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Anthropometric characteristics are highly correlated with anaerobic power in male handball and soccer players

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Abstract

The purpose of this research is to examine the relationship between anthropometric characteristics and anaerobic power of volunteer male athletes. Male athletes in the college soccer and handball teams (n: 20; age: 23.20±1.94 years; height: 179.81±7.96cm; weight: 79.50±9.23kg) volunteered for the study. For anthropometric characteristics, some measurements (body height, arm span, hand length, and chest, waist, arm, thigh and leg circumferences) were taken. Vertical jump height via Countermovement Jump (CMJ) test and body weight were also measured. Anaerobic power value was obtained using Lewis formula. For statistical analysis, descriptive statistics and Pearson correlation analyses were performed using the SPSS 17.00 package program. Significance value was set as $p<0.05$. There found a positive correlation between anaerobic power values and the values of body height (r=.660), body weight (r=0.912), arm span (r=0.547), dominant hand length (r=0.578), upper arm circumference (relaxed) (r=0.690), upper arm circumference (flexed) (r=0.689), thigh circumference (r=0.643), calf circumference (r=0.533), waist circumference (r=0.826), chest circumference (r=0.704), vertical jump height (r=0.493). The results showed that there was a statistically significant and high correlation between all measured anthropometric characteristics and anaerobic power values. Therefore, it is recommended trainers pay attention to these characteristics in player selection, training plans and determining performance of athletes.

Keywords: Arm span, anaerobic performance, body height, thigh circumference, vertical jump

Erkek hentbol ve futbolcularda antropometrik özellikler anaerobik güç ile yüksek düzeyde ilişkilidir

Özet

Bu araştırmanın amacı, erkek sporcularda antropometrik özellikler ve anaerobik güç arasındaki ilişkinin incelenmesidir. Çalışmaya üniversite futbol ve hentbol takımlarında yer alan erkek sporcular (n: 20; yaş: 23,20±1,94 yıl, boy uzunluğu 179,81±7,96 cm, vücut ağırlığı 79,50±9,23 kg) gönüllü olarak katılmıştır. Antropometrik özellikler için bazı uzunluk (boy, kulaç ve el uzunluğu) ve çevre (göğüs, bel, kol, uyluk ve bacak çevresi) ölçümleri alınmıştır. Vücut ağırlığı ve dikey sıçrama yüksekliği (CMJ) ölçülmüştür. Anaerobik güç değeri, Lewis formülü ile hesaplanmıştır. İstatistiksel analizler için SPSS 17.00 paket programında, tanımlayıcı istatistik ve Pearson Korelasyon analizleri yapılmıştır. Anlamlılık düzeyi başlangıçta p<.05 olarak kabul edilmiştir. Anaerobik güç değerleri ile boy uzunluğu (r=.660), vücut ağırlığı (r=0,912), kulaç uzunluğu (r=0,547), baskın el uzunluğu (r=0,578), üst kol çevresi (ekstansiyonda) (r=0,690), üst kol çevresi (fleksiyonda) (r=0,689), uyluk çevresi (r=0,643), baldır çevresi (r=0,533), bel çevresi (r=0,826), göğüs çevresi (r=0,704), dikey sıçrama mesafesi (r=0,493) değerleri arasında istatistiksel açıdan anlamlı (p<0,05) pozitif korelasyonların olduğu tespit edilmiştir. Çalışma sonucunda, ölçülen tüm antropometrik özellikler ile anaerobik güç değerleri arasında istatistiksel olarak anlamlı yüksek düzeyde ilişkilerin olduğu görülmüştür. Antrenörlerin oyuncu seçiminde, antrenman planlamalarında ve sporcu performanslarını belirlemede bu özelliklere önemle dikkat etmeleri tavsiye edilir.

Anahtar Kelimeler: *Kulaç uzunluğu, anaerobik performans, boy uzunluğu, uyluk çevresi, dikey sıçrama*

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Bu çalışma 6. Uluslararası Avrasya Spor Eğitim ve Toplum Kongresi'nde özet bildiri olarak sunulmuştur.

Genişletilmiş Türkçe Özet makalenin sonunda yer almaktadır.

INTRODUCTION

Soccer is known to be the one of the most watched sports all over the world with more than 250 million players and billions of fans (Orangi et al., 2021). Similar to soccer, with close to 20 million players in the world, handball has also become one of the favourite sports (Raeder et al., 2015). In both of these sports, where defensive and offensive players constantly compete with each other, it is very important to be physically and technically at their best as well as condition (Mohammed el al., 2009; Hermassi et al., 2015; Ortega-Becerra et al., 2018). In addition to technical movements performed with or without a ball in these two sports, during the game various movements such as shuttle runs, short sprints, jumps are performed intensively in both defence and offense (Gorostiaga et al., 2005; Visnapuu & Jürimae, 2009; Chelly et al., 2011; Zapartidis et al., 2018). All these movements appear by using the explosive power, the lower-upper extremity strength, and speed. It is noted that the lower and upper extremity muscle power should be used simultaneously in a coordinated manner in many sports (Bencke et al., 2002).

If the force transmission reaches the ball through the kinetic chain, the ball is kicked at maximum speed with the ground reaction force, which occurs when movements such as 3-step shot/pass in handball and throw-in in soccer performed in contact with the ground (Jöris et al., 1985; İnal, 2004; Roach, 2012; Karadenizli et al., 2014). A good performance, especially in sports involving overhead throwing, means that both upper and lower extremity muscles of athletes need to be strenuous and vigorous (Chelly et al., 2010). Furthermore, even though core, upper extremity muscles, and dynamic balance (İnal, 2004; Akuthota et al., 2008; Reed et al., 2012) are all active during force transfer, the lower extremity muscles that initiate the movement (Karadenizli, 2016; Ortega-Becerra et al., 2018; Hermassi et al., 2019; Arı et al., 2020) are also of great importance.

Parameters such as jumping, shooting, turning, dribbling, sprinting, ball control are frequently performed in team sports that require high tempo like handball and soccer (de Villarreal et al., 2009). Moreover, jumping performance is very important in such sports, where there are both defensive and offensive movements, because jumping is frequently performed in handball while shooting or blocking, and while performing headers in defence and offence in soccer. That's why performing effective jumps provide a great advantage to athletes. It is seen that explosive power is an important factor for the desired performance due to the nature of the game because strong and fast movements are often made in a short time in both handball and soccer.

The studies in the literature with handball players have showed that there is significant correlation between anaerobic power and agility (Sekulic et al., 2013; Chittibabu, 2014; Arı et al., 2020), body mass index and grip strength (Arı et al., 2020). Although there are many studies on quickness (Makhlouf et al., 2021), leg muscle volume, mass and strength (Harmancı et al., 2007), and speed (İbrahim et al., 2021; Aslan et al., 2011), in soccer, it has been observed that there are only few studies investigating the relationships between anthropometric characteristics and anaerobic power. Therefore, the aim of this study is to examine this relationship between some anthropometric characteristics and anaerobic power in male handball and soccer players.

METHOD

The study was conducted with 20 male athletes playing in the University Soccer and Handball Team. The volunteers' mean age was 23.20±1.94 years, the mean height was 179.81±7.96 cm, and the mean weight was 79.50±9.23 kg. Before the study, ethics committee report was obtained from Bilecik Şeyh Edebali University Ethics Committee (2021/60230). As participants' rights are required to be protected throughout the study, researchers adhered to the Helsinki Declaration of Human Rights, and all the participants volunteered to participate in the study and filled out a voluntary participation form and were verbally informed about the procedures of the study. The researchers started with taking anthropometric measurements (body height, body weight, arm span, dominant hand length, diametric measurements). Then, the participants performed a 15-minute active warm-up, and then the vertical jump test was performed.

The body height and weight: The height of the soccer and handball players was measured by a stadiometer with an accuracy of ±1 cm (SECA, Germany), and the body weight was measured with an electronic scale (SECA, Germany) with an accuracy of ±0.1 kg. (Peine et al., 2012).

Arm span: It was measured using a tape measure by taking the longest distance between the tip of the middle finder of the right and left hands, with the back against the wall and the arms extended to each side and the palms facing down parallel to the floor (Günay et al., 2005).

Hand length: The dominant hand was used for this measurement. It was taken one end of the calliper at the styloid process of the radius bone and the other at the tip of the middle finger with the forearm in horizontal position (Günay et al., 2005).

Diametric measurements (arm, forearm, thigh, calf, waist, chest circumference): These were measured by Harpenden callipers (Holtain, UK) with an accuracy of ±1mm (Günay et al., 2005).

Counter Movement Jump Test (CMJ): By using Ergojump (Bosco System, Globus, Italy), the height of each jump performed by the participants was measured. With no requirement to bend their knees, the participants were instructed to jump vertically with both feet while keeping their hands on their waist. Each participant had three attempts jumping upward vertically with their maximum power after a two-minute break. The best score of three attempts was documented in centimetres (Chelly et al., 2014; Ramirez et al., 2015).

Anaerobic performance evaluation: Anaerobic power value was determined by using Lewis Formula (√4.9 x (Body weight) x √D (D=jumping distance) (Fox, 1988).

The statistical analyses were performed in Statistical Package for the Social Science (SPSS 17.00). Normality of the data was tested with the Shapiro-Wilk test, and homogeneity of variance was analysed with the Levene test. Pearson Correlation Test was used for the data showing normal distribution. Statistical significance was set at $p<0.05$.

FINDINGS

Table 1. Descriptive characteristics of the participants

Variables	n	$\bar{x}$	sd
Age (year)	20	23.20	1.94
Body Height (cm)	20	179.81	7.96
Body Weight (kg)	20	79.50	9.23

Table 2. The Results of the correlation analysis between anthropometric measurements and anaerobic power

		Body Height (cm)	**Body Weight (kg)**	**Arm Span (cm)**	**Dominant hand Length (cm)**	**Upper Arm Circumference – relaxed (cm)**	**Upper Arm Circumference – flexed (cm)**	**Thigh Circumference (cm)**	**Calf Circumference (cm)**	**Waist Circumference (cm)**	**Chest Circumference (cm)**	**Anaerobic Power (kg-m/s)**	**Vertical Jump Height (cm)**
Body Height (cm)	r	1	0.679	0.871	0.554	0.172	0.154	0.422	0.341	0.403	0.354	0.660	0.144
	p		0.001**	0.000**	0.011*	0.470	0.517	0.064	0.141	0.078	0.126	0.002**	0.543
Body Weight (kg)	r		1	0.570	0.605	0.768	0.695	0.630	0.608	0.851	0.773	0.912	0.095
	p			0.009**	0.005**	0.000**	0.001**	0.003**	0.004**	0.000**	0.000**	0.000**	0.690
Arm Span (cm)	r			1.	0.513	0.141	0.195	0.340	0.233	0.462	0.359	0.547	0.120
	p				0.021*	0.552	0.409	0.142	0.323	0.040*	0.120	0.013*	0.614
Dominant hand Length (cm)	r				1	0.383	0.299	0.277	0.316	0.433	0.434	0.578	0.109
	p					0.095	0.200	0.237	0.175	0.056	0.056	0.008**	0.648
Upper Arm Circumference – relaxed (cm)	r					1	0.911	0.370	0.607	0.739	0.700	0.690	0.061
	p						0.000**	0.108	0.005**	0.000**	0.001**	0.001**	0.799
Upper Arm Circumference – flexed cm)	r						1	0.388	0.469	0.775	0.782	0.689	0.223
	p							0.091	0.037*	0.000**	0.000**	0.001**	0.344
Thigh Circumference (cm)	r							1	0.579	0.643	0.395	0.643	0.234
	p								0.008**	0.002**	0.085	0.002**	0.321
Calf Circumference (cm)	r								1	0.441	0.275	0.533	0.021
	p									0.052	0.240	0.016**	0.930
Waist Circumference (cm)	r									1	0.874	0.826	0.211
	p										0.000**	0.000**	0.372
Chest Circumference (cm)	r										1	0.704	0.084
	p											0.001**	0.724
Anaerobic Power (kg-m/s)	r											1	0.493
	p												0.027*
Vertical Jump Height (cm)	r												1
	p												

p<0.01**, p<0.05*

It can be seen in the Table 2 that there is a positive and high statistical correlation between the anaerobic power values of the participants and their body height (r= .660), body weight (r= .912), arm span (r= .547), dominant hand length (r= .578), upper-arm circumference (relaxed) (r= .690), upper-arm circumference (flexed) (r= .689), thigh circumference (r= .643), calf circumference (r= .533), waist circumference (r= .826), chest circumference (r= .704), vertical jump height values (r= .493) ($p<.05$).

Table 3. Cohen's correlation table (Cohen, 1998)

Correlation	Negative	Positive
Low	-0.29 to -0.10	0.10 to 0.29
Moderate	-0.49 to -0.30	0.30 to 0.49
High	-0.50 to -1.00	0.50 to 1.00

DISCUSSION AND CONCLUSION

The purpose of this study was to examine the relationship between some anthropometric characteristics and anaerobic power of male handball and soccer players. It was hypothesized that there would be a correlation between these parameters.The results clearly showed that all anthropometric characteristics were highly correlated with anaerobic power (Table 2). These results show similarities with the research in the literature (Gül & Mengütay, 2000; Günaydın et al., 2002; Harmancı et al., 2007; Yıldırım & Özdemir, 2010; Debanne & Laffeye, 2011; Fathloun et al., 2011; Aslan et al., 2011; Karadenizli, 2016; Arı et al., 2020).

Debanne and Laffeye (2011), conducted a study with 42 male handball players with a mean age of 21 years and investigated the relationship between the general anthropometric variables (body height, body mass, lean mass, and body mass index), handball-specific anthropometric variables (hand size and arm span), upper extremity power and strength (medicine ball throwing performance), and ball velocity in an over-arm throw while standing for a penalty throw in handball. Their findings showed that the correlation between the performance in the 2 kg medicine ball throwing test and the ball velocity was the most significant, so this parameter/test was the best predictor in estimating the ball velocity compared to the others. The results also indicated that general anthropometric parameters for ball velocity were better predictors than handball-specific anthropometric parameters.

Another study revealed that there was a correlation between the medicine ball throwing test and the vertical jump test values, which suggested that the studies on vertical jumping could be beneficial for the development of penalty throws in handball (Fathloun et al., 2011).

The difference between the height a person can reach in a standing position and the height they can reach by jumping gives the vertical jump performance value. Anatomically, hip extensors, knee extensors and ankle plantar flexor muscles are respectively used during movement. Therefore, elastic and contractile components are activated together with the eccentric and concentric contraction of the leg muscles, and this leads the muscle to release force quickly. (Myer et al., 2005; Markoviç, 2007; Chelly et al., 2014). This's why the vertical jump test is accepted as an indicator of jumping ability and explosive power.

In a study conducted with 56 male handball players with a mean age of 24 years playing in the Super League teams, the anthropometric characteristics, leg strength and flexibility values, and vertical-horizontal jump height of the athletes were measured. It was concluded that anthropometric characteristics had significant effects on vertical and horizontal jump height (Yıldırım & Özdemir, 2010). It has been seen that vertical jump, leg strength (Gül & Mengütay, 2000; Günaydın et al., 2002), and anaerobic power (Harmancı et al., 2007) are positively correlated with each other.

In another study, vertical jump, standing long jump and 20-meter sprint tests were conducted to examine the anaerobic performance values of 80 male physical education and sports school students training regularly and participating in competitions with the mean age of 22 years. It was found out that body weight, body fat percentage, body height, and back strength values were determining factors for the anaerobic performance of the athletes (Aslan et al., 2011).

Moreover, in a study investigating the relationship between lower extremity parameters and speed in soccer and handball female athletes, it was concluded that both vertical and horizontal jump values were positively correlated with anaerobic power and had a moderately negative correlation with 30-meter sprint performance (Karadenizli, 2016).

In their study examining the relationship between anaerobic power and upper extremity strength in young handball players, Arı et al., (2020), stated that there was a moderately positive correlation between anaerobic power and body mass index. It was reported that with the inclusion of exercises to improve lower and upper extremity muscle strength in the training programs of young handball players, the skills gained through these exercises can be maintained

throughout the season, and this may positively affect the performance development of the players.

These studies have similar results to our research. However, there are other studies in the literature with different results on similar issues.

Temur (2017), examined the relationship between arm and forearm circumference measurement values and right- and left-hand grip strength, and between thigh and calf circumference measurement values and vertical and horizontal jump distance values of the 54 athletes playing different sports in university teams. It was determined that there was significant correlation between right- and left-hand grip strength, height, body weight and arm circumference values. However, it was emphasized in the study that there was no significant correlation between horizontal and vertical jump height and thigh and calf circumference. It was also stated that training should be performed to improve the strength of the quadricep and hamstring muscles in order to increase the vertical and horizontal jump height.

Hazır et al. (2010), studied on the relationship between agility, body composition, and anaerobic power in young soccer players. It was determined that body composition was not a determinant in agility performance in these soccer players. In addition, since the Illinois agility test is strongly linked with anaerobic power, it was concluded that the 505-agility test was a more valid test for the evaluation of agility in young soccer players.

In a study conducted with 133 young male handball players aged between 10 and 17, anthropometric parameters such as body height, sitting height, arm span, leg length and body mass were analysed using basic and specific motor skill tests (30-m run from standing position, vertical jump with hands on hip and with arm swing, medicine ball (1 kg) overhead throw with dominant hand from sitting position, and handgrip strength). It was found that anthropometric characteristics were poor determiners/predictors for basic and specific motor skill tests in young handball players (Visnapuu & Jürimae, 2009).

Nikolaidis et al. (2016), in their study with 181, 23-year-old soccer players investigated the relationship between 20-meter sprint running performance and anthropometric and physiological parameters. As well as performing Wingate anaerobic test and vertical jump test to measure lower extremity muscle strength and power, anthropometric measurements such as body height, body muscle mass and fat mass were also taken. It was determined that there was a very high correlation between the values of 20-meter sprint time and lower extremity muscle

strength and power, and this correlation was greater than the one with anthropometric characteristics.

At the beginning of the research, it was mentioned that there are few studies examining the relationship between anaerobic power and only anthropometric characteristic. Some findings of our study (i.e., vertical jump and body weight measurement results) are supported by studies in terms of other parameters and partially anaerobic power.

Practical applications

All in all, great anaerobic power is required for high level success in handball and soccer (Hermassi et al., 2015; Nikolaidis et al., 2016; Hermassi et al., 2019; Makhlouf et al., 2021). Considering the high correlation between anaerobic power and anthropometric characteristics found in our study, these parameters are thought to have provided important findings in terms of performance. It is recommended that trainers pay attention to these characteristics in player selection, training planning and determining athlete performances.

GENİŞLETİLMİŞ ÖZET

GİRİŞ

Savunma ve hücum oyuncularının birbirleriyle devamlı birebir mücadele ettikleri hentbol ve futbolda, sporcuların fiziksel yapıları ve teknik becerilerinin iyi olması kadar kondisyon seviyelerinin de üst seviyede olması, oyundaki performans için çok önemlidir (Mohammed ve ark., 2009; Hermassi ve ark., 2015; Ortega-Becerra ve ark., 2018). Hentbol ve futbolda toplu veya topsuz yapılan teknik becerilerin yanı sıra savunma ve hücumda; yön değişmeli koşular, kısa sprintler, sıçramalar gibi çeşitli hareketler, oyun süresince yoğun bir şekilde yapılmaktadır (Gorostiaga ve ark., 2005; Visnapuu ve Jürimae, 2009; Chelly ve ark., 2011; Zapartidis ve ark., 2018). Bahsedilen tüm bu hareketler; patlayıcı güç, alt-üst ekstremite kuvveti ve hareket hızı ile birlikte ortaya çıkmaktadır. Bir çok spor branşında da alt ve üst ekstremite kas gücünün birlikte ve koordineli kullanılması gerektiği belirtilmektedir (Bencke ve ark., 2002). Hentbolda dayanma adımlı atışta, futbolda ise taç atışı gibi yerle temaslı olarak yapılan hareketlerde ortaya çıkan yer reaksiyon kuvvetinde; kuvvet aktarımı kinetik zincir ile topa kadar ulaşırsa top, maksimum hızla fırlatılır (Jöris ve ark., 1985; İnal, 2004; Neil, 2012; Karadenizli ve ark., 2014). Özellikle baş üstü atışların olduğu sporlarda iyi bir performans hem üst hem de alt ekstremite kaslarının güçlü ve kuvvetli olmasını gerektirir (Chelly et al., 2010). Diğer yandan her ne kadar kuvvet aktarımı sırasında kor bölge ve üst ektremite kasları ile birlikte dinamik denge (İnal, 2004; Akuthota ve ark., 2008; Reed ve ark., 2012) etkin olsa da, hareketi başlatan alt ekstremite kaslarının da önemi büyüktür (Karadenizli, 2016; Ortega ve ark., 2018; Hermassi ve ark., 2019; Arı ve ark., 2020). Sözü edilen

etkenler düşünüldüğünde özellikle takım sporlarında antropometri ile yüksek güç çıktısı içeren hareketlerin ilişkili olabileceği düşünülmektedir. Bu nedenle bu çalışmanın amacı, erkek hentbol ve futbolcularda bazı antropometrik özellikler ve anaerobik güç arasındaki ilişkilerin incelenmesidir.

YÖNTEM

Çalışmaya üniversite futbol ve hentbol takımlarında yer alan erkek sporcular (n: 20; yaş: 23,20±1,94 yıl, boy uzunluğu 179,81±7,96 cm, vücut ağırlığı 79,50±9,23 kg) gönüllü olarak katılmıştır. Antropometrik özellikler için bazı uzunluk (boy, kulaç ve el uzunluğu) ve çevre (göğüs, bel, kol, uyluk ve bacak çevresi) ölçümleri alınmıştır. Vücut ağırlığı ve dikey sıçrama yüksekliği (CMJ) ölçülmüştür. Anaerobik güç değeri, Lewis formülü ile hesaplanmıştır. İstatistiksel analizler için SPSS 17.00 paket programında, tanımlayıcı istatistik ve Pearson korelasyon analizleri yapılmıştır.

BULGULAR

Anaerobik güç değerleri ile boy uzunluğu (r=0,660), vücut ağırlığı (r=0,912), kulaç uzunluğu (r=0,547), baskın el uzunluğu (r=0,578), üst kol çevresi (ekstansiyonda) (r=0,690), üst kol çevresi (fleksiyonda) (r=0,689), uyluk çevresi (r=0,643), baldır çevresi (r=0,533), bel çevresi (r=0,826), göğüs çevresi (r=0,704), dikey sıçrama mesafesi (r=0,493) değerleri arasında istatistiksel açıdan anlamlı ($p<.05$) pozitif korelasyonların olduğu tespit edilmiştir.

TARTIŞMA VE SONUÇ

Bu çalışmanın amacı, erkek hentbol ve futbolcularda bazı antropometrik özellikler ile anaerobik güç arasındaki ilişkilerin incelenmesidir. Çalışma sonuçları açıkça antropometrik özelliklerin tümünün anaerobik güçle yüksek düzeyde ilişkili olduğunu göstermiştir. Temur (2017), üniversite takımlarında farklı branşlarda spor yapan 54 sporcu ile kol ve ön kol çevre ölçüm değerleri ile sağ ve sol el kavrama kuvveti, ayrıca uyluk ve baldır çevre ölçüm değerleri ile de dikey ve yatay sıçrama mesafesi arasındaki ilişkileri incelemiştir. Bulgularda, sağ ve sol el kavrama kuvvetleri, boy uzunluğu, vücut ağırlığı ve kol çevre ölçüm değerleri arasında anlamlı ilişkiler olduğu tespit edilmiştir. Fakat yatay ve dikey sıçrama mesafeleri ile uyluk ve baldır çevre ölçümleri arasında anlamlı ilişkilerin olmadığı vurgulanmıştır. Çalışma sonucunda, dikey ve yatay sıçrama mesafelerini artırmak için quadriceps ve hamstring kaslarının kuvvetini artırmaya yönelik eğitimler verilmesi gerektiği belirtilmiştir. Nikolaidis ve arkadaşları (2016), yaşları 23 olan 181 futbolcu ile yaptıkları bir çalışmada; 20m sprint koşu performansı ile antropometrik ve fizyolojik parametreler arasındaki ilişkileri incelemişlerdir. Alt ekstremite kas kuvveti ve gücü için Wingate anaerobik testi ve dikey sıçrama testi uygulanmıştır. Ayrıca, boy uzunluğu, vücut kas kütlesi ve yağ kütlesi gibi antropometrik ölçümler de yapılmıştır. Çalışma sonucunda, 20m sprint derecesi ile alt ekstremite kas kuvveti ve gücü arasında çok yüksek oranda bir ilişki olduğu ve bu korelasyon değerinin, antropometrik özellikler ile olan ilişki değerinden daha büyük olduğu ifade edilmiştir. Bu ve bu çalışmalara benzer birçok çalışmada (Debanne & Laffeye, 2011; Fadhloun ve ark., 2011; Yıldırım & Özdemir, 2010; Gül & Mengütay, 2000; Günaydın ve ark., 2002; Harmancı ve ark.,

2007; Aslan ve ark., 2011; Karadenizli, 2016; Arı ve ark., 2020) sonuçlar bizim bulgularımız ile paralellik göstermektedir. Çalışma sonucunda, ölçülen tüm antropometrik özellikler ile anaerobik güç değerleri arasında istatistiksel olarak anlamlı yüksek düzeyde ilişkilerin olduğu görülmüştür. Sonuç olarak; hentbol ve futbolda, üst düzey başarı için anaerobik gücün yüksek olması beklenmektedir. Çalışmamızda tespit edilen anaerobik güç ile antropometrik özellikler arasındaki yüksek ilişki dikkate alındığında, bu parametrelerin performans açısından önemli bulgular olduğu düşünülmektedir. Antrenörlerin oyuncu seçiminde, antrenman planlamalarında ve sporcu performanslarını belirlemede bu özelliklere önemle dikkat etmeleri tavsiye edilir.

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Etik Kurul Beyanı/ ***Statement of Ethics Committee***

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This study was conducted with the decision of Bilecik Şeyh Edebali University Faculty of Medicine Ethics Committee dated 24.11.2021 and numbered E10333602-050.01.04-60230.