonunda bir değişim olmadığını ifade etmişlerdir (Aktaş ve ark., 2011). Malliou ve arkadaşları (2010), otuz altı erkek tenis sporcusu üzerinde tenis teknik antrenmanlarının denge performansı üzerine etkilerini araştırmışlar, sonuç olarak denge performansının sporcular üzerinde herhangi bir fark yaratmadığı görülmüştür.

Fiziksel performans bakımından tenis sporcusu için önemli olan çevikliğin ölçüm ve değerlendirme, bugün hala tartışma konusudur. Armstrong ve Greig, (2008), yaptıkları çalışmada genel anlamda yön değiştirme ile ilişkilendirilen çevikliğin aynı zamanda algılama, karar verme ve görsel tarama gibi bilişsel özellikler şeklinde ifade etmişlerdir (Armstrong & Greig, 2018). Sonuç olarak amatör tenis oyuncuları, regreatif gruba göre çeviklik ve reaksiyon zamanı parametrelerinde farklılık görülürken vücut kompozisyonu, dinamik postur kontrolüne yönelik denge ve hareket zamanı parametrelerinde anlamlı bir değişiklik görülmemektedir. Amatör tenis oyuncularına yönelik yapılan bu çalışma geniş kapsamlı bir şekilde dizayn edilecek çalışmalar için bir tasarım modeli oluşturmak adına önemlidir. Amatör tenis eğitiminin, regreatif amaçlı spor yapan bireyler ile karşılaştırmalarına yönelik eksikliklerin ortaya çıkması adına tenis branşına yönelik temel eğitim modüllerinin belirlenmesi yapılan çalışma ile ortaya çıkmaktadır. Çalışmanın sonuçları,tenis antrenmanlarında spesifik antrenmanların önemini de göstermektedir. Özellikle denge parametresinin ayrı bir birimde çalışılması gerektiği yapılan çalışma ile de desteklenmiştir.

REFERENCES

Afsharnezhad, T., & Soumander, S. Y. (2022). The effects of resistance training with and without electrical muscle stimulation on body composition of obese women. *Iranian Journal of Health Sciences, 10*(4), 51-62.

Aktaş, F., Akkuş, H., Harbili, E., & Harbili, S. (2011). Kuvvet antrenmanının 12-14 yaş grubu erkek tenisçilerin bazı motorik özelliklerine etkisi. *Beden Eğitimi ve Spor Bilimleri Dergisi, 5*(1). 7-11

Ando S, Kida N., & Oda S. (2001) Central and peripheral visual reaction time of soccer players and non-athletes. *Percept Mot Skills*. 92, 786-94.

Bańkosz, Z., Nawara, H., & Ociepa, M. (2013). Assessment of simple reaction time in badminton players. *Trends In Sport Sciences, 1*(20), 54-61.

Bass, A. (2016). *Mental game of tennis,* Oxford University Press.

Bauman, A. (2009). *Sosyal ve kültürel etkileri,* Oxford Üniversitesi Basımevi.

Collins, A. (2019). Tenisin motor gelişimi üzerine bir inceleme. *Motor Gelişim Dergisi, 28*(3), 39-45.

Correa, A., Lara, T., & Madrid, J. A. (2013). Influence of circadian typology and time of day on temporal preparation. *Timing & Time Perception, 1*(2), 217-238.

Crawford, J. D., Medendorp, W. P., & Marotta, J. J. (2004). Spatial transformations for eye–hand coordination. *Journal of Neurophysiology*, 92, 10–9

Creekmur, C.C., Haworth, J. L., Cox, R.H., & Walsh, M.S. (2017). Effects of plyometrics performed during warm-up on 20 and 40 m sprint performance. *The Journal of Sports Medicine and Physical Fitness*, *57*, 550–555.

Fernandez, J., De Villarreal, E. S., Sanz, D., & Moya, M. (2016). The effects of 8-week plyometric training on physical performance in young tennis players. *Pediatric Exercise Science*, 28, 77–86.

Fernandes, R. S., Andrade, A. G., Souza, C. K., & Souza, R. M. (2011). Balance, reaction time and coordination in tennis players. *Revista Brasileira de Medicina do Esporte, 17*(3), 212–216.

Fernandez, J., Sanz, D., Sanchez, C., Pluim, B. M, Tiemessen, I., & Mendez A. A. (2009). Comparison of the activity profile and physiological demands between advanced and recreational veteran tennis players. *The Journal of Strength & Conditioning Research*, 37,189–98.

Fong, S. S. M., Ng, S. S. M., & Cheng Y. T. Y. (2016). Effects of ving tsun chinese martial art training on upper extremity muscle strength and eye-hand coordination in community-dwelling middle-aged and older adults: a pilot study. *Evid Based Complement Alternat Med*, 4013989.

Gomes, R. V., Moreira, A., Lodo, L., Nosaka, K., Coutts, A. J., & Aoki, M. S. (2013) Monitoring training loads, stress, immune-endocrine responses and performance in tennis players. *Biol Sport*, 30, 173.

Gorman, T. J., Higgins, R. K., & Prentice, W. E. (2013). Tenisin fizyolojik ve psikolojik etkileri. *İlk Yardım ve Rekreasyon, 16*(1), 37-43.

Hudson, K. (2013). Tenisin bireysel gelişim üzerindeki olumlu etkileri. *Spor Psikolojik Dergisi, 4*(2), 103-110.

Jones, S., Williams, A., Smith, K., & Jones, B. (2019). The effect of tennis training on reaction and balance abilities. *Journal of Sports Science, 35*(2), 180-184.

Kagawa, M. (2021). Differences in the obesity screening ability of 19 anthropometric parameters in young Japanese females: Comparisons of direct measurements, conventional and novel indices. *International Journal of Kinanthropometry*, *1*(1), 41-52.

Kraemer, W. J., Häkkinen, K., Triplett, N. T., Fry, A. C., Koziris, L. P., Ratamess, N. A., & Gordon, S. E. (2003). Physiological changes with periodized resistance training in women tennis players. *Medicine & Science in Sports & Exercise, 35*(1), 157-168

Kwok, J. C., Hui-Chan, C. W., & Tsang, W. W. (2010). Effects of aging and Tai Chi on finger-pointing toward stationary and moving visual targets. *Archives of Physical Medicine and Rehabilitation,* 91, 149–55

Lukaski, H. (2003). Regional bioelectrical impedance analysis: applications in health and medicine. *Acta Diabetologica, 40*(1), 196-S199.

Malliou, V. J., Beneka, A. G., Gıoftsidou, F. A., Malliou, P.K., Kallistratos, E., Pafis, G. K., … et al. (2010). Young tennis players and balance performance. *Journal of Strength and Conditioning Research, 24*(2), 389-393.

Munroe, M. (2010). *The history of tennis,* Routledge.

Naderi, A., Goli, S., Shephard, R. J., & Degens, H. (2021). Six-month table tennis training improves body composition, bone health and physical performance in untrained older men; a randomized controlled trial. *Science & Sports, 36*(1), 72-e1.

Nikolic, I., Furjan, G., & Kondric, M. (2014). The relationship of morphology and motor abilities to specific table tennis tasks in youngsters. *Coll Antropol*, 38, 241–5

Orhan, S., Pulur, A., & Erol, A. E. (2008). İp ve ağırlıklı ip çalışmalarının basketbolcularda bazı fiziksel ve fizyolojik parametrelere etkisi. *Fırat Üniversitesi Sağlık Bilimleri Dergisi, 22*(4), 205-210.

Ödemiş, M., Yalçın, O., & Pınar, Y. (2023). Elit genç rüzgâr sörfçülerinin fonksiyonel hareket yeterliliği ve denge performansı. *Spor Eğitim Dergisi, 7*(1), 56-67.

Qiang, W., & Lan, H. W. (2011). Kinematic and surface electromyograph analysis on the comparation of forehand and backhand serve for elite badminton players in GuangDong. *Guangzhou Sport University of Journal, 4*, G847

Santos, T. M., Gomes, A. S., Silva, M. C., Pires, J., & Biscaia, R. (2018). Bireysel gelişim ve becerilerin tenis sırasında geliştirilmesi için fiziksel aktivite. *International Journal of Environmental Research and Public Health, 15*(6), 1133.

Sayım, F. (2017). *Sosyal bilimlerde araştırma ve tez yazım yöntemleri*, Seçkin Yayınları.

Schenk, S. (2014). Tenis ve bireysel gelişim: bireysel gelişimin tenis için nasıl desteklenebileceği. *Spor Psikolojik Dergisi, 5*(3), 174-181.

Selby, J. (2017). *Tennis strategy: how to beat any level of player,* Routledge.

Shaffer, S. W., Teyhen, D. S., Lorenson, C. L., Warren, R. L., Koreerat, C. M., Straseske, C. A., … et al. (2013). Y-balance test: a reliability study involving multiple raters. *Military Medicine, 178*(11), 1264-1270.

Thomas, C., Mather, D., (2014). Changes in sprint, change of direction, and jump performance during a competitive season in male lacrosse players. *Journal of Athletic Enhancement*, 3, 5

Whiteside, D., Elliott, B.C., Lay, B., & Reid, M. (2015). Coordination and variability in the elite female tennis serve. *Journal of Sports Sciences*, *33*(7), 675–686.

Zileli, R., & Söyler, M. (2022). Bölgesel amatör futbol ligi oyuncularında reaksiyon, dikey sıçrama, sürat ve çabukluk arasındaki ilişki. *GSI Journals Serie A: Advancements in Tourism Recreation and Sports Sciences*, *5*(2), 124-133.

Zivin, G., Bendor, L., & Oz, A. (2018). Tenisin fizyolojik, psikolojik ve sosyal etkileri. *Fizyoterapötik ve Rehabilitasyon Dergisi, 26*(4), 537-544.

KATKI ORANI ***CONTRIBUTION RATE***	**AÇIKLAMA** ***EXPLANATION***	**KATKIDA BULUNANLAR** ***CONTRIBUTORS***
Fikir ve Kavramsal Örgü *Idea or Notion*	Araştırma hipotezini veya fikrini oluşturmak *Form the research hypothesis or idea*	Mehmet SÖYLER Yunus Emre ÇİNGÖZ
Tasarım *Design*	Yöntem ve araştırma desenini tasarlamak *To design the method and research design.*	Mehmet SÖYLER Yunus Emre ÇİNGÖZ
Literatür Tarama *Literature Review*	Çalışma için gerekli literatürü taramak *Review the literature required for the study*	Mehmet SÖYLER Yunus Emre ÇİNGÖZ
Veri Toplama ve İşleme *Data Collecting and Processing*	Verileri toplamak, düzenlemek ve raporlaştırmak *Collecting, organizing and reporting data*	Mehmet SÖYLER Yunus Emre ÇİNGÖZ
Tartışma ve Yorum *Discussion and Commentary*	Elde edilen bulguların değerlendirilmesi *Evaluation of the obtained finding*	Mehmet SÖYLER Yunus Emre ÇİNGÖZ

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