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Anthropometric and Motor Features of Young Judoists in Vojvodina

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A B S T R A C T

The aim of the study was to identify differences between trained and untrained subjects with respect to body composition and motor abilities. Two groups of subjects participated in the study: young judoists (110 boys and 56 girls) and their untrained mates (115 boys and 60 girls), aged 11 to 16 years, all from the Province of Vojvodina, Serbia. Young male judoists proved significantly better than their untrained mates in repetitive and static strength exercises, running speed, whole-body coordination, and had lower subcutaneous fat tissue of the upper arm. Young female judoists were significantly better in repetitive strength, whole-body coordination and plate tapping, chest girth and stretched upper arm, and also had lower subcutaneous fat tissue of the upper arm and back.

***Key words**: functional coordination, strength, body build*

Introduction

Judo is a high-intensity activity; a judoist tries to throw the opponent on the back or to control the opponent during fighting on the floor. For these reasons, judoists are required to have excellent physical condition[1,2]. Judo fight lasts 5 minutes of active time, or up to 9 minutes including breaks. Judo exertions are predominantly anaerobic[3], consisting of repeated segments of active fight (10–30 s) and rest (10–15 s)[4–7].

The analysis of morphological variables and types of children and youths, athletes and non-athletes alike, involves age-dependent changes throughout the growth period. This raises issues such as dieting, the role of physical activity, and factors affecting growth and development[8,9]. As sport training may, under extreme conditions, affect the longitudinal and/or transversal dimensions of the skeleton, judo training aims at optimizing muscle structure and subcutaneous fat tissue. Previous research[10] confirmed significant differences between athletes and non-athletes with respect to subcutaneous fat and the relative lean body mass. Those differences may partly result from selection, as well as adaptation of body components to prolonged (judo) training[11], leading to the development of specific constitutional or morphological characteristics of young athletes.

The gender-related differences in morphological variables of judoists may lead to gender-specific effects of training[12]. Somatotypes of judoists show a domination of the endo- and mesomorphic components, the ectomorphic one being in judoists of both genders alike. In addition, in light-weight categories the mesomorphic component prevails, whereas in heavy-weight categories the endomorphic one is increased[13].

Motor abilities are of great importance for success in judo. Full attention should be thus paid to shaping these abilities from the very beginning of training. It ought to be remembered that environmental factors, including carefully planned and programmed training methods, contribute to shaping motor abilities together with genetic predispositions. According to the requirements of long-term planning and programming, the proportions and relations of certain elements of sport preparation vary at different stages.

The most frequently reported researches deal with relationship between physical activity, morphological characteristics, motor skills and sports performance. Some of them determined the impact of motor abilities and morphological characteristics on sport performance[14] and differences between elite and non-elite athletes[15], and

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other identified biomotor systems that determine performance of competitive technical elements[16]. The aim of these studies was the evaluation of specific motor abilities, motor skills, and sport performance interdependance[17], in order to assess the basic motor abilities in preadolescence that determines top performance in sport[18], or differences in basic motor abilities between children included and those not included in training[19].

The aim of this study was to assess the differences between the judo-trained and untrained children in their anthropometric and motor variables. The underlying reason was the need of an analysis of current judo practices with introducing judo classes in schools across the Province of Vojvodina in perspective.

Material and Methods

Subjects

The subjects were classified into 8 groups by training status, gender, and age. Group JM1: male judoists aged 11–13 years (n=57); Group JM2: male judoists aged 14–16 years (n=53); Group UM1: untrained boys aged 11–13 years (n=64); Group UM2: untrained boys aged 14–16 years (n=51); Group JF1: female judoists aged 11–13 years (n=29); Group JF2: female judoists aged 14–16 years (n=27); Group UF1: untrained girls aged 11–13 years (n=25); Group UF2: untrained girls aged 14–16 years (n=35). The judoists were recruited from various judo clubs in Vojvodina, the untrained ones – from elementary schools in Novi Sad, Sombor, Sremska Mitrovica and Bačka Palanka (Vojvodina, Serbia).

Measurements and tests

The following measurements were conducted according to the International Biological Programme[20]: anthropometric variables – body height, body mass, chest girth, midarm girth, forearm girth; abdominal, subscapular and triceps skinfolds; motor fitness variables – obstacle course backwards and slalom with 3 balls (functional coordination), plate tapping (speed of hand movement), sit-and-reach (flexibility), standing broad jump and 20-m dash (explosive strength), bent-arm hang (isometric muscular endurance) and sit-ups with crossed arms (isotonic muscular endurance). A short description of the tests is given below. The battery of those 8 motor tests assessed the following functional mechanisms: movement structuring, tonus and synergetic regulation, regulation of excitation intensity and regulation of excitation duration[21,22].

Every subject performed a trial test in order to get familiar with the protocol, after that the results were recorded.

Obstacle course backwards: The subject walks backwards on all fours the distance of 10 m, climbs the top of Swedish bench and goes through the frame of the bench. Time is measured in 0.1-s units.

Slalom with 3 balls: On command »GO« the subject rolls three balls between cones at the distance of 10 m. After having passed the last of five cones, the subject rounds it and continues rolling all three balls toward the start line. Time is measured in 0.1-s units.

Plate tapping: The subject taps alternately two plates on a tapping board with his dominant hand, the other hand being held between plates, for 15 s. The number of double taps is recorded.

Sit-and-reach: The subject sits on the floor in straddle position leaning against the wall, and reaches forward along a straight-angle ruler as far as possible. The reach (in cm) is recorded.

Standing broad jump: The subject jumps with both feet from the reversed side of Reuter's bounce board onto a carpet with scale. The jumping distance (in cm) is recorded.

20-m dash: On command »GO« the subject runs 20-m distance at highest speed possible. The subjects run in pairs. Time is measured in 0.1-s units.

Sit-ups with crossed arms: The subject lies on the back, knees bent, arms crossed on the chest, and performs sit-ups, feet being held fast by an assistant. The number of correctly executed sit-ups in 60 s is recorded.

Bent-arm hang: The subject grips the bar, fingers on top and thumb underneath, pulls up (chin above the bar) and holds the position as long as possible without resting the chin on the bar. Time is measured in 0.1-s units.

These tests were supposed to reflect motor functions and were considered the primary latent motor factors. This approach enabled decreasing the number of motor tests in order to improve motivation of schoolchildren. The reliability of tests was assessed in a pilot study on 64 boys and girls aged 11–16 years, by computing the α-coefficients of Spearman-Brown-Kuder-Richardson-Guttman-Cronbach which ranged from 0.82 to 0.98.

Data analysis

Multivariate and univariate differences between two groups of examinees in the sample of variables were calculated and tested by MANOVA and ANOVA, respectively, the level of $p \leq 0.05$ being considered significant. The structure of differences in the entire sample of variables, and the importance of each variable for the discrimination between groups, was analyzed by Discriminant Analysis. All statistical analyses were performed with the use of SPSS software.

Results

Multivariate analysis of variance (MANOVA) revealed significant differences between judo-trained and untrained boys (Table 1, p=0.00). It was thus necessary to assess the differences in individual variables (ANOVA), and in the variables contributing most to the observed discrimination between groups in the applied set of variables (DISCRA; Table 3).

During the age period of 14–16 years, mean values (M) of basic anthropometric characteristics (body height and mass) of young male judoists were similar to those of the untrained boys (Table 1) while the content of subcu-

TABLE 1
DESCRIPTIVE STATISTICS OF BOYS

Variable	Judoists, 11–13 years (n=57)		Untrained, 11–13 years (n=64)		f	p
	M	SD	M	SD		
20-m dash (0.1 s)	40.72	3.62	42.13	3.89	4.20	0.04
Obstacle course backwards (0.1 s)	126.82	42.39	165.05	47.35	21.66	0.00
Slalom with 3 balls (0.1 s)	369.42	75.13	361.41	61.46	0.42	0.52
Arm plate tapping (freq.)	27.67	4.73	28.25	4.30	0.50	0.48
Forward bend (cm)	44.95	10.44	42.31	8.48	2.34	0.13
Standing broad jump (cm)	178.25	19.64	169.63	24.26	4.54	0.03
Bent-arm hang (0.1 s)	391.89	241.13	296.77	235.53	4.81	0.03
Crossed-arm sit-ups (freq.)	44.79	10.47	37.88	7.96	16.92	0.00
Body height (mm)	1496.32	82.54	1552.05	89.89	12.51	0.00
Body weight (0.1 kg)	429.07	102.04	466.80	115.89	3.57	0.06
Chest girth (mm)	734.74	66.69	729.23	70.78	0.19	0.66
Midarm girth (mm)	225.16	30.12	223.16	34.84	0.11	0.74
Forearm girth (mm)	209.07	22.27	208.27	22.56	0.04	0.84
Abdominal skinfold (0.1 mm)	123.26	85.08	153.72	95.20	3.41	0.07
Subscapular skinfold (0.1 mm)	80.07	43.33	95.22	60.45	2.45	0.12
Triceps skinfold (0.1 mm)	98.42	38.48	128.47	64.71	9.34	0.00
Abdominal girth (mm)	673.79	79.66	685.77	101.00	0.52	0.47
	F=6.74		p=0.00			
Variable	Judoists, 14–16 years (n=53)		Untrained, 14–16 years (n=51)		f	p
	M	SD	M	SD		
20-m dash (0.1 s)	38.21	3.17	39.63	3.34	4.95	0.03
Obstacle course backwards (0.1 s)	116.62	25.44	140.78	32.02	16.91	0.00
Slalom with 3 balls (0.1 s)	349.92	91.15	308.84	56.11	7.59	0.01
Arm plate tapping (freq.)	30.58	4.64	31.53	4.55	1.10	0.30
Forward bend (cm)	50.87	10.39	48.96	10.51	0.87	0.35
Standing broad jump (cm)	201.36	26.82	196.55	30.05	0.74	0.39
Bent-arm hang (0.1 s)	506.70	287.62	397.92	222.01	4.64	0.03
Crossed-arm sit-ups (freq.)	48.13	8.33	43.35	6.97	10.03	0.00
Body height (mm)	1675.96	99.39	1676.69	107.69	0.00	0.97
Body weight (0.1 kg)	611.32	165.78	572.00	119.77	1.91	0.17
Chest girth (mm)	845.36	95.05	799.51	77.48	7.24	0.01
Midarm girth (mm)	255.26	36.36	237.71	32.09	6.80	0.01
Forearm girth (mm)	237.15	28.24	223.82	21.87	7.20	0.01
Abdominal skinfold (0.1 mm)	138.19	96.63	147.49	94.64	0.25	0.62
Subscapular skinfold (0.1 mm)	92.45	59.76	101.61	76.26	0.47	0.50
Triceps skinfold (0.1 mm)	91.28	37.59	118.27	64.80	6.81	0.01
Abdominal girth (mm)	753.94	105.27	729.43	84.52	1.71	0.19
	F=7.96		p=0.00			

taneous fat over the triceps was significantly lower and circumferences (chest, midarm and forearm girths) were significantly greater in judoists than in the untrained subjects. These differences could be attributed mainly to the effects of judo training.

Judo-trained boys aged 11–13 years significantly differed from the untrained ones in the results of motor tests: 20-m dash, standing broad jump, bent-arm hang ($p<0.05$), crossed-arm sit-ups and obstacle course backwards ($p<0.01$); the same was true for the older ones who additionally differed in the slalom with 3 balls ($p<0.01$; cf. Table 1). Interestingly, the younger boys were significantly ($p<0.01$) shorter (by 5.6 cm) than their untrained mates.

Judo trained girls aged 11–13 years significantly differed from the untrained ones in 20-m dash, slalom with

TABLE 2
DESCRIPTIVE STATISTICS OF GIRLS

Variable	Judoists, 11–13 years (n=29)		Untrained, 11–13 years (n=25)		f	p
	M	SD	M	SD		
20-m dash (0.1 s)	41.52	2.97	43.80	4.19	5.44	0.02
Obstacle course backwards (0.1 s)	130.07	24.07	179.80	40.90	30.63	0.00
Slalom with 3 balls (0.1 s)	381.62	53.78	418.48	77.85	4.19	0.04
Arm plate tapping (freq.)	29.97	3.63	27.64	4.08	4.91	0.03
Forward bend (cm)	51.17	10.67	51.84	10.91	0.05	0.82
Standing broad jump (cm)	172.45	15.05	162.00	20.43	4.66	0.03
Bent-arm hang (0.1 s)	325.07	201.45	228.60	147.43	3.91	0.05
Crossed-arm sit-ups (freq.)	46.03	6.62	35.32	7.53	30.96	0.00
Body height (mm)	1509.03	85.26	1523.12	67.50	0.44	0.51
Body weight (0.1 kg)	440.34	100.84	433.20	105.94	0.06	0.80
Chest girth (mm)	751.31	72.73	712.64	65.16	4.18	0.04
Midarm girth (mm)	230.07	30.45	214.68	28.80	3.60	0.06
Forearm girth (mm)	208.00	18.69	198.80	13.59	4.16	0.04
Abdominal skinfold (0.1 mm)	128.07	69.22	158.32	87.98	2.00	0.16
Subscapular skinfold (0.1 mm)	85.38	39.27	110.72	57.31	3.67	0.06
Triceps skinfold (0.1 mm)	108.76	34.16	130.64	56.15	3.05	0.08
Abdominal girth (mm)	662.48	70.96	665.80	77.30	0.03	0.87
	F=6.86		p=0.00			
Variable	Judoists, 14–16 years (n=27)		Untrained, 14–16 years (n=35)		f	p
	M	SD	M	SD		
20-m dash (0.1 s)	41.11	3.82	42.23	3.78	1.32	0.25
Obstacle course backwards (0.1 s)	123.48	23.55	165.14	40.94	22.23	0.00
Slalom with 3 balls (0.1 s)	345.85	51.96	374.34	52.83	4.50	0.04
Arm plate tapping (freq.)	32.59	3.98	30.23	4.92	4.13	0.04
Forward bend (cm)	54.41	12.10	59.31	13.60	2.18	0.14
Standing broad jump (cm)	182.19	20.84	177.71	22.10	0.65	0.42
Bent-arm hang (0.1 s)	341.74	203.50	295.06	188.84	0.87	0.35
Crossed-arm sit-ups (freq.)	47.37	8.70	39.03	7.45	16.51	0.00
Body height (mm)	1607.07	60.81	1629.00	62.73	1.91	0.17
Body weight (0.1 kg)	551.85	113.57	524.40	91.39	1.11	0.30
Chest girth (mm)	798.59	71.64	762.23	63.39	4.48	0.04
Midarm girth (mm)	246.78	28.12	227.74	24.06	8.23	0.01
Forearm girth (mm)	220.93	18.67	225.20	86.67	0.06	0.80
Abdominal skinfold (0.1 mm)	160.96	67.06	174.34	75.50	0.53	0.47
Subscapular skinfold (0.1 mm)	101.19	43.47	117.54	58.63	1.47	0.23
Triceps skinfold (0.1 mm)	109.70	34.70	146.34	55.29	9.08	0.00
Abdominal girth (mm)	725.37	89.24	700.34	83.76	1.28	0.26
	F=0.69		p=0.00			

3 balls, plate tapping, standing broad jump ($p<0.05$), crossed-arm sit-ups and obstacle course backwards ($p<0.01$); the same was true for the older ones except 20-m dash and standing broad jump (no significant differences). Some differences between trained and untrained girls were also noted in somatic variables (Table 2).

Application of discriminant function enabled a significant differentiation in the structure of the set of motor and anthropometric variables between the two groups of boys at the level of $p<0.001$ and a hierarchy of contributions of individual variables determined by the canonic discriminant analysis (Table 3). The following variables were found to make the greatest contribution to discriminating the two groups of subjects: obstacle course backwards, crossed-arms sit-ups, triceps skinfold, bent-arm hang and 20-m dash. Other variables that were signifi-

TABLE 3
SUMMARY OF CANONICAL DISCRIMINANT FUNCTIONS

Variable	Discriminant Function Structure			
	M11-13	M14-16	F11-13	F14-16
20-m dash	0.18	0.18	0.18	0.09
Obstacle course backwards	0.40	0.32	0.43	0.35
Slalom with 3 balls	–0.06	–0.22	0.16	0.16
Arm plate tapping	0.06	0.08	–0.17	–0.15
Forward bend	–0.13	–0.07	0.02	0.11
Standing broad jump	–0.18	–0.07	0.17	–0.06
Bent-arm hang	–0.19	–0.17	–0.16	–0.07
Crossed-arm sit-ups	–0.36	–0.25	–0.43	–0.30
Body height	0.31	0.00	0.05	0.10
Body weight	0.16	–0.11	–0.02	–0.08
Chest girth	–0.04	–0.21	–0.16	–0.16
Midarm girth	–0.03	–0.21	–0.15	–0.21
Forearm girth	–0.02	–0.21	–0.16	0.02
Abdominal skinfold	0.16	0.04	0.11	0.05
Subscapular skinfold	0.14	0.05	0.15	0.09
Triceps skinfold	0.27	0.21	0.13	0.23
Abdominal girth	0.06	–0.10	0.01	–0.08
Canonical Correlation	0.73	0.78	0.87	0.86
Wilks' Lambda	0.47	0.39	0.24	0.25
χ^2	82.62	88.41	62.85	71.04
p	0.00	0.00	0.00	0.00
Group	Group Centroids			
Judoists (J)	–1.11	–1.22	–1.64	–1.93
Untrained (U)	0.99	1.26	1.90	1.49

cantly different between the two groups of subjects were irrelevant for discrimination. Thus, only the first 5 variables will be discussed below. Table 3 also shows that the discriminant function was significant at $p<0.001$ which confirms that the linear combination (structure) of the applied set of variables makes a significant discrimination between the groups of female judoists and untrained girls. In this discrimination, the most important variables are those that evaluate functional coordination (obstacle course backwards), muscular endurance (isotonic strength; crossed-arms sit-ups) and triceps skinfold. According to the centroids of female subjects from both groups, it was confirmed that young female judoists attained better results in all mentioned variables.

Discussion and Conclusion

Anthropometric variables can make different contributions to the morphological structure of the body at different periods of development. In addition to biological growth and development, child's body can be significantly affected by training of high intensity and correctly applied, especially a long-lasting one. In this study, significant differences in the judo-trained *vs*. untrained boys were demonstrated for chest, midarm and forearm girths, and for triceps skinfold. In girls, these differences were observed for chest and midarm girths and for triceps skinfold. It may thus be concluded that the manifestation of these features was significantly better in boys and girls practicing judo compared to their untrained peers.

Judo is classified into 7 weight categories. Normally, judoists in heavier categories are expected to contain more fat tissue. However, according to some recent studies, elite judoists are characterized by a lower content of subcutaneous fat tissue[23,24], as well as greater forearm and midarm girths compared to less experienced competitors[25,2], which points to a greater share of muscular tissue in elite judoists. Such a finding has been confirmed in this research on young male and female judoists.

Coordination has been highly ranked among the desired motor abilities in judo. The complexity of motion structures in judo is manifested by a high number of techniques which may contribute to success only if they are applied in a timely fashion, and in accordance with judo principles. By continuously modifying dynamic situations during a fight, judoists are required to accept the applied technical-tactical stereotypes, demonstrate the ability for instant reorganization of these stereotypes, and create new plans of defense, attack and counterattack actions[26]. In this research, female judoists demonstrated better coordination abilities than their untrained peers in both coordination tests (obstacle course backwards and slalom with 3 balls), while male judoists were better in the obstacle course backwards, but worse in slalom with 3 balls. This can be explained by the fact that judo-trained boys do not spend much time playing ball games. The set of coordination abilities is formed rather early, especially the abilities of rhythmic coordination, agility, rhythm, and motor responses. Starting to work on development of coordination abilities is never too early due to the fact that it is a prerequisite for a better motor learning at later stages of athletic training. Psychomotor coordination develops by learning new, differentiated exercises, as well as by performing already known exercises under new, altered conditions[27].

In this research male judoists performed better than their untrained peers in the tests of repetitive and static strength, whereas female judoists did better in the former. Repetitive strength is a desired characteristic both in judo competitions and in training. In order to improve the techniques applied in a competition (Tokui Waza), it is necessary to repeat them several times during a training session. Moreover, with reference to dynamics of the fight itself, characterized by multiple attacks and counterattacks, this feature is highly important. A great number of techniques can be performed insistently (Ken-Ken), which also requires well-developed repetitive strength especially of legs. Judoists require static strength for floor fight in order to be able to sustain a hold or a grip. Systematic transformation of strength should begin only when active and passive parts of the motor system of young judoists become sufficiently strong. This might be

achieved by appropriate training methods for developing strength of the entire locomotor system but also for developing speed, coordination, aerobic endurance and flexibility[28]. Intensive strength training of young judoists should begin after they have completed puberty, provided that strength training exercises with manipulating one's own body weight or passive/active resistance of a partner had already been mastered. It is necessary to avoid long-lasting static loads. Varied loads are beneficial both for joint cartilage and ligaments. Static loads negatively affect blood supply of the loaded structure, whereas an active load makes it better. For this reason, preference should be given to dynamic strength exercises[29,30].

In relation to the untrained subjects, significant differences in speed (20 m dash) were found in both genders, whereas female judoists also showed these differences in the frequency test (plate tapping). Leg movement speed is one of the important characteristics both in leg-attack techniques and in avoiding them. In other throwing techniques, fast leg movements are also required so that passing to a hold is as efficient as possible in order to decrease the possibility of a counterattack. Thus, in training young judoists, special attention should be paid to speed development since the final development level of grown-up judoists is highly affected by age at which its systematic development had begun. Speed should be developed applying a differentiated pattern. Reaction speed should be worked on in judoists at the age of 6–10 years, movement frequency is desired to be developed between 8–13 years of age, whereas training of speed strength should be practiced predominantly in early adolescence. An early practice in specific exercises for speed development yields fast effects but may eventually limit the overall speed development[31].

Our results have shown that there is no significant difference in suppleness between judoists and untrained subjects which is rather astonishing since even though it is not a major factor in judo fights, suppleness is expected to be better developed in the former. It is well-known that suppleness up to the age of 10 years is well pronounced, hence intensive training should be continued after that in order to at least maintain the desired level. Active and dynamic stretching exercises should be given preference. Passive stretching exercises should be applied only during adolescence[32].

Summing up, the following statements can be formulated:

(1) During the ages of 14–16, significant differences in anthropometric features were observed between male judoists and their untrained mates as manifested by the scores in chest, midarm and forearm girths and in triceps skinfold. In girls of that age such differences have been found in chest and midarm girths and in triceps skinfold;

(2) Judoists have performed better than their peers in the whole-body coordination test (obstacle course backwards), and, surprisingly, performed much worse in slalom with 3 balls. Female judoists have shown better coordination abilities than their untrained peers in both coordination tests;

(3) Male judoists were superior to their peers in all tests of repetitive and static strength (crossed-arm sit--ups and bent-arm hang), whereas female judoists were better in repetitive strength (crossed-arms sit-ups);

(4) Subjects of both genders were significantly different compared to the untrained subjects in speed (20 m dash), whereas female judoists have shown this difference in movement frequency (plate tapping).

Judo loads increase with years and the competition timetable gets increasingly harder for young judoists. Thus, physical preparation is highly required[33]. Judo development, quality and professional planning and programming of the training process rely heavily on the selection of children, as well as on proper training right from the beginning of their career. For these reasons, training must be carried out professionally and under a team supervision by skilled coaches and professionals from all relevant sport fields (physicians, nutritionists, psychologists, trainers, and others).

The presented data can provide judo coaches significant information as to how to direct the training in order to compensate for those abilities and technical and tactical knowledge in which their judoists are deficient. A judo competitor who does not fit in the ideal profile can succeed by means of a superior technique and tactics, but he/she will surely perform better if all anthropological characteristics are highly developed. Future studies should be directed towards creation of a professional database not only for elite judoists, but also for all age categories; this will be useful for selection purposes in judo, as well as for creation and execution of specific training plans and programs. Such systematic work would enable national judo to achieve better results in great international competitions in the oncoming period.

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ANTROPOMETRIJSKE KARAKTERISTIKE I MOTORIČKE SPOSOBNOSTI MLADIH DŽUDISTA VOJVODINE

S A Ž E T A K

Cilj istraživanja je bio da se identifikuju razlike u tjelesnom sastavu i motoričkim sposobnostima između treniranih i netreniranih ispitanika. Uzorak ispitanika bio je podeljen u dve grupe: mladi džudisti (110 dečaka i 56 devojčica) i njihovi vršnjaci (115 dečaka i 60 devojčica) koji se ne bave sportom, uzrasta 11–16 godina sa područja AP Vojvodine. Mladi muški džudisti su se pokazali značajno boljim u odnosu na netrenirane vršnjake u vežbama repetitivne i statičke snage, brzini trčanja, koordinaciji celog tela, dok su vrednosti potkožnog masnog tkiva nadlaktice bile niže kod džudista. Džudistkinje su bile bolje u odnosu na netrenirane vršnjakinje u repetitivnoj snazi, koordinaciji celog tela, tapingu rukom, obimu grudnog koša i obimu opružene nadlaktice. Takođe su džudistkinje imale i niže vrednosti potkožnog masnog tkiva nadlakta i leđa.