ANTHROPOMETRIC AND BIOMOTOR VARIABLES OF JUDOKAS IN THE TURKISH NATIONAL YOUNG TEAM[1]

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ABSTRACT

Purpose. Each sport is characterized by athletes with particular physical and biomotor attributes favoring performance in their given sport. This study aimed to identify anthropometric and biomotor variables of Turkish female judokas in national young team and also to find potential relationship between the variables.
Methods. Twenty-nine female judokas (age 17.8±0.78 years, body height 163.3±6.25 cm, and body mass 67.6±14.21 kg) volunteered to participate in this study. The anthropometric variables included body mass index, body fat % and the sum of five adipose skinfolds. Somatotype was determined using the Heath-Carter method. The biomotor variables were maximal aerobic power, lower limbs maximal muscle power (30-second Wingate and vertical jump tests), hand grip strength and flexibility of the trunk.
Results. Turkish judokas showed meso-endomorphic characteristics and moderate to high body fatness, a low flexibility, a low to moderate aerobic power, a moderate anaerobic power and hand grip strength, and a high anaerobic capacity. Significant negative correlations were found between anthropometric features and biomotor abilities, except for ectomorphy.
Conclusion. The young female judokas, most of competing in the heavyweight division, required to develop essential skills for judo.
***Key words**:* Judo, somatotype, aerobic power, anaerobic power, flexibility.

TÜRK ULUSAL GENÇ TAKIM BAYAN JUDOCULARININ ANTROPOMETRİK VE BİYOMOTOR ÖZELLİKLERİ

ÖZET

Amaç. Her spor dalı kendine has fiziksel ve biyomotor özellikleri taşıyan sporcularla karakterizedir. Bu çalışmada amaç, ulusal genç takımdaki Türk bayan judocuların antropometrik ve biyomotor özelliklerini tanımlamaktır.
Yöntem. Çalışmaya yirmi dokuz bayan judocu (yaş17.8±0.78 yıl, boy 163.3±6.25 cm, ve ağırlık 67.6±14.21 kg) gönüllü olarak katılmıştır. Antropometrik özellikler; vücut kütle indeksi, vücut yağ % ve 5 bölgenin deri altı yağı toplamını içermiştir. Somatotip, Heath-Carter metodu ile saptandı. Biyomotor yetiler; maksimum aerobik güç, alt ekstremitenin maksimum kas gücü (30 sn Wingate ve dikey sıçrama testleri ile), el pençe kuvveti ve anaerobik kapasitedir.
Bulgular. Türk judocular; mezo-endomorfik, orta-yüksek vücut yağlılığı, düşük esneklik, düşük-orta aerobik güç, orta anaerobik güç ve el pençe kuvveti ve yüksek anaerobik güç özellikler göstermiştir. Antropometrik ve biyomotor özellikler arasında, ektomorfi hariç, anlamlı negatif korelasyonlar saptanmıştır.
Sonuç. Çoğu ağır sıklette yarışan genç bayan judocuların, branşın gerektirdiği yetilerini geliştirmesi gerekmektedir.
***Anahtar kelimeler*:** Judo, somatotip, aerobik güç, anaerobik güç, esneklik.

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[1] A familiar version of this study was presented at XI. International Sport Science Congress, Antalya, 10-12 November, 2010

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INTRODUCTION

There are specific physical and physiological characteristics in many sports, which can be used to distinguish among athletes based on the sport participated in such as the anthropometric profile and aerobic power (Leone et al., 2002). Researchers' attention has been focused on mostly elite male judokas' characteristics who have already reached a high standard of performance (Degouette et al., 2003; Kubo et al., 2006, Imamoglu et al., 2000b; 2001; Agaoglu et al., 2001). However, studies on young and especially female judokas who are still in the development phase, both physically and physiologically, are inadequate.

As an exciting grappling sport, judo is one of the most popular sports in the world. It is a dynamic, physically demanding sport that requires complex skills and tactical excellence for success (Thomas et al., 1989), characterized by short duration (15 to 30 second), high intensity (mean levels of plasma lactate of 12.3 mM), intermittent exercise (Degoutte et al., 2003) that lasts approximately 8 min per competition. Judo competitors should be strongly built, particularly in shoulders and upper parts of the trunk, should have a robust skeleton (large dimensions of knee and elbow breaths) and well developed muscles of legs (especially calf muscles), to enable them to withstand and transmit the forces applied during the fights (Lewandowska et al., 2011). Somatotypes of judokas are generally endo- and mesomorphic. In addition, in light-weight categories the mesomorphic component prevails, while in heavy-weight categories the endomorphic one is increased (Bala, 2010; Lewandowska et al., 2011; Farmosi, 1980).

As for energy requirements during a judo match, the primary source of energy is anaerobic way; technical elements in judo like throws, arm-locks, and holds require high effectiveness of phosphagen processes and anaerobic glycolysis (Laskowski et al., 2008). Throwing, pushing and pulling against an opponent required anaerobic peak power and hand-to-hand contact with an opponent is related to anaerobic mean power (Umeda et al., 2004).

A judo combat also induces both protein and lipid metabolism. The entire duration of judo combat (5 minutes plus intervals between actions) involves the aerobic system, especially toward the end of the combat (Thomas et al., 1989). In addition, a recent rule (the "golden score") has allowed for a 5 minute extra-time in the event that no final verdict is gained at the end of the normal 5 minute combat, which may also require aerobic energy system. Furthermore, each judokas can be involved in several combats in the same day and need faster recovery between the fights, which emphasizes the need for an adequate aerobic conditioning (Sbriccoli et al., 2007; Laskowski et al., 2008).

Women's judo has a comparatively short history as an international sport hence it was first officially adopted in the 1992 Olympic Games. Besides, number of licensed female judokas is only 11000 since 1960 when it has recognized in Turkey. Therefore scientific information on Turkish female judokas remains scarce: on junior (Yuksek, 2004), young (Imamoglu et al., 2000a) and adult group (Kurt et al., 2010). In evaluation of the training process the fitness profile variables enable monitoring of trainable abilities. Therefore, the purpose of this study was to identify anthropometric and biomotor variables of Turkish female judokas in national young team and to find potential relationship between anthropometric and biomotor variables.

MATERIALS AND METHODS

Participants. Twenty nine healthy young female judokas (17–19 years) participated in this study in the following weight categories: under 48 kg (n=3), under 57 kg (n=4), under 63 kg (n=5), under 70 kg (n=8) and +70 kg (n=9). All were post-pubescent and trained athletes (at least 3 years at the national level). On average, the subjects have participated in judo for 7.2 years (± 2.4) and have practiced between 10 and 15 hr per week. Regular judo training consists of a repetitive series of short and intense exercises involving agility and stretching. The tests were performed during two days of the winter camp period. None of the participants were taking any medication or supplements during the protocol period.

The anthropometric and biomotor variables were selected from those previously used by Leone et al. (2002) to describe athletic populations.

Anthropometric Measurements. The anthropometric measurements were carried out by the same researcher on all subjects according to the Anthropometric Standardization Reference Manual (Lohman et al.,1998). (a) Height and weight; body mass index (BMI) was calculated by formula: weight (kg) / height (m^2). (b) Sum of five skinfolds (thicknesses of the triceps, subscapula, suprailiac, abdominal, and calf); all skinfold measurements were taken with a Holtain skinfold caliper (Holtain Ltd., UK) in triplicate; and body fat %; body fat ratio was calculated using the equation of Faulkner (Martinez et al., 2011), (c) bi-epicondylar breadth of the distal extremity of the humerus and femur, maximal girth of the biceps and the calf (Heath, 1967).

Biomotor Measurements

Aerobic Power: The Yo-yo endurance test (continuous- level 2) was used for evaluating athletes' aerobic power (VO_2max) fitness. VO_2max value was estimated according to the relative nomogram of the running distance and associated oxygen consumption. The Yo-yo endurance test is a type of beep tests. Athletes were positioned at each 20 m starting point within a 40 m long and 20 m wide rectangle, running at a pace dictated by a sound system. Running speed was monitored with a sound system giving out a signal every 20 m. The test is stopped if the subject fails to catch up with the pace within the two ends (Bangsbo, 1996).

Wingate Anaerobic Power and Capacity test: The anaerobic power was assessed by means of a 30-second Wingate test for the lower limbs performed on a model 824E Monark cycle ergometer by using loads of 75 $g \cdot kg^{-1}$ for the body weight (Monark, Stockholm, Sweden). Subjects were instructed to pedal as fast as possible throughout the 30 seconds. From the Wingate test, four indices of muscle power were computed ($W \cdot kg^{-1}$): peak power, mean power, minimum power and fatigue index. Peak power, calculated as the highest value achieved within the first 5 seconds of the test, represents the highest mechanical power that is generated during the test and is considered to be an expression of the anaerobic power. Mean power corresponds to the average mechanical power obtained across the 30 seconds of the test and is thought to reflect the ability of muscles to sustain extremely high power demands (Sbriccoli et al., 2007). Minimum power is the lowest power outcome obtained in 30 seconds. Fatigue Index is formulated by [(peak power output - min power output) / peak power output] x 100.

Lower limbs muscle power (Vertical Jump): Performance in a vertical jump describes jumping ability and explosive force production of the lower extremities. The vertical jump was performed statically

with both feet on a Newtest jump force plate (Newtest 2000, Powertimer Measuring System, 1995, Finland). It started from a semi-squatting position without a prepatory counter movement.

The results of the vertical jumping test were used to determine the anaerobic power ($kgm \cdot sec^{-1}$) on The Lewis Nomogram.

Hand-Grip Test: A grip dynamometer (Takei Physical Fitness Test, Hand Strength Dynamometer, Japan), calibrated by the suspension of weights, was used to measure grip strength. One practice trial on each hand was followed by three tests on both hands. Tests were performed alternately between the left and right hands (Grant et al.,2001). The highest score for each hand was expressed in kg or $kg.body\ mass^{-1}$.

Sit and Reach Flexibility Test: The stretching procedure started from a floor sitting position. Subjects extended the knees of both legs bending forward at the hip slowly and gently until a feeling of "maximum stretch without pain" at the hamstrings, while keeping the knees fully extended (Chan et al., 2001). The result is expressed in cm.

Statistical analyze: Statistical analyses were carried out using SPSS/PC 13.0 program for windows. Descriptive statistics were used for the data analysis. All data are presented as means and standard deviation. To evaluate the correlation between anthropometric and biomotor variables the Pearson Correlation Coefficient test was used. A $p<0.05$ was considered to be significant.

RESULTS

The mean age of Turkish judokas is 17.8 years and they have 7.2 years of experience in sports. Their BMI value is 25.24, sum of five skinfold areas is 92.0 mm and body fat ratio is 17.3%. The group has 5.0-3.95-1.26 somatotype characteristic. The physical characteristics of the judokas are shown in table 1.

Table 1. Physical characteristics of the judokas, n=29

Variable (unit)	Mean ± SD	Min	Max
Age (y)	17.8 ± 0.78	17.0	19.0
Training years (y)	7.2 ± 2.39	1.50	12.0
Body mass (kg)	67.6 ± 14.21	47.00	111.5
Body height (cm)	163.3 ± 6.25	153.0	176.0
BMI (kg/m^2)	25.24 ± 4.52	18.36	40.54
Triceps skinfold (mm)	17.04 ± 7.71	8.40	39.0
Subscapula skinfold (mm)	15.46 ± 7.80	7.60	41.0
Suprailiac skinfold (mm)	18.04 ± 7.83	6.00	35.0
Abdomen skinfold (mm)	24.89 ± 9.11	7.40	39.60
Calf skinfold (mm)	16.57 ± 5.96	8.60	31.40
Sum of 5 skinfolds (mm)	92.01 ± 34.23	39.80	166.80
Body fat (%)	17.32 ± 4.56	10.56	28.49
Biceps girth (cm)	31.53 ± 3.49	26.00	44.50
Calf girth (cm)	37.77 ± 4.24	31.00	50.00
Humerus breadth (cm)	5.30 ± 0.49	4.30	6.30
Femur breadth (cm)	8.11 ± 0.87	6.80	10.20
Endomorphy	5.01 ± 1.75	2.38	9.23
Mesomorphy	3.95 ± 1.66	1.65	8.83
Ectomorphy	1.26 ± 1.06	0.10	3.86

Mean = arithmetic mean, SD = standard deviation, Min = minimum value, Max = maximum value, BMI = body mass index

The somatotype analysis of the 29 judokas in the study is given on the somatochart (figure 1). The group has a meso-endomorphic character.

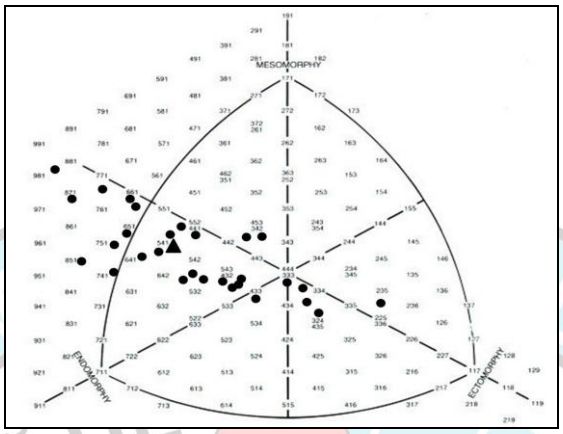

Figure 1.Somatochart of judokas, n =29. (●; individual somatotypes, ▲; mean somatotype)

According to Table 2, maximal oxygen consumption capacity (VO_2max) of the judokas measured by indirect method is 44.16 ml/kg/min, maximal heart rate (HR) reached during the maximal test is 181.6 beat/min, peak power, mean power and min power values determined using Wingate Anaerobic Power Test are 9.1, 6.3 and 4.0 W/kg, respectively. The mean vertical jump height of the group is 43.3 cm, anaerobic power value determined by Lewis Nomogram is 97.4kgm/sec, and average flexibility measured with sit and rich test is 18.5 cm. Right and left isometric hand-grip strengths are 28.5 and 26.5 kg, respectively.

Table 2. Biomotor variables of the judokas

Variable (unit)	Mean ± SD	Min	Max
VO_2max (ml.kg^{-1}.lt^{-1})	44.16 ± 2.87	39.11	47.93
Max HR (beatmin^{-1})	181.60 ± 17.88	150.0	205.0
Peak power (W·kg^{-1})	9.10 ± 2.08	5.11	14.11
Mean power (W·kg^{-1})	6.28 ± 1.08	3.98	8.85
Minimum power (W·kg^{-1})	4.01 ± 0.76	2.58	5.78
Fatigue index (%)	54.35 ± 9.52	38.32	75.72
Vertical jump height (cm)	43.31 ± 7.07	27.0	58.0
Anaerobic power (kgm·sec^{-1})	97.40 ± 16.97	64.13	139.35
Flexibility (cm)	18.48 ± 5.96	8.0	30.0
Absolute right hand-grip (kg)	28.48 ± 5.38	20.90	38.80
Absolute left hand-grip (kg)	26.45 ± 4.71	19.90	38.20
Relative right hand-grip(kg body mass^{-1})	0.43 ± 0.8	0.21	0.61
Relative left hand-grip (kg body mass^{-1})	0.40 ± 0.7	0.22	0.56

Mean = arithmetic mean, SD = standard deviation, Min = minimum value, Max = maximum value, BMI = body mass index, VO_2 max = maximal oxygen consumption HR = heart rate.

Significant negative correlations were found between anthropometric features and biomotor abilities, except for ectomorph. Significant positive correlations were found between training year and peak power/kg, between body height and anaerobic power, significant negative correlation was found between body height and VO_2max (Table 3).

Table 3. Correlation between anthropometric and biomotor variables of Turkish judokas

	VO_2max	Peak power/kg	Average power/kg	Vertical jump	Anaerobic power	Flexibility	right hand-grip/kg	left hand-grip/kg
Training years		r=0,405 p=0,032						
Body mass	r=-0,699 p=0,000	r=-0,575 p=0,001	r=-0,645 p=0,000	r=-0,474 p=0,009	r=0,896 p=0,000	r=-0,496 p=0,006	r=-0,593 p=0,001	r=-0,611 p=0,000
Body height	r=-0,453 p=0,039				r=0,562 p=0,002			
BMI	r=-0,657 p=0,001	r=-0,536 p=0,003	r=-0,619 p=0,000	r=-0,465 p=0,011	r=0,818 p=0,000	r=-0,532 p=0,003	r=-0,622 p=0,000	r=-0,684 p=0,000
Sum of 5 skinfolds	r=-0,762 p=0,000	r=-0,600 p=0,001	r=-0,703 p=0,000	r=-0,585 p=0,001	r=0,710 p=0,000	r=-0,488 p=0,007	r=-0,535 p=0,003	r=-0,647 p=0,000
Body fat %	r=-0,748 p=0,000	r=-0,625 p=0,000	r=-0,720 p=0,000	r=-0,591 p=0,001	r=0,715 p=0,000	r=-0,505 p=0,005	r=-0,529 p=0,003	r=-0,634 p=0,000
Endo-morphy	r=-0,738 p=0,000	r=-0,625 p=0,000	r=-0,720 p=0,000	r=-0,574 p=0,001	r=0,674 p=0,000	r=-0,466 p=0,011	r=-0,518 p=0,004	r=-0,663 p=0,000
Meso-morphy	r=-0,492 p=0,024	r=-0,392 p=0,039	r=-0,464 p=0,013		r=0,711 p=0,000	r=-0,560 p=0,002	r=-0,517 p=0,004	r=-0,599 p=0,001
Ecto-morphy	r=0,502 p=0,021	r =0,403 p=0,033	r=0,532 p=0,004		r=-0,639 p=0,000			r=0,522 p=0,004

BMI = body mass index, VO_2 max = maximal oxygen consumption HR = heart rate.

DISCUSSION

The aim of this study was to determine the anthropometric and biomotor features of female judokas in national young team. To this end, it was considered appropriate to group the athletes by their weight in order to reveal group characteristics. However, the fact that 29 of the athletes were distributed as under 48 kg (n=3), under 57 kg (n=4), under 63 kg (n=5), under 70 kg (n=8) and +70 kg (n=9) was not found suitable statistically. Therefore, the physiological parameters measured were divided into body weights of the individuals and were presented as the value per weight.

Body weight control is extremely important for many athletes in weight category sports and in general these athletes compete at a 10% lowers of their usual

weight. In judokas, as larger fat-free mass affects performance positively whereas increase in weight due to increase in fat mass would cause them to compete in an upper weight category, it is claimed to be disadvantageous (Kubo et al., 2006; Krstulovic et al, 2006). Body fat can be defined as % or the sum of total fat (mm). Sum of five skinfold values of the judokas in the study is 92.0 mm (39.8-166.8), while these values were found to be 57.4, 47.7, 56.0, 63.1 mm in female athletes aged 12-17 in different branches (tennis, skating, swimming, volleyball respectively) (Leone et al., 2002). Sum of six skinfold value of Turkish female judokas (aged 20.6 years) was 61.7±29.7 (Kurt et al., 2010). It was found that the sum of six skinfold values of middleweight and heavyweight Philippine female judokas are 76.00 and 136.3 mm respectively (Pieter et al., 2006). Body fat % values of the judokas in this study vary between 10.6 - 28.5 and the average is 17.3 ± 4.6%. Mean body fat of Turkish female judokas aged 15.2 was 20.1±3.9% (17.82-24.58), while it was found to be 20.2±6.0% (17.24-25.94) for Russian female judokas aged 14.9 (Yuksek, 2004). Body fat ratios of Turkish female judokas were measured to be 13.26 % in 2009 (Kurt et al., 2010). The fact that weight category differences were not presented in this study and that there were 17 individuals having values over 63 kg in the heavyweight category might have caused us to reach high values in the total fat measures. Subcutaneous fat and the relative lean body mass differences may partly result from selection, as well as adaptation of body components to prolonged (judo) training, leading to the development of specific constitutional or morphological characteristics of young athletes (Bala, 2010).

A somatotype is the definition of the morphological structure of the body as endomorphy, ectomorphy and mesomorphy in terms of fatness, slimness and muscularity, respectively (Heath, 1967). The identification of anthropometric profiles is essential for both the identification of sports talents and the development of professional athletes. Kurt et al. (2010) state that judokas usually have a mesomorphic body structure, but that in heavyweight categories (>60 kg), body structure tend to be endo-mesomorphic. That there were 17 individuals having values over 63 kg in our study may have caused the formation of a meso-endomorphic (5-4-1) somatotype.

The lower limb muscle power indices were high in all athletes in accordance with the functional demands imposed by this sport activity. Franchini et al. (2011) results indicated that judokas with a lower proportion of adipose tissue and high anaerobic capacity have a higher rate of attempted use of various techniques in fight (Krstulovic et al., 2006). Peak power and mean power results obtained with Wingate test of our study group are 9.1 and 6.3 W/kg respectively. In fact, peak power values obtained in our judokas were lower than those obtained in elite female judokas from Italy, Poland (Sbriccoli et al., 2007; Borkowski et al., 2001; Laskowski et al., 2008), but mean power, as an expression of the ability of muscle to sustain extremely high power, was higher than İtalian Judokas (Sbriccoli et al., 2007). Furthermore, Sbriccoli et al. (2007) indicated that martial arts are characterized by leg mean power values approximately 40% lower than the correspondent peak power values, which is comparable to the results obtained in our study; our mean power values were 30% lower than peak power.

Imamoglu et al. (2000a) found that the anaerobic power measured with Lewis Nomogram of the female judokas aged 18.0 ±3.1 in Turkish National Team was 75.0 ±6.5kgm/sec for lightweight category athletes, 92.5 ±5.8kgm/sec for middleweight, 107.4±2.0kgm/sec for

athletes over 70 kg and 88.6±12.7 kgm/sec was total. In another study, anaerobic power value of young female judokas was found 9l.1±26.8 kgm/sec (Kurt et al., 2010). This value was found to be 92.5±9.7 kgm/sec in elite female basketball players, 82.1±4.2 kgm/sec in handball players, 99.0±11.0 kgm/sec (Cicioglu et al., 1998) in volleyball players and 77.3±12.7 kgm/sec (Gunaydın et al., 2002) in wrestlers. The anaerobic power value of 97.4±17.0 kgm/sn measured with Lewis Nomogram in this study is considered to be higher than that of both female judokas and athletes in other branches.

All athletes in our study showed a low to moderate aerobic power capacity, with VO_2max values (44.2 ml/kg/min) lower than both olympic level Italian female judokas (52.9 ml/kg/min) (Sbriccoli et al.,2007), Polish National Team judokas (49.9ml/kg/min) (Borkowski et al.,2001), and also elite adolescent female tennis players (49.5ml/kg/min), female skaters (48.3ml/kg/min), female swimmers (47.6 ml/kg/min), volleyball players (48.9 ml/kg/min) (Leone et al.,2002). The lower VO_2 values obtained in our judokas compared with previous studies may be ascribed to the lack of homogeneity present within our group, due to the coexistence of athletes belonging to different weight categories, with an inverse relationship observed between body mass and VO_2max.

Flexibility is associated with gender, age, body weight, body fat percentage and the sport branch engaged in and; is affected negatively by injury and fatigue. Although flexibility is important for judokas for the proper use of techniques and defense against the opponent, flexibility values of the judokas in our study were measured with sit and rich test, which measures the development of the athlete's lower back and hamstring flexibility, and found lower than that of both female judokas and athletes in other branches: 18.5 ± 6.0 cm (8-30 cm). While this value was 32.2 and 36.3 cm for Turkish and Russian (15 years) female judokas (Yuksek, 2004), in elite adolescent female athletes with different sport branch it was 37.3 cm, 42.6 cm, 41.0 cm, 39.1 cm for tennis, skating, swimming, volleyball, respectively (Leone et al., 2002).

The importance of handgrip technique is great in judo, both for a sound grip of the opponent's clothes for a proper practice of gripping techniques and for preventing the opponent from attack using good techniques (Yuksek, 2004). The handgrip strength of the female judokas in our study was found 28.5 ± 5.4 for the right hand and 26.5 ± 4.7 for the left one. Hand handgrip strength of Turkish and Russian young female judokas was determined to be 28.8 and 33.5 kg for the right hand and 28.0 and 32.5 for the left one (Yuksek, 2004). This value was found 35.16 for the right hand and 33.54 for the left one in Turkish Judo National Team athletes aged 20.6 (Kurt et al., 2010). Handgrip strength values of female athletes in different branches were found as follows; 27.3±5.2 kg, 25.4±5.7 kg in basketball players, 30.9±4.9 kg, 27.3±3.7 kg in handball players, and 31.1±3.7 kg, 30.5±3.6 kg in volleyball players (Cicioglu et al., 1998).

Research of anthropometric characteristics of judokas as well as their motor performance has suggested the existence of associations between them; however, these relationships were examined only in a few studies. Significant negative correlations were found between anthropometric (body mass, body mass index, body fat, and two components of somatotype) and biomotor (VO_2max, peak power, average power, vertical jump, flexibility, and handgrip strength) properties in the study. The study conducted by Silva et al. (2010) showed very high correlation of the fat mass and anaerobic power in elite judo athletes. In

Turkish judokas, a positive correlation was found between anaerobic power and body fatness, right handgrip strength ($p<0.05$), body weight, height, left handgrip strength ($p<0.01$) (Imamoglu et al., 2000a). Lewandowska et al. (2011) indicated that the values of mesomorphic and ectomorphic somatotype components influence muscle torque and power output, thus body shape could be an important factor affecting results in judo. However, Farmosi (1980) did not find significant correlations between the characteristics of body build (body weight, body fat, lean body mass, components of somatotype) and motor performance (hand grip and vertical jump) in Hungarian judokas (Lewandowska et al.,2011)

CONCLUSIONS

All athletes in our study showed meso-endomorphic characteristics, moderate to high body fatness, a low flexibility, a low to moderate aerobic power, a moderate anaerobic power and hand grip strength, and a high anaerobic capacity. Significant negative correlations were found between anthropometric (body mass, body mass index, body fat, and two components of somatotype) and biomotor (VO_2max, peak power, average power, vertical jump, flexibility, and handgrip strength) properties.

Further studies with large sample size should be carried out and difference among weight categories in terms of anthropometry and performance should be focused. Physiological and biochemical features which might affect performance should be studied on a regular basis for many years.

ACKNOWLEDGEMENTS

The authors would like to thank all judokas, their coaches and all members of the Turkish Judo Federation for their permission to set up this study and for their full support and collaboration during the investigation.

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