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Examination of Lower and Upper Limb Reaction Characteristics of Elite Racquet Athletes after Strength Training

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Abstarct

In this study, the reaction characteristics of elite racquet athletes in the lower and upper limb strength and strength parameters were examined and interpreted. 8 Men, 8 women, 4 Athletes from each branch (tennis, table tennis and badminton) participated in the study. Lower and upper ectremite wingate measurements were made and tested by each volunteer participating in the study. Isokinetic measurements were performed in such a way that the dominant leg and arm were. Statistical analysis of the data was carried out in the SPSS 22 package program. T test in binary variables, Tukey analysis with LSD was performed from post hoc tests to determine which groups the differences were caused by a one-way analysis of variance (Anova) in comparisons made with branches.Pearson correlation matrix was used in intergroup decoupling. Statistically, the significance level was taken as 0.05. In our study, it was determined that there is a relationship between Force parameters and wingate levels, but this relationship is stronger in the lower extremity than in the upper extremity Dec. Both Isokinetic arm strength and arm wingate levels were found to be significantly higher in the branches where the upper limb was dominant ($p<0.05$), but this difference in the upper limb was not observed in the lower limb. It is believed that the lower extremities are actually active in branches where the upper extremity is dominant (tennis and table tennis), but the same activity does not apply to the upper extremities in branches where the lower extremity is dominant (badminton).

Keywords: Limb reaction, racquet sports, strength training, isokinetic

1. INTRODUCTION

Strength is one of the important components of training. Although the term force is basically the same, it has been defined differently in different fields. The skeletal muscle moves the nerve impulses reaching them and the joint or joint group to which it is connected in principle as a result of some biochemical events caused by these impulses, or causes it to remain stable (Günay and Yüce, 2001).

Resistance exercises are among the exercises that are highly sought after by the masses in order to establish physical fitness in order to maintain and improve health, and to provide hypertrophy in parallel with the increase in strength. While performing strength exercises, different combinations of training components affect the biochemical, physiological, physical and morphological responses that occur in the exercise, as well as the scope of the response to this exercise. Factors such as the type of contraction occurring in the muscle, the degree and size of the training, the preference and order of exercise, the rest periods, the duration and frequency of repetitions form these responses (Bird, 2015: 841).

Hypertrophy caused by the answers given is associated with gaining muscle volume in those who engage in recreational or professional fitness sports. In addition to all these, it is frequently done to protect and improve health (Glass, 2005).

It is known that approximately two million people in our country are engaged in fitness. The development of hypertrophy has become one of the most important focal points in research. When the literature is examined, it is stated that the hypertrophic response is formed by three main systems. These; mechanical tension, metabolic stress and muscle damage (Schoenfeld, 2016:16).

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However, it is stated in the literature that these mechanisms do not provide a similar level of response in every person, and that there is a different hypertrophy response even at the same exercise intensity (Petrella et, 2008). Hypertrophic data has a highly complex order. Hypertrophy occurs as a result of the activities of hormones, cytokine activity, the mechanism of muscle damage, and the complex activity of satellite cell signaling pathways involved in the occurring parts (Schoenfeld, 2016:17).

There are two main systems that design the coordination and arrangement of many applications in the organism. The first is the nervous system and the other is the endocrine system. The endocrine system manages the metabolic processes of organs and tissues in different parts of the body, thus performing an important task in establishing homeostasis. Independent nerves and endocrine glands manage the coordination of different functions of the body in daily life. For this reason, exercise endochronology occupies an important place in terms of adaptation of the organism to exercise. Different stress situations such as exercise and intense training cause the levels of some hormones to rise and fall during and after exercise, due to their effect on the hormonal system. This is where the concept of stress comes into play. First Canadian physiologist Selye in 1952; He defined the response of the organism to stimuli as stress (Selye, 1946).

The human organism is in constant interaction with the internal and external environment. The stimuli and messages that cause movement in the organism, as factors, cause the harmony of the organism to be disrupted after reaching a certain value and limit, and the process in question affects the different construction and functions of the organism. The organism tries to find balance, order and hormones. The resulting state is precisely described as stress. Considering that exercise is a stress position for the organism due to physical and mental strains, it is likely that there are hormonal differences for adaptation. It is as important as possible to determine the effects of exercise on the endocrine system in order to determine the positive or negative effects of the exercise performed in this manner. The acute and chronic effects of strength training on total testosterone, IGF-1, CK hormones, as well as the effects of exercise on resistance and body whole, constitute the main part of this study.

The effects of hormones on exercise have been an important issue in sports physiology and sports medicine examinations in recent years. Exercise endochronology occupies an important place in terms of adaptation of the organism to exercise. Various stress situations such as exercise and intense training cause the levels of some hormones to increase and decrease in the resting position, due to their effect on hormonal release.

Resistance exercises for the lower and upper extremities have been the subject of many studies in terms of their effects on hormones for many years. When national sources are examined, limited research has been found on this subject so far. At the same time, exercises for the upper and lower extremities were studied separately in the literature, and they were not considered together. Therefore, this research will provide valuable evidence in terms of determining how much lower and upper extremity resistance exercises are affected by each other in terms of hormones during activity.

It is known that the use of different extremities is a very important issue when determining exercise preferences. Upper and lower extremity muscles are very determinative in increasing sportive performance, preventing injuries and creating a rehabilitation approach. However, combined studies on the upper and lower extremities have not been conducted in the literature and focused on a single region. In this context, considering the resistance exercises for the lower and upper extremities separately, together with the possible results, will reveal important evidence.

Durability; It is defined as the ability of the whole organism to resist fatigue in long-term sportive exercises and to maintain very high-intensity loads for a long time (Sevim, 1991).

These different effects, which occur in different forms in different sports branches in terms of the organism's ability to resist fatigue, violence and endurance, have created different endurance categories in sports science (Dündar, 2003: 1-2).

Resistance to the type of sport has been classified in a certain way. These types are described below.

-General stamina: It is the stamina characteristic that every athlete should have. In general endurance, it is the endurance of the respiratory and circulatory systems. In addition, general endurance supports athletes to successfully demonstrate a high scope of work to overcome fatigue in competitions and to recover more quickly for future training and competitions (Sevim, 1991).

-Special durability; It can be affected by the tensions caused by such endurance competitions, the performance of difficult sports tasks or the type of training offered (Muratlı, 1976).

In terms of energy generation, endurance types are divided into two as aerobic endurance and anaerobic endurance.

Aerobic Endurance; In this type of endurance, the energy expended in the work is balanced. Generally, it is the endurance of the organism, which is revealed in a sufficient oxygen environment without going into oxygen debt. It is developed to be resistant to the aerobic energy system in continuous work of three minutes or more (Sevim, 1991).

Anaerobic Endurance; It is the ability of the organism to carry out any sportive activity by taking advantage of the energy stores in the body at fast, dynamic, very high and maximal loads (Sevim, 1991).

Endurance in terms of training time; Endurance, which is one of the important factors of performance, refers to the duration of the organism's ability to resist fatigue, including short (45 seconds-2 minutes), medium (2 minutes-8 minutes), and long-term (8 minutes and above) (Üstündal and Köker, 1998).

Types of durability in terms of engine characteristics are listed below.

Continuity in strength; It is valid in branches where high strength efficiency is needed, when the waste products of anaerobic metabolism start to accumulate in the body (Eyüpoğlu, 2006: 7).

Continuity in quick strength; It is the ability of the neuromuscular system to overcome resistance for a long time by contracting at a high speed (Sevim, 1995: 27-28).

Endurance in terms of the way the muscles work; It is divided into two as dynamic endurance and static endurance.

Dynamic endurance; it is the ability to continue a movement for a long time (Dündar, 1999: 83-84). It is the endurance created by the contraction and relaxation of the muscles.

Static durability; It is explained as the ability of the muscles to resist a resistance for a long time. It is the endurance created by the muscle by contracting and maintaining its condition (Dündar, 1999: 85).

Starting sports activities in childhood and applying exercises suitable for their characteristics in various periods gives children a healthier life in the future (Taskiran, 1997: 79). With the onset of school age, a better structuring occurs in the muscles. The muscular system is strengthened, accelerated and the ratio of muscle mass in body weight increases.

The necessity of developing endurance in children and young people independently of other motoric features is due to the positive effects of improvements in endurance on other conditional features such as speed, quick strength, continuity in strength, maximal strength and skill. Especially in youth, 60% of the training should be endurance, 25% strength and 15% speed training (Günay et al., 1996: 381-382).

The concept of strength in sports science is defined and classified in many ways and in a wide variety of fields. In the definitions of many sports scientists, it is seen that the definition and concept of strength have different meanings and forms. Force is the basic feature of man, with the help of it, he moves a mass, overcomes a resistance or counters it with muscle power (Kale, 1993: 39).

When considered in terms of sports science, strength is created by bone, joint and muscle structure, which is considered as a lever system. Strength is a result of the muscle mass and the speed revealed by this muscle mass (Günay et al., 1996: 383).

General strength is the strength of all muscles without being directed to any sport (Fox, 1985: 15-16). In other words, it indicates the strength of the entire muscular system. A low level of general strength may be a factor limiting the overall development of the athlete (Oktaylar, 2006). It should cover studies parallel to the technique of the branch. Station or circular (curcuit) studies can be done. While there are 8-12 stations in general force works, there are 3-4 stations in special force works. We can say a little more specific (Baser, 1996).

Maximal force; It is the greatest force produced by the muscular nervous system as a result of voluntary contraction. In other words, it is the maximum amount of force that an athlete can produce at one time (Bompa, 1998).

Quick force; It is the largest force that can be created in the shortest time. It is the ability of the nervous musculature to overcome external resistance with a high-speed contraction. Quick strength is a product of two skills, speed and strength, and is defined as the ability to exhibit the highest strength in the shortest time interval (Günay et al., 2006).

Continuity in strength is the ability of muscles to continue working over a long period of time. In other words, it is the ability of the muscular system to resist fatigue in continuous and repeated contractions. Continuity in strength; reaction, sprint, jump, throwing, pulling, hitting and explosive strength endurance is divided into sub-forms (Fox, 1986: 16; Akgün, 1994: 48). Dynamic force; The muscle shortens during contraction. It is the most commonly used type of contraction in team sports. Thanks to this strength, the athlete can overcome his own body weight or the weight of a foreign body and other resistances (Kale, 1993: 39-40).

In static strength, there is no visible shortening of the muscle, but with a high tension, the strength is revealed. In other words, there is no convergence at the starting and ending points of the muscle. However, there is intramuscular expansion in static contraction. In addition, the athlete maintains his condition against resistance in static strength, and internal and external forces adapt to each other (Kale, 1993: 41). Pure strength is the highest force that the athlete can apply regardless of his own body weight (Sevim, 1991). Knowing the highest weight that a person can lift in one attempt is sufficient to determine the loads in the training.

Strength development in children increases in parallel with age, height, weight, the ratio of levers in the skeletal system and the development in muscle mass. This development contributes to the body's athletic structure. However, the improvements in the force level are not only dependent on the optimization of the levers system. Because strength development in children depends on hormonal development, the ability of the central nervous system (CNS) to start working in accordance with the purpose, and the development of its ability to better tolerate O2 borrowing. For these reasons, some age-specific differences can be seen in the development of maximal strength, quick strength and continuity in strength in children (Erol et al., 1999).

Muscle strength increases with age in children. During adolescence, there is a marked increase in muscle strength. Improvement in sports based on muscle strength and speed occurs gradually as age progresses. For this reason, efforts to achieve early success by pushing children more than necessary at very early ages can have negative effects on the physical development of the child (Günay & Cicioğlu, 2001).

Grip strength is of great importance in elite racquet athletes. The most important indicator of Health IS grip strength. Grip force is one of the most important methods for estimating power (Tamiya, 2012; Groslambert, 2002). In different sports, throwing the ball by catching it by the tool is of great importance in terms of grip strength. Here, it can be seen that if the finger and hand surface parameters of individuals are longer than necessary to grasp an object, the fingers are less spread out and will be more efficient and less tiring to grasp an object (Nac, 2003).Hand grip strength; the maximum force that can be applied under all conditions of normal biyokinetik finger joints in the hands and forearms as a result of a lot is defined as the result of a strong flexion of Nov (Richards et al., 1996; Bohannon, 1997; Bassey and Harrie, 1993).

Grip strength is generally considered as a functional index of physical strength and hand and forearm November performance (Massey-Westrop et al., 2004; Foo, 2007; Nwuga, 1975). There are many physical variables in which grip strength is affected. These are many factors such as age, gender and body size. Strong correlations have been found between grip strength and many deciduous anthropometric features (Singh et al., 2009; Koley et al., 2009; Kaur, 2009). It has been determined that players with good fitness characteristics are more advantageous than their competitors, as in any sport. These athletes appear to move faster than their competitors, think faster, recover quickly after long periods of scoring, become less tired and have less risk of injury.

It has been determined that the difference between winning and losing athletes depends on conditioning characteristics such as endurance, strength, sprint (Ölçücü et al., 2010). Tennis and badminton are seen as a sport where the arms, legs and upper body are used completely. In terms of muscle and strength endurance, insufficient force and endurance for the arms and torso come towards the end of a long series of strokes or competition. Here, it was determined that the strike power decreases with attention and the body shape changes accordingly (Bompa, 1998).

In Latin, the limb is defined as the arms and legs. The extremities are divided into upper and lower extremities. While the arms form the upper extremity, the legs are seen as the lower extremities. The upper extremity is connected to the trunk through the shoulder joint. The lower extremity is attached to the trunk by the hip bone. The muscles here are considered as limb muscles. The muscles acting around the shoulder joint and the clavicle joint are examined as formations that form a motion circle. Upper extremity muscles are divided into four groups according to their structure. These; shoulder, arm, forearm and hand muscles.

The lower extremity muscles are listed as hip, thigh, leg and foot muscles. It has been revealed that the lower and upper extremity muscles are decisive in increasing performance, preventing injuries and creating a rehabilitation approach (Kafkas and Çoksevim, 2014). Lower extremity strength; while determining the shortest time to catch the ball, the upper extremity strength will ensure that the balls are hit more quickly during the match. A firm and correct grip on the racket prevents wrist and elbow injuries and ensures protection of the racket, especially in off-center hits, by using the racket together (Polat, 2009).

In order for a tennis player to hit effectively, especially the physical fitness parameters must be at a high level. In the tennis game where there is no contact with the opponent, especially fast change of direction, fast arm movements, jumps and moves are needed (Weber, 1982). For this reason, individuals who play tennis should have high aerobic and anaerobic power, and the muscles that create the strength should be strong (Ferrauti et al., 2002; Chu, 1995; Gullikson, 2003).

It is seen as one of the strength training components. Although the term force is basically the same, it has been used in different fields and in different ways. As a result of nerve impulses reaching the muscles in the skeleton and a number of biochemical events caused by these impulses, they keep the joint or joint group to which they are connected in principle, to stay stable (Günay and Yüce, 2001).

Resistance exercises are one of the most preferred sports by large masses as a result of establishing physical fitness for maintaining and improving people's health and providing hypertrophy in parallel with the increase in strength. During the application of strength exercises, it was determined that different combinations of the training components affected the physiological, biochemical, physical and morphological responses of the exercise at the same time, and the scope of the response to this exercise. The elements that form the answers here are; It is seen as the type of contraction occurring in the muscle, the degree and size of training, exercise preference, order, rest periods, repetition time and frequency (Bird, Tarpenning and Marino, 2005). Hypertrophy, which occurs with the answers given here, is associated with gaining muscle volume, especially in people who are engaged in recreational or professional fitness sports. In addition to these, it is seen that it is done very often in order to protect and improve health (Glass, 2005). It is known that approximately two million people in Turkey are engaged in fitness.

When the researches are examined, it is seen that the development of hypertrophy is one of the important focal points. Accordingly, it is seen that the hypertrophic response occurs with three main systems. These main systems are; muscle damage, metabolic stress and mechanical stress (Schoenfeld, 2016). In studies, it has been concluded that these mechanisms do not provide a similar level of response in each person, and that there is a different hypertrophy response even at the same exercise intensity (Petrella et al., 2008).

Hypertrophic data appear to be in a complex order. The activities of hormones for the formation of hypertrophy, cytokine supplementation, the mechanism of muscle damage, are formed as a result of the complex activity of the signaling pathways involved in the occurring parts (Schoenfekd, 2016). It has been determined that there are two main systems as a result of the arrangement and coordination of many applications in the organism. These systems are; nervous system and endocrine system. When the endocrine system is examined, it manages the metabolic functioning of organs and tissues in different parts of the body. Therefore, it has played an important role in determining its homeostasis. In daily life, it is seen that independent nerves and endocrine glands manage the coordination of different functions of the body. For this reason, it has been determined that exercise endochronology occupies an important place due to the adaptation of the organism to exercise. By affecting the hormonal system in different stress situations such as exercise and intense exercise, it causes the levels of some hormones during rest to rise and fall during and after exercise. At this point, the concept of stress emerges.

In 1952, Canadian Physiologist Selve named the response of the organism to stimuli as stress (Selye, 1952). It has been determined that the human organism is in constant interaction with the internal and external environment. It is seen that the stimuli and messages that cause movement in the organism, as factors, reach a certain value and limit and cause the harmony of the organism to deteriorate. The process here affects the different constructions and functions of the organism. At this point, it is seen that the organism is in an effort to find balance, order and hormones. This situation is called stress. Considering a stress position in organisms that depend on mental and physical strains in exercise, hormonal differences must be found for adaptation.

When the international studies are examined, it has been determined that there are limited studies on this subject. In the literature, it is seen that the exercises for the upper and lower extremities are studied separately and not considered together. For this reason, this study was conducted to examine the reaction characteristics of the upper and lower extremities of elite racket athletes after strength training. With this aspect of the research, important contributions have been made to the literature with the theoretical findings obtained.

Although strength training increases muscle strength and endurance performance, it is thought that it does not affect the maximum oxygen consumption (VO_2 max), which is an indicator of aerobic capacity. An increase in endurance performance after strength training was demonstrated in a study with an increase in running time on the bicycle ergometer and on the treadmill. In the same study, no change in $V0_2$ max was found despite the increase in endurance (Mathews and Fox, 1986). It is thought that the increase in endurance performance is largely due to the increase in muscle strength and endurance (Jones, 1992; Marcinik e.t, 1991; Mathews and Fox, 1986; sharkey, 1997). One of the factors limiting exercise time is the lactate threshold. For this reason, it has been suggested that there may be a change in the anaerobic threshold and lactate threshold in the increase of muscle strength and endurance. In a study investigating this relationship, it was shown that there was an increase in the lactate threshold without any change in VOmax with strength training (Marcinik et, 1991).

It is seen that the use of different extremities is a very important issue when determining exercise preferences. Upper and lower extremity muscles are considered to be quite decisive in increasing their athletic performance, preventing injuries and creating a rehabilitation approach. It has been determined that there are no combined studies in the literature for the lower and upper extremities and that they focus on a single region. In this context, important evidence will emerge as a result of the combination of resistance exercises for the lower and upper extremities, together with their separate results. As a result of the findings, it will also serve as a guide for resistance exercise practitioners and participants in terms of choosing exercise equipment.

2. MATERIAL AND METHOD

Research Group

A total of 12 university students, 6 male and 6 female athletes, including 4 table tennis, 4 tennis and 5 badminton, participated in this research we have done voluntarily. Age, height, body weight and BMI values of the athletes are given in Table 1.

Tablo 1. Anthropometric characteristics of the athletes participating in the research

	Group	N	Mean	SS
Age (year)	Table Tennis	4	24,25	2,34
	Tennis	4	22,78	3,14
	Badminton	4	23,55	2,75
Length (cm)	Table Tennis	4	179	0,08
	Tennis	4	178	1,21
	Badminton	4	180	0,05
Body Weight (kg)	Table Tennis	4	68,85	12,14
	Tennis	4	60,24	8,12
	Badminton	4	70,23	6,58
BMI(kg/m2)	Table Tennis	4	23,54	2,39
	Tennis	4	21,31	2,14
	Badminton	4	22,96	3,03

3. Data Collection Tools

Height, body weight, BMI and age measurements were made for the three groups in the study. Here, the body weights of the athletes were measured with an electronic scale with a precision of 0.1 kg, and the height was measured with a digital height meter with a precision of 0.01 cm. Before the study was conducted, the subjects were informed about the study design and procedure. Before the measurements, the subjects were checked for health to avoid any health problems. Subjects were tested 2 hours after breakfast in the morning. Measurements were made between 09.00 and 11.00 in the morning on different days as upper extremity and lower extremity anaerobic power and isokinetic strength measurements. Subjects were taken to Wingate upper and lower test and dominant arm and leg tests.

4. Statistical Analysis

In the study, the analysis was carried out using the SPSS 22 package program in the analysis of the data. The mean values and standard deviations of the parameters of all subjects are given. The normal distribution of the data belonging to the research was tested with the Shapiro-Wilk Test. Independent sample t-test was used in binary variables for normally distributed data, and one-way analysis of variance (Anova) was used in comparisons of branches, and post hoc tests LSD and Tukey were used to determine which groups caused the differences. The KruskalWallis test was applied to the data that did not show normal distribution. Pearson correlation matrix was used in the relationship between isokinetic strength and anaerobic power of the groups, in this correlation matrix 0.00-0.29 weak, 0.30-0.49 low correlation, 0.50-0.69 moderate relationship, 0.70-0.89 indicates a strong relationship and 0.90-1.00 indicates a very strong relationship. The statistical significance level was taken as 0.05.

5. RESULTS

It was found that the age and height of the athletes participating in the study were statistically similar, and there was a significant difference between the 3 groups according to their body weights ($p<0.05$).

Table 2. Lower extremity wingate results of the athletes participating in the study according to their branches

Wingate Lower	Group	Mean±Standard Deviation	Letter
	Table Tennis	720,43±140,86	b
PP(W)	Tennis	978,67±143,54	a
	Badminton	823,45±118,54	ab
	Table Tennis	9,80±1,32	ab
RPP(W/kg)	Tennis	9,21±2,25	ab
	Badminton	10,22±1,78	a
	Table Tennis	512,98±85,54	b
AP(W)	Tennis	623,87±78,98	a
	Badminton	605,64±57,87	ab
	Table Tennis	7,23±1,12	-
RAP(W/kg)	Tennis	7,12±1,03	-
	Badminton	7,67±0,34	-

abcd: The difference between the means with different letters in the same column is significant ($p<0.05$). PP: Peak Power, RPP: Relative Peak Power, AP: Average Power, RAP: Relative Average Power

When Table 2 is examined, it has been determined that there is a significant difference between the other two groups in the lower extremity wingate peak strength according to the branches of the athletes participating in the research ($p<0.05$). As a result of the examination made between RAP data, it was determined that there was no significant difference between branches ($p>0.05$).

Table 3. Upper extremity wingate results of the athletes participating in the study according to their branches

Wingate Upper	Group	Mean±Standard Deviation	Letter
	Table Tennis	887,98±145,76	a
PP(W)	Tennis	804,34±258,98	a
	Badminton	665,76±76,56	ab
	Table Tennis	14,34±3,23	a
RPP(W/kg)	Tennis	9,69±3,98	ab
	Badminton	9,23±1,12	b
	Table Tennis	448,07±54,34	a
AP(W)	Tennis	386,56±37,67	ab
	Badminton	356,45±52,34	b
	Table Tennis	6,98±0,84	a
RAP(W/kg)	Tennis	5,46±1,21	b
	Badminton	5,23±0,48	b

abcd: The difference between the means with different letters in the same column is significant ($p<0.05$). PP: Peak Power, RPP: Relative Peak Power, AP: Average Power, RAP: Relative Average Power

When Table 3 is examined, a statistically significant difference was found between the table tennis and badminton groups in the upper extremity wingate RPP values according to the branches of the athletes participating in the research ($p<0.05$). There is no statistically significant difference between sports branches in PP values ($p>0.05$). There is a significant difference between table tennis and badminton in AP value ($p<0.05$). There is a significant difference between table tennis, tennis and badminton sports in RAP values ($p<0.05$).

Table 4. Isokinetic test results in dominant leg extension and flexion 60/s and 180/s rotation of the athletes participating in the study

			Group	Mean±SD	Letter
			Table Tennis	218,98±33,00	ab
		Extension	Tennis	226,45±32,23	a
	PP(Nm)		Badminton	190,87±40,87	b
			Table Tennis	110,98±19,78	b
		Flexion	Tennis	140,34±17,65	a
60/s			Badminton	109,45±17,45	b
			Table Tennis	133,37±38,56	ab
		Extension	Tennis	170,98±23,99	a
	AP(w)		Badminton	168,54±37,67	a
			Table Tennis	82,34±16,45	ab
		Flexion	Tennis	103,45±16,75	a
			Badminton	98,78±18,76	a
			Table Tennis	140,34±25,45	bc
		Extension	Tennis	169,98±32,48	a
	PP(Nm)		Badminton	117,87±34,98	c
			Table Tennis	74,54±21,35	-
		Flexion	Tennis	86,78±9,87	-
180/s			Badminton	90,34±24,34	-
			Table Tennis	220,98±34,54	bc
		Extension	Tennis	287,67±45,98	a
	AP(W)		Badminton	254,78±49,98	ab
			Table Tennis	120,93±42,23	-
		Flexion	Tennis	138,56±18,03	-
			Badminton	140,56±35,63	-

abcd: The difference between the means with different letters in the same column is significant ($p<0.05$). PP: Peak Power, RPP: Relative Peak Power, AP: Average Power, RAP: Relative Average Power

In Table 4, there is a statistically significant difference between tennis and Badminton in the PP extension 60/s rotation when Isokinetic test results were examined in the dominant leg and flexion 60/s and 180/s rotation of the athletes participating in the study ($p<0.05$). There is a statistically significant difference between tennis and Table Tennis and tennis and badminton athletes in the PP Flexion 60/s rotation ($p<0.05$). There are no significant differences between sports branches in AP extension 60/s rotation ($p> 0.05$). There are no significant differences between sports branches in AP flexion 60/s rotation ($p>0.05$). There is a statistically significant difference between tennis and Badminton in the PP extension 180/s rotation ($p<0.05$). There are no statistically significant differences in PP Flexion 180/s rotation, AP extension 180/S and AP flexion 180/s rotation ($p>0.05$).

Table 5. Isokinetic test results of the athletes participating in the study in the dominant arm internal and external 60°/s and 180°/s rotation

			Group	Mean±SD	Letter
			Table Tennis	68,76±13,34	-
		Internal	Tennis	64,56±10,45	-
	PP(Nm)		Badminton	58,78±7,67	-
			Table Tennis	43,45±9,56	-
		External	Tennis	44,56±9,78	-
60/s			Badminton	33,45±4,54	-
			Table Tennis	54,78±12,98	a
		Internal	Tennis	48,76±9,87	a
	AP(w)		Badminton	42,34±5,65	b
			Table Tennis	34,54±7,67	-
		External	Tennis	35,65±8,65	-
			Badminton	18,78±8,95	-
			Table Tennis	61,87±16,98	a
		Internal	Tennis	60,45±9,78	a
	PP(Nm)		Badminton	40,22±14,35	b
			Table Tennis	38,98±8,45	-
		External	Tennis	35,76±9,54	-
180/s			Badminton	32,45±7,67	-
			Table Tennis	78,98±28,98	-
		Internal	Tennis	67,98±16,98	-
	AP(W)		Badminton	58,65±9,45	-
			Table Tennis	44,56±9,67	-
		External	Tennis	42,34±7,65	-
			Badminton	38,87±6,56	-

abcd: The difference between the means with different letters in the same column is significant PP: Peak Power, RPP: Relative Peak Power, AP: Average Power, RAP: Relative Average Power

When Table 5. is examined, there is a statistically significant difference between table tennis and badminton and tennis and badminton sports in internal 60°/s rotation ($p<0.05$). When other data were examined, no significant difference was found between branches ($p>0.05$).

6. CONCLUSION

In our study, it was determined that there is a relationship between strength parameters and wingate levels, but this relationship is stronger in the lower extremity than in the upper extremity. It was determined that both isokinetic arm strength and arm wingate levels were found to be significantly higher in branches in which the upper extremity was used dominantly than in the branches in which the lower extremity was dominant ($p<0.05$), but this difference in the upper extremity was not observed in the lower extremity.

It is thought that the lower extremities are actually effective in branches where the upper extremity is dominant (tennis and table tennis), but the same effectiveness is not valid for the upper extremities in branches where the lower extremity is dominant (badminton).

- Factors such as both the athlete level of the groups formed while conducting similar studies and the performance levels of the individuals at the time of the study are considered as factors that affect the results more. For this, the homogeneous distribution of the groups should be taken into account while forming the groups.

-Besides, it is thought that more healthy results will be obtained from the study if the body weight and average age of the groups are similar.

-During the study, planning should be done by taking into account the training periods of the individuals and groups participating in the research.

-In the study; lower and upper extremity groups were formed from three branches. It is recommended that similar studies be carried out by increasing the number of groups and branches.

-In the study; isokinetic measurements were made with the dominant leg and arm at 60°/s and 180°/s rotation. In similar studies, it is recommended to measure the non-dominant leg and arm in different rotations.

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