Mine Taskin[1]
Yagmur Akkoyunlu[2]

EFFECT OF ANAEROBIC POWER ON AGILITY AND QUICKNESS IN MALE NATIONAL TAEKWONDO ATHLETES

UČINEK ANAEROBNE MOČI NA AGILNOST IN HITROST PRI REPREZENTANČNIH TAEKWONDOISTIH

ABSTRACT

The aim of this study was to determine the effect on anaerobic power on agility and quickness male national taekwondo athletes. The sample included 16 national male taekwondo athletes. These taekwondo athletes were from Turkey male national team. Athletes characteristics were as follows: age = 21.81 ± 3.229 years, height = 1.82 ± 0.088 m, body weight = 73.75 ± 14.187 kg, and sport age = 11.94 ± 3.454 years. To determine the quickness and agility performance of taekwondo athletes, a 5-m quickness test and T test was used. Wingate anaerobic test was used for anaerobic power. There is no a significantly relationship between agility with anaerobic peak power (w) and anaerobic power mean (w). There is a significantly relationship between agility with anaerobic peak power ($w.kg^{-1}$) and anaerobic peak power mean ($w.kg^{-1}$). Anaerobic peak power ($w.kg^{-1}$) and anaerobic peak power mean ($w.kg^{-1}$) in a unit change affect agility performance (respectively, -0.23 and -0.34 rate) ($P<0.05$). There is a significantly relationship between quickness with anaerobic peak power (w) and anaerobic peak power mean (w). Anaerobic peak power (w) and anaerobic peak power mean (w) in a unit change affects quickness performance (respectively, 0.0004 and 0.0001 rate) ($P<0.05$). There is no a significantly relationship between quickness with anaerobic peak power ($w.kg^{-1}$) and anaerobic peak power ($w.kg^{-1}$).In conclusion, this results have reported that male taekwondo athletes produce a high level of power during a short momentary situation and relative power is more important in momentary change of direction when the distance increases.

Key words: Change of direction, explosive power, fighting sport, individual sport, and promptness.

[1]School of Applied Sciences, Selcuk University, Beysehir, Konya, TURKEY

[2]Faculty of Sport Sciences, Dumlupınar University, Kütahya, TURKEY

IZVLEČEK

Cilj raziskave je bil ugotoviti učinek anaerobne moči na agilnost in hitrost pri moških reprezentančnih taekwondoistih. Vzorec je zajemal 16 taekwondoistov reprezentantov. Vsi so bili člani turške moške reprezentance. Značilnosti športnikov so bile: starost = 21,81 ± 3,229 let, telesna višina = 1,82 ± 0,088 m, telesna teža = 73,75 ± 14,187 kg in obdobje ukvarjanja s športom = 11,94 ± 3,454 let. Za ugotavljanje hitrosti in agilnosti taekwondoistov smo uporabili 5-metrski test hitrosti in t-test. Za ugotavljanje anaerobne moči smo uporabili anaerobni test Wingate. Med agilnostjo z maksimalno anaerobno močjo (w) in povprečjem anaerobne moči (w) ni značilne povezave. Značilna povezava je med agilnostjo z maksimalno anaerobno močjo ($w.kg^{-1}$) in povprečjem maksimalne anaerobne moči ($w.kg^{-1}$). Maksimalna anaerobna moč ($w.kg^{-1}$) in povprečje maksimalne anaerobne moči ($w.kg^{-1}$) v enoti spremembe vplivata na agilnost (–0,23 oz. –0,34) ($P < 0,05$). Med hitrostjo z maksimalno anaerobno močjo (w) in povprečjem anaerobne moči (w) je značilna povezava. Maksimalna anaerobna moč (w) in povprečje maksimalne anaerobne moči (w) v enoti spremembe vplivata na hitrost (0,0004 oz. 0,0001) ($P < 0,05$). Med hitrostjo z maksimalno anaerobno močjo ($w.kg^{-1}$) in maksimalno anaerobno močjo ($w.kg^{-1}$) ni značilne povezave. Sklenemo lahko, da so rezultati pokazali, da imajo taekwondoisti visoko raven moči v krajših nenadnih situacijah in je relativna moč pomembnejša pri nenadni spremembi smeri gibanja, ko se razdalja povečuje.

Ključne besede: sprememba smeri, eksplozivna moč, borilni šport, individualen šport, hitrost

Corresponding author:
Mine TASKIN
Selcuk University, Beysehir, Konya,
School of Applied Sciences, TURKEY
Email: mtaskin@selcuk.edu.tr
Phone: +905333599120

INTRODUCTION

Taekwondo is a full contact, combative, weight-classed, free sparring, competitive sport. Also it is characterized by specific fast, high and spinning kicks (Heller, Peric, Dlouha, Kohlikova, Melichna, & Novakova 1998). Performance in taekwondo may be determined by a player's technical, tactical, psychological, physical and physiological characteristics. The physical activity and physiological requirements of taekwondo competition require athletes to be competent in several aspects of fitness, including aerobic and anaerobic power, muscular strength, muscular power, flexibility, speed and agility (Markovic, Misigoj-Durakovic, & Trninic, 2005; Pieter, 1991; Heller, Peric, Dlouha, Kohlikova, Melichna, & Novakova 1998; Bouhlel, Jouini, Gmada, Nefzi, Abdallah, & Tabka, 2006).Agility is generally considered to be an important factor in physical fitness and motor ability (Koropanovski et al., 2011). Agility may be defined as a rapid whole-body movement with a change of velocity or direction in response to a given stimulus (Sheppard & Young, 2006). Quickness is similar to speed and agility, but in quickness the brief movement of the stimulus that comes with these movements follow a certain pattern and must be done with movements that are also appropriate. The faster the brain sends signals to the body, the more rapid the movement; but still, concentration is the key to the formation of quickness (Brown & Ferrigno, 2014). In particular, speed, agility, and quickness training is intended to increase the ability to exert maximal force during high-speed movements. Some benefits of speed, agility, and quickness training include increased muscular power in all multiplanar movements and enhanced brain – signal efficiency, kinesthetic spatial awareness, motor skills, and reaction time (Brown & Ferrigno, 2014). Explosive power is an important element of physical strength. It enables successful kicking through quickness and force (Kil, 2006). The anaerobic power is an important criterion for performance in sports such as taekwondo where short-term explosive efforts are made. Also, anaerobic power is described as a capability to utilize an individual's phosphagen system in a high volume and short-term muscle activities and show an individual's maximal efficiency in the first seconds (Reiser, Maines, Eisenman, & Wilkinson, 2002). Some studies have shown that related training activities such as sparring and kicking drills and repetition of basic techniques can improve anaerobic power, quickness and agility in adult male and female taekwondo players (Bridge, Jones, Hitchen, & Sanchez, 2007; Markovic, Misigoj-Durakovic, & Trninic, 2005; Toskovic, Blessing, & Williford, 2004). (Markovic, Misigoj-Durakovic, & Trninic, 2005) reported that the performance of Taekwondo female athletes primarily depends on the anaerobic a lactic power, explosive power expressed in the stretch-shortening cycle movements, agility and aerobic power.The Wingate Anaerobic Test (WAnT) was frequently used to ascertain the anaerobic profile of Taekwondo and other martial arts athletes (Chiodo et al., 2011). Relatively little is known about the agility, quickness and anaerobic power of taekwondo athletes, as the existing literature is limited.

This investigation was therefore undertaken to examine the effect of anaerobic power on agility and quickness in elite male Taekwondo athletes.

METHODOLOGY

Experimental Approach to the Problem

To test our hypotheses, 16 male national taekwondo athletes from Turkey were assessed. These taekwondo athletes were from elite levels (Turkey male national team). To determine the quickness and agility performance of taekwondo athletes, a 5-m quickness test and T test was used.

Also, Wingate anaerobic test was used for anaerobic power. The tests were performed on indoor field and conducted on a single day for each test subject.

Subjects

Subject characteristics were as follows: age = 21.81 ± 3.229 years, height = 1.82 ± 0.088 m, body weight = 73.75 ± 14.187 kg, and sport age = 11.94 ± 3.454 years. The sample included 16 national male taekwondo athletes in Turkey. Before data collection, all participants signed a university approved consent form. After receiving a detailed explanation of the study's benefits and risks, each subject signed an informed consent document that was approved by the local ethics committee. Also, they signed an informed consent document according to the Helsinki Declaration.

Procedure

Height and weight were measured with subjects in training clothes (shorts and t-shirt) and barefoot. Height was measured to the nearest 0.1 cm. Weight was measured to the nearest 0.1 kg using a scale. In first test day, quickness and agility was conducted. In second test day, Wingate anaerobic test was applied.

Anaerobic power test (Wingate test)

The Wingate power test is used in the measurement of anaerobic peak power, anaerobic peak power/kg, anaerobic mean power and anaerobic mean power/kg (work in 30 s). The male national taekwondo athletes warmed up for 5 minutes at a pedaling rate of 60–70 rpm against a resistance equal to 20% of that calculated for the subsequent Wingate anaerobic test. Two unloaded 5-second sprints were performed at the end of the third and fifth minutes of the warm-up period. The maximal pedaling rate (RPM_{max}) attained during the sprints was recorded. The male national taekwondo athletes were instructed to pedal as fast as possible from the onset of the test. The resistance was applied when 75% of the previously recorded RPM_{max} was attained, as determined by the computer. The male national taekwondo athletes were verbally encouraged to maintain as high a pedaling rate as possible throughout the 30-second test duration. Pedal revolutions were monitored at a resolution of 0.025 revolutions and recorded at 1-second intervals. Male national taekwondo athletes' PP (determined as the highest value over a 5-second period of testing) and MP (determined as the average power throughout the 30 seconds of testing), were calculated for each test (Hoffman, Epstein, Einbinder, & Weinstein, 2000).

T test procedures for agility

An athlete starts at the start line. Coach gives signal to go and when athlete crosses the photocell the time begins. Athlete runs to middle cone and touches it. And side step 4.54 meters to the right cone and touches it. Athlete side steps 9.10 meters to the far cone and touches that one. Athlete side step 4.54 meters back to the middle cone and touches it. Athlete runs 9.10 meters backwards and touches the cone at the finish line. When athlete crosses the photocell, time stop (Figure 1) (Gabbett & Georgieff, 2007).The intraclass correlation coefficient for test-retest reliability and typical error of measurement for the T-test were 0.92 and 0.19 seconds, respectively (Gabbett, Sheppard, Pritchard-Peschek, Leveritt, & Aldred, 2008).

Quickness test

The ability to rapidly accelerate from a standing position was measured over a 5-m dash initiated from a standing position. The athletes wait for the signal at the starting point. On the signal,

they run at maximum speed. When they reach the finish point, the time between the starting and finish lines is measured with photocell in terms of seconds (Professional Sport Technologies, Sport Expert). This test allows the assessment of quickness performance (Figure 2) (Jovanovic, Sporis, Omrcen, & Fiorentini, 2011).

FIGURES

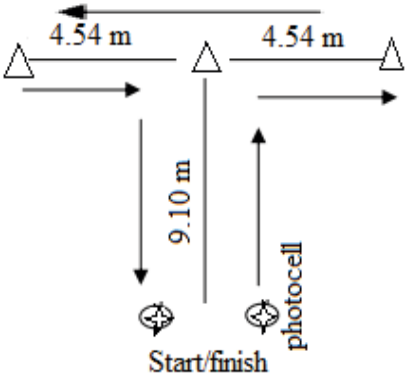


Figure 1. T test for agility

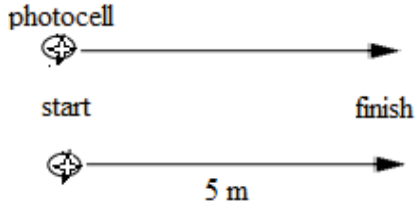


Figure 2. Quickness test

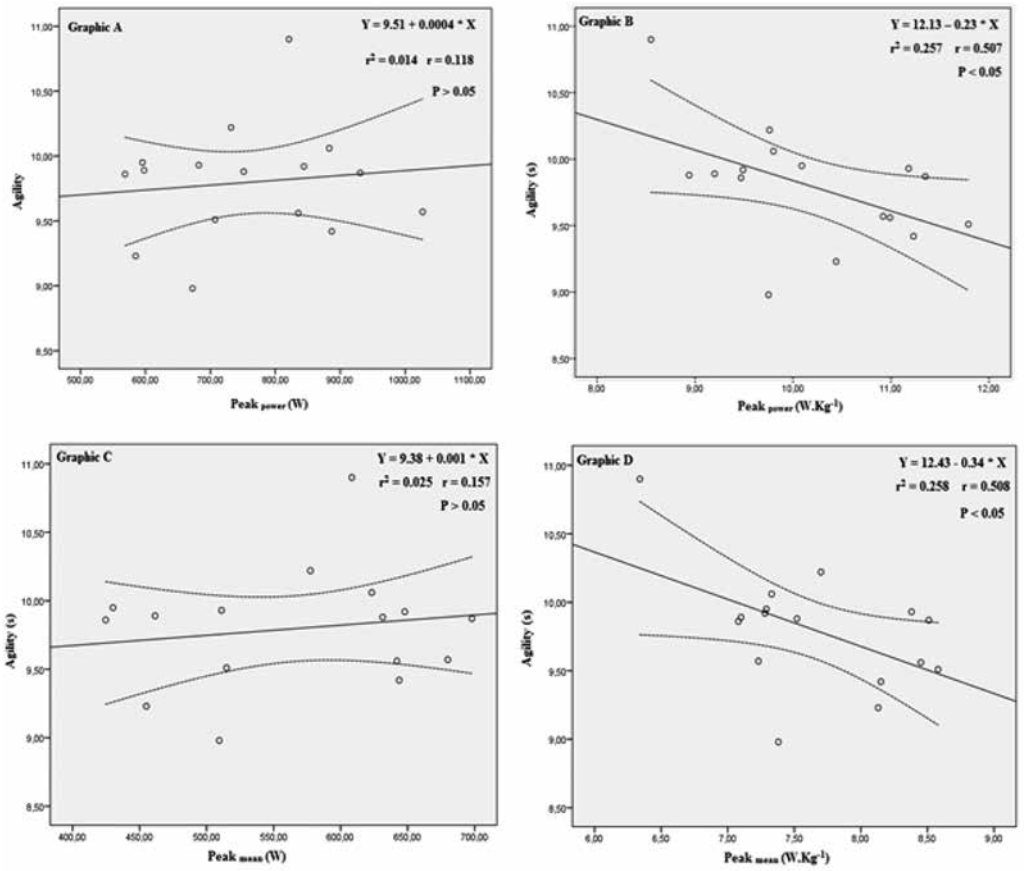
Statistical Analysis

All analyses were performed using SPSS IBM 22. Values were expressed as mean and standard deviation (SD). One Sample Kolmogorov-Smirnov test was used to examine whether the variables were normally distributed. In case of normality, the associations between quickness and agility performance with anaerobic power tests were analyzed using Pearson product-moment correlation analysis. Also, effect of the independent variable (Anaerobic power) on dependent variable (Quickness and agility performance) was analyzed as linear regression analysis. The level of significance chosen was $p<0.05$.

RESULTS

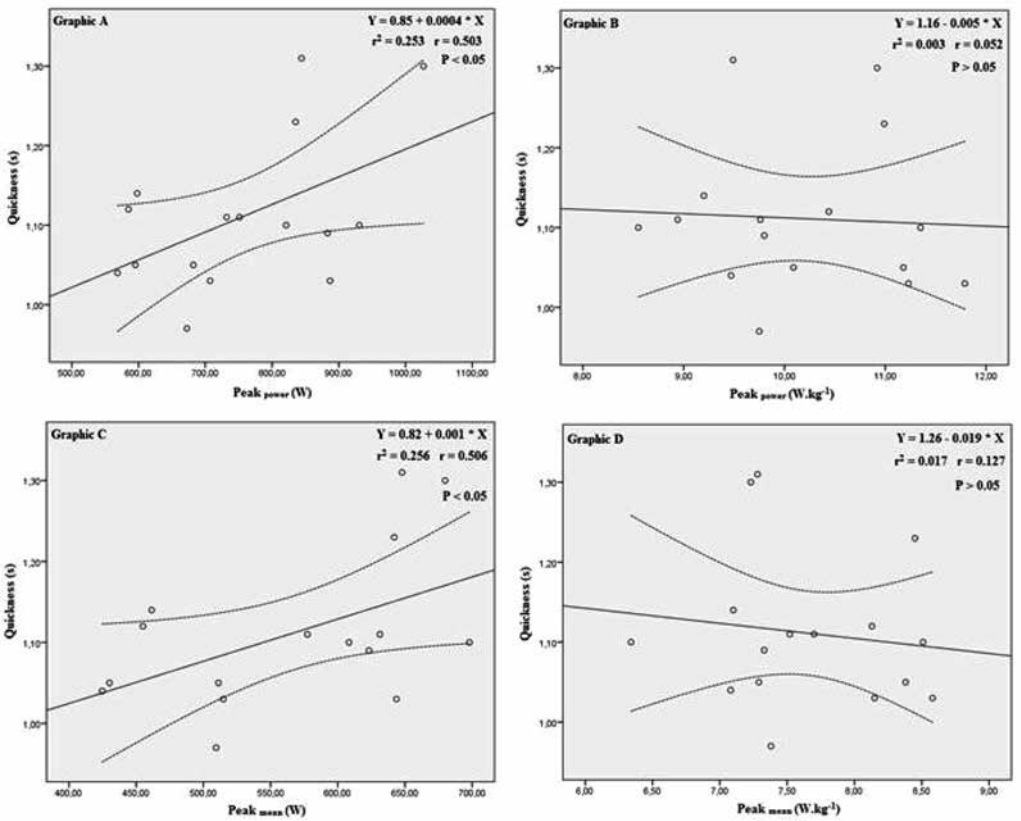
Table 1. Summary of all recorded variables as means ±SD

Variables (N=16)	Mean ± S.D
Age (years)	21.81 ±3.229
Height (m)	1.82 ± 0.088
Body weight (kg)	73.75 ± 14.187
Sport age (years)	11.94 ±3.454
Quickness (s)	1.11 ± 0.10
Agility (s)	9.80 ± 0.44
Anaerobic peak power (watt)	757.488 ± 138.131
Anaerobic peak power/kg (watt.kg-1)	10.184 ± 0.966
Anaerobic mean peak power (watt)	566.173 ± 92.688
Anaerobic mean peak power/kg (watt.kg-1)	7.653 ± 0.645



Graphic 1: Regression analysis is between agility and anaerobic power. **Graphic A** is between agility and peak power (w), **Graphic B** is between agility and peak power (w.kg^{-1}), **Graphic C** is between agility and peak mean (w), **Graphic D** is between agility and peak mean (w.kg^{-1}).

As Shown Graphic 1 for agility and anaerobic power, graphic A; regression model is insignificant (p>0.05.) There is no a significantly relationship between agility and anaerobic peak power (w) in male taekwondo national athletes. **Graphic B;** regression model is significant (p<0.05.) There is a significantly relationship between agility and anaerobic peak power (w.kg^{-1}) in male taekwondo national athletes.Also, regression analysis revealed that anaerobic peak power (w.kg^{-1}) was a significant predictor of agility performance, explaining 26% of the variance for male national athletes. Anaerobic peak power (w.kg^{-1}) in a unit change affects agility performance in -0.23 rate (P<0.05) for male athletes. **Graphic C;** regression model is insignificant (p>0.05.) There is no a significantly relationship between agility and anaerobic peak power mean (w) in male taekwondo national athletes. **Graphic D;** regression model is significant (p<0.05.) There is a significantly relationship between agility and anaerobic peak power mean (w.kg^{-1}) in male taekwondo national athletes. Also, regression analysis revealed that anaerobic peak power mean (w.kg^{-1}) was a significant predictor of agility performance, explaining 26% of the variance for male national athletes. Anaerobic peak power mean (w.kg^{-1}) in a unit change affects agility performance in -0.34 rate (P<0.05) for male athletes.



Graphic 2: Regression analysis is between quickness and anaerobic power. **Graphic A** is between quickness and peak power (w), **Graphic B** is between quickness and peak power (w.kg^{-1}), **Graphic C** is between quickness and peak mean (w), **Graphic D** is between quickness and peak mean (w.kg^{-1}).

As Shown Graphic 2 for quickness and anaerobic power, Graphic A; regression model is significant (p<0.05.) There is a significantly relationship between quickness and anaerobic peak power (w) in male taekwondo national athletes. Also, regression analysis revealed that anaerobic peak power (w) was a significant predictor of quickness performance, explaining 25% of the variance for male national athletes. Anaerobic peak power (w) in a unit change affects quickness performance in 0.0004 rate (P<0.05) for male athletes. **Graphic B;** regression model is insignificant (p>0.05.) There is no a significantly relationship between quickness and anaerobic peak power (w.kg^{-1}) in male taekwondo national athletes.**Graphic C;** regression model is significant (p<0.05.) There is a significantly relationship between quickness and anaerobic peak power mean (w) in male taekwondo national athletes. Also, regression analysis revealed that anaerobic peak power mean (w) was a significant predictor of quickness performance, explaining 25% of the variance for male national athletes. Anaerobic peak power mean (w) in a unit change affects quickness performance in 0.0001 rate (P<0.05) for male athletes. **GraphicD;** regression model is insignificant (p>0.05.) There is no a significantly relationship between quickness and anaerobic peak power mean (w.kg^{-1}) in male taekwondo national athletes.

DISCUSSION

Taekwondo require quickness, agility, and explosive power as well as more complex and exquisite neuromuscular coordination to quickly move. There have been no previous studies that have profiled quickness and agility performance and anaerobic power in elite male taekwondo athletes. In a previous study of agility training, agility training seems to produce most desirable effect in muscles reaction time; to enhance explosive muscle power and dynamic athletic performance, complex agility training can be used. This study indicated relationship between anaerobic power and quickness performance on male taekwondo national athletes. It was found that is between quickness performance with anaerobic peak power (r= 0.503) and anaerobic mean power (r= 0.506).A study examined the differences between successful and less successful in VO_2Max, explosive and elastic leg strength, maximal strength, muscular endurance, anaerobic a lactic power, agility and flexibility of thirteen Croatian national Taekwondo champions divided in two groups according to their senior international competitive achievements and found that successful athletes achieved significantly higher maximum running speed, significantly higher ventilatory anaerobic threshold at significantly lower heart rate, significantly higher explosive power, anaerobic a lactic power and lateral agility somewhat lower body fat (2.3%), and were slightly taller (by 5.8 cm) than less successful athletes (Markovic, Misigoj-Durakovic, & Trninic, 2007). These authors also reported that were significant differences in explosive power, anaerobic a lactic power and lateral agility. (Keeney, 1955) investigated the relationship of quickness of bodily movement to success in athletics. His findings indicated that athletes were faster than no athletes on agility measures.In previous a study, (Chiodo et al., 2011) investigated physiological and performance aspects of 15 elite Taekwondo athletes (4 females and 11 male), age means 24.0±5.7 years, during their National Championship. Their results indicate that intermittent activity of the Taekwondo competition elicits a high neuromuscular activation of the lower limbs. Instead, the decreases in grip strength could be because of the repeated concussions on the upper limbs used to protect from the opponent's kicks and punches directed toward the scoring area of the torso. Anaerobic power reported in this investigation was 10.184±0.966 $W.kg^{-1}$.This value was lower than maximum anaerobic power value of Czech national team taekwondo male athletes (14.7±1.3W.kg-1; Heller, Peric, Dlouha, Kohlikova, Melichna, & Novakova 1998), in Spanish taekwondo contestants (12.1 $W.kg^{-1}$; Drobnic et al., 1995), and comparable to that of Japanese and Korean martial art wrestlers (14.3 and 13.7 $W.kg^{-1}$ respectively; (Ota, Toba, Kasai, Tomiyama, & Nemoto, 1993). Also, previous a study has reported anaerobic power value as 10.3 W/kg for nineteen Taekwondo athletes that is age 13.8 years. There are the strong relationships between body size (anthropometric features and body composition), anaerobic power, and performance in Taekwondo (Boraczyński, Boraczyński, Podstawski, Laskin, Choszcz, & Lipiński, 2017). A study shows the effectiveness of eleven sessions of high-intensity interval training in producing significant improvements in anaerobic capacity relevant to successful Taekwondo competition performance in collegiate Taekwondo athletes (Monks, Seo, Kim, Jung, & Song, 2017). In a study made by the (Chaouachi et al., 2009), it did not find associate between vertical jumping (61.9±6.2 cm) and quickness performance (0.82±0.05 s) (r= –0.39; P=0.12). The same study reported sprint times for distance of 5 m (0.82 second) for elite basketball players. (Singh, Sathe, & Sandhu, 2017) reported that 6 weeks of agility training was able to increase agility, anaerobic power, reaction time, balance, and flexibility in taekwondo players.

In conclusion, this result have reported that male taekwondo athletes produce a high level of power during a short momentary situation and relative power is more important in momentary

change of direction when the distance increases. It is thought that taekwondo athletes' agility performances can be tested more positively by testing with change direction shorter distance run. To improve explosive muscle power, complex agility training should be used by coaches.

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