DIFFERENCES IN THE MORPHOLOGICAL PROFILE AND PERFORMANCE OF MOTOR TESTS IN RELATION TO MARTIAL SPORTS

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Abstract: *The aim of the research was to determine the differences in the morphological profile and performance of motor tests between karate and judoka. 30 subjects participated in the research, divided into two groups, karate and judoka. The variables for the assessment of motor abilities are age-adjusted and consist of 10 variables (6 strength variables, 2, 1 balance, 1 flexibility, 2 speed), while 7 variables were used for the assessment of morphological characteristics. Based on the measurement results, we came to the conclusion that judokas achieved superior results in static strength tests, while karate athletes achieved better times in speed tests. With this, we came to the conclusion that the morphological profile in relation to martial arts makes a statistically significant difference in the performance of the motor tests that are shown in the research results. In some of the following research, it would be interesting to test other populations of combat sports on the same variables and find out if a difference will appear in the variables in which it did not appear now.*
Key words: *Strength, Skill, Martial Arts, Speed*

INTRODUCTION

Judo and karate belong to the group of martial arts, where there is an indirect or direct confrontation and an effort to overcome the opponent (Zovko, 2020). They include complex acyclic movements dominated by semi-open motor structures (Milanović, 2013). Even if they are similar and come from the same group of sports, their different abilities bind them to success, especially at younger ages. In karate, the first place would be speed, the second would be coordination, while the third would be strength, while in judo coordination, then strength and speed (Sertić, 2004). The overall development of children as well as the planning of a long-term and successful sports career begins very early, still in the initiation process in the period from eight to nine years (Bompa, 2005). With sports diagnostics, that is, by assessing the dimensions of the athlete's preparation, we get to know about the current state and its shortcomings for the high-quality realization of the goal (Milanović, 2013; Savić, Ranđelović, Stojanović, Stanković and Šiljak, 2018). In order for the results to be as accurate and valid as possible, the measurements must be taken by the same person at the same time of day, with the same instruments and the same technique (Mišigoj-Duraković, 2008). Adequate anthropology is one of the most important elements of success, it represents a system of all motor characteristics, abilities and their mutual functioning (Pejčić and Trajkovski, 2018). The motor skills used in the research that was conducted, (Sekulić and Metikoš (2007); Gamilec, (2020); Fulurija, Bjelica and Gojković, (2017) defined as follows: explosive power is the body's ability to produce maximum force in the shortest time Repetitive strength is defined as the ability of certain musculature to perform a dynamic movement in the longest possible period of time. Static strength is defined as the ability to maintain the desired position for a long time. While speed was defined as the ability to react quickly and perform multiple movements in the shortest possible period of time. Breslauer , Hublin & Zegnal Koretić, (2014) point out that strength is "the ability to effectively use muscle power in overcoming various resistances". In addition to strength, which is represented in a large dose, judo is a sport characterized by a large number of technical elements expressed through acyclic movements that are performed in the effort to destroy and control the opponent in order to achieve victory, where strength and speed are represented in large quantities (Sertić, 2004). These are short explosive movements that take place quickly and consist of a group of explosive movements related to one entity (Malacko, 1997; Bratić and Đurašković, 2001 and Ranđelović, 2002; Bratić, Drid, Nurkić, and Obadov, 2006). The technique itself contains more than 1500 technical-tactical elements (Kuleš, 1990). The basic judo technique is divided into eight groups: stances, movements, falls, grips, throws, levers,suffocation and restraints (Sertić, 2004). In the research carried out by (Krstulović, 2004), the inviting effect of judo on the development of morphology (increase in muscle mass and decrease in fat tissue) as well as a positive effect on motor skills (repetitive strength, static strength, flexibility and frequency of movement) were proven. Karate as a sport aims at the "symbolic" destruction of the opponent, which it achieves with strictly controlled blows of the arms and legs (Jukić, Čavala, Katic, Zagorac and Blažević, 2017). Every movement is clearly precise and executed with maximum speed. The movements that characterize karate are movements of large amplitudes during which it is necessary to maintain the best possible balance position (Sertić, 2004). Vidranski (2006) in his research shows how programmed karate training has a positive effect on qualitative and quantitative changes in the motor skills of the subjects, where after 9 months of the program between the initial and final measurement of motor skills, a significant difference and tendency to success in karate appeared. The aim of this research was to determine the differences in the morphological profile and performance of motor tests between karate and judoka.

METHOD

A sample of respondents

The research was conducted on a sample of 30 subjects aged 13 ± 1 years. The participants were divided into two groups and entered the research without somatic and organic diseases. The first group consisted of the "Romanija" karate club and the "Zenshin" karate club (15 respondents), while the second group consisted of the "Rajko Kušić" judo club (15 respondents). With the written consent of the coaches and parents of the children, testing was performed through standardized motor and morphological tests.

Measuring instruments

A total of 17 standardized tests adapted to the age of the subjects were applied, of which 10 were tests for motor skills and 7 were tests of morphological characteristics. The variables that were used to evaluate the motor tests are: wall (squad) test (MSK), push-up (MSSIZ), sit-ups (MRSPTL), burpees (MBM), long jump (MSDM), "quadrathlo" with medicine chest (MXT), flamingo (MFR), deep bench press (MDUPRKL), 10X5M run (TRC10X5), 20m high start run (TRC20VS). The following variables were used to assess morphological characteristics: height (TV), weight (TT), forearm circumference (OPL), upper arm circumference (ONL), upper leg circumference (ONK), chest circumference (OGR), waist circumference (OST).

Data processing

Basic descriptive parameters, arithmetic mean (Mean), standard deviation (Std. Dev.), standard error (Std. Error), minimum value (Min.), maximum value (Max.) were used for data processing. One-factor analysis of variance ANOVA was used to determine the differences between the groups. The significance level was set at $p<0.05$. Statistical analyzes were performed using SPSS v20.0 software.

RESULTS AND DISCUSSION

Table 1 Descriptive statistics of morphological tests in relation to sports

		N	Mean	Std. Dev.	Std. Error	Min.	Max.
TV	Judo	15	163.7333	5.76277	1.48794	154.00	177.00
	Karate	15	168.6000	6.83269	1.76419	157.00	180.00
	Total	30	166,1667	6.68546	1.22059	154.00	180.00
TT	Judo	15	60,1333	6.06944	1.56712	50.00	72.00
	Karate	15	53.6667	8.60786	2.22254	42.00	70.00
	Total	30	56.9000	8.02303	1.46480	42.00	72.00
OST	Judo	15	70.8333	3.95360	1.02082	65.00	77.00
	Karate	15	67.4000	4.29368	1.10862	62.00	75.00
	Total	30	69,1167	4.41526	,80611	62.00	77.00
OPL	Judo	15	23.5667	2.30579	,59535	20.00	28.00
	Karate	15	22.4000	2.12300	,54816	19.00	27.00
	Total	30	22.9833	2.25711	,41209	19.00	28.00
ONL	Judo	15	25.0667	3.07563	,79413	20.00	32.00
	Karate	15	23.9133	2.63598	,68061	19.50	29.50
	Total	30	24.4900	2.87490	,52488	19.50	32.00
ONK	Judo	15	51.3333	6.31514	1.63056	40.00	68.50
	Karate	15	52.3333	4.69295	1.21172	43.50	60.50
	Total	30	51.8333	5.49033	1.00239	40.00	68.50
OGR	Judo	15	80.7000	5.34790	1.38082	74.00	90.00
	Karate	15	76.7000	4.80253	1.24001	69.00	83.50
	Total	30	78.7000	5.39252	,98454	69.00	90.00

Legend: number of respondents (N), arithmetic mean (Mean), standard deviation (Std. Deviation), standard error (Std. Error), minimum (Min.), maximum (Max.)

Longitudinal dimensionality is a very important factor in the structure of karate, which further implies that an athlete who has better longitudinal dimensionality will have longer limbs than his opponent who is in the same weight category with similar technical-tactical knowledge, that is, he will have a slight advantage. For this reason, it is expected that karate club members will be significantly taller and lighter compared to judokas who prefer more voluminous bodies. Another relevant indicator of the morphology of the athletes of these martial arts is the categorization based on weight in competitions, we see that in the cadet age judoka (men) the largest weight category is ±90 kg, while for karate athletes it is ±70 kg, while for seniors it is ±100 kg (judo) and ±84 kg (karate). By comparing the central values in table 1, where the basic descriptive statistical parameters of the morphological tests are presented, we can state that karate players are significantly taller (TV) and have a smaller waist circumference (OST) than judokas, while judokas are significantly heavier (TT) and have a larger circumference chest (OGR) from karate. In the forearm circumference (OPL) and upper arm circumference (ONL) tests, judokas had a larger but not numerically significant result, while in the upper leg circumference (ONK) test, karate athletes had a larger circumference. By making a comparison from the youngest age between these two sports, we can conclude that even if judokas are significantly heavier and shorter, they have a lower body mass index compared to karate athletes. Which contradicts the research they conducted (Kirk, 2016; Bujak, Gierczuk, Hubner-Woźniak & Saulite, 2016) where judokas had a higher fat mass, sum of skin folds (especially on triceps and subscapular skin folds), percentage of body fat and a lower percentage of lean body mass compared to taekwondo, karate and track and field athletes.

Table 2 ANOVA, statistical significance of morphological tests in relation to sport

		Sum of Squares	df	Mean Square	F	Sig.
TV	Between Groups	177,633	1	177,633	4,447	,044
	Within Groups	1118,533	28	39,948		
	Total	1296,167	29			
TT	Between Groups	313,633	1	313,633	5,654	,024
	Within Groups	1553,067	28	55,467		
	Total	1866,700	29			
OST	Between Groups	88,408	1	88,408	5,190	,031
	Within Groups	476,933	28	17,033		
	Total	565,342	29			
OPL	Between Groups	10,208	1	10,208	2,078	,160
	Within Groups	137,533	28	4,912		
	Total	147,742	29			
ONL	Between Groups	9,976	1	9,976	1,216	,280
	Within Groups	229,711	28	8,204		
	Total	239,687	29			
ONK	Between Groups	7,500	1	7,500	,242	,626
	Within Groups	866,667	28	30,952		
	Total	874,167	29			
OGR	Between Groups	120,000	1	120,000	4,645	,040
	Within Groups	723,300	28	25,832		
	Total	843,300	29			

Legend: Sum of Squares - sum of squares, df - degrees of freedom, Mean Square - mean value, F - f test, Sig. - level of significance

Table 2 shows the results of morphological tests in relation to the sport practiced by the respondents (judo-karate). Observing the column Sig. (significance level) statistically significant difference between karate and judoka is noticeable in the tests: height (.044), weight (.024), waist circumference (.031) and chest circumference (.040). In three other tests, forearm circumference (.160), upper arm circumference (.280) and upper leg circumference (.626) have no statistical significance.

In order to properly analyze the obtained results, it is necessary to mention that the development of strength in children is a very important factor, which provides a large number of benefits, the most important of which are: an increase in the level of strength (Faigenbaum, Kraemer, Cahill, Chandler, Dziados, et al. 1996; Siegel, 1988), general health (Faigenbaum, 1993; American Academy of Pediatrics, 2001), achieving better outcomes (Woloham & Micheli, 1990; Pitton, 1992), injury prevention (Faigenbaum & Schram, 2004; Bielchech, 1989; Williams, 1993), which was recorded and shown in Tables 3 and 4, where judokas achieved better numerical results in the tests: static strength (wall (squad) test (MSK) and pull-up endurance (MSSIZ) as well as in the repetitive strength test (burpee (MBM). While in the speed test (running 10x5 meters (TRC10X5)) the karate players achieved a numerically more significant difference. In the other six tests in which there were no significant numerical differences, the karate players achieved better results in the tests: flamingo (MFR), deep bow on bench press (MDUPRKL) and running 10x5 meters (TRC10X5), while judokas achieved better but not significant results in the tests: long jump from standing (MSDM), quadrathlon with medicine chest (MXT) and sit-ups (MRSPTL). In addition to the already listed benefits, training also has a positive impact on psycho-sociological characteristics, which are represented by improving self-esteem, self-esteem and mental health (Faigenbaum, 1995; Faigenbaum, Zaichkowsky, Westott, Long, LaRosa-Loud, et. al. 1997) . All these factors show us how useful, necessary, and safe strength training is for children (Schafer, 1991; Haff, 2003; Faigenbaum, et. al., 1996).

Table 3 Descriptivestatistics of motor tests in relation to sports

		N	Mean	Std. Dev.	Std. Error	Min.	Max.
MSK	Judo	15	143.2667	43.27564	11.17372	82.00	231.00
	Karate	15	109.7233	44.52333	11.49587	63.00	220.00
	Total	30	126.4950	46.39046	8.46970	63.00	231.00
MSSIZ	Judo	15	37.6493	14.43513	3.72714	7.00	60.00
	Karate	15	24.5607	14.07137	3.63321	6.65	48,61
	Total	30	31.1050	15.50764	2.83129	6.65	60.00
MRSPTL	Judo	15	27.0000	3.11677	,80475	23.00	35.00
	Karate	15	24.9333	8.01308	2.06897	14.00	40.00
	Total	30	25.9667	6.06564	1.10743	14.00	40.00
MBM	Judo	15	16.2667	2.18654	,56456	11.00	19.00
	Karate	15	14.2667	2.28244	,58932	12.00	20.00
	Total	30	15.2667	2.42022	,44187	11.00	20.00
MSDM	Judo	15	186.4000	47.56169	12.28038	21.00	216.00
	Karate	15	185.0000	24.46572	6.31702	138.00	220.00
	Total	30	185.7000	37.16891	6.78608	21.00	220.00
MXT	Judo	15	339.4667	87.03847	22.47324	235.00	530.00
	Karate	15	360.6667	87.60436	22.61935	220.00	520.00
	Total	30	350.0667	86.47780	15.78861	220.00	530.00
MFR	Judo	15	84.6667	86.13583	22.24018	12.00	300.00
	Karate	15	106.8120	79.77526	20.59788	21.00	311.00
	Total	30	95.7393	82.34635	15.03432	12.00	311.00
MDUPRKL	Judo	15	-4.2667	7.48777	1.93333	-15.00	11.00
	Karate	15	-6.9667	7.78842	2.01096	-19.00	7.00
	Total	30	-5.6167	7.63125	1.39327	-19.00	11.00
TRC10X5	Judo	15	14.7587	1.72757	,44606	12.45	19,18
	Karate	15	13.4547	1.04864	,27076	11.96	4:30 p.m
	Total	30	14,1067	1.55287	,28351	11.96	19,18
TRC20VS	Judo	15	3.9787	,34351	,08869	3.48	4.56
	Karate	15	3.7667	,28665	,07401	3.16	4.13
	Total	30	3.8727	,32902	,06007	3.16	4.56

Legend: number of respondents (N), arithmetic mean (mean), standard deviation (Std. Deviation), standard error (Std. Error), minimum (min.), maximum (max.)

Table 4 shows the results of motor tests in relation to martial arts (judo-karate). Observing the column Sig. (significance level) statistically significant difference between judoka and karate is noticeable in tests: wall (squad) test (.046), push-up endurance (.018), burpee (.021), running 10x5 meters (.019). In six other tests: sit-ups (.360), long jump (.920), quadrathlon with medicine ball (.512), flamingo (.471), deep bench press (.341) and 20-meter dash (.077) no static significance. Looking at the judo specification equations, the first three motor skills would include strength, coordination and speed (Sartić, 2004). In the research conducted by (Segedi, Franjić, Kuštro, Petrović & Sertić, 2011), statistically significant differences were found between judokas and karatekas in certain strength variables in favor of judokas, while no statistically significant differences were found in other variables, judokas achieved better results, which justifies the research results as well as the thesis of the performance specification. The very structure of judo (throwing techniques: foot, hand) increases the percentage of development of strength dimensions as well as strengthening the strength of arms, shoulder girdle, legs and trunk (Kajmović, Rađo and Mekić, 2011), which justifies the results. In the research (Popović, Savić and Bojović, 2016), the analysis of the results confirms that judokas are characterized by greater strength compared to karate athletes. Among karate athletes, speed, coordination and strength are most prevalent (Sertić, 2004; Segedi, et al., 2011; Tatar and Karadžić, 2012). Speed is the most important thing in karate. Speed can also be viewed through explosive power (Malacko and Rađo, 2004), where if we look at table 4, we can notice that statistically more significant results in speed tests (TRC10X5, TRC20VS)and explosive strength (MSDM, MXT) achieved by karate fighters.Sertić, Segedi, and Segedi (2008) they conducted a study in which also by looking at the results karate players were superior in the variables of speed and explosive power. Flexibility is an important ability of karateka that is given a lot of attention. The sheer amplitude of kicks and kicks requires and develops flexibility in the groin area, lower back, lower extremities and hip area. Popović et al. (2016) conducted a study in which 200 subjects of junior and senior age (18-27 years) were tested, divided into two groups of 100 subjects each tested on 15 variables defined as a mechanism for structuring movement, a mechanism for regulating muscle tone and synergistic regulation, a mechanism for regulating the intensity of excitation and a mechanism for regulating the duration of excitation. In the interpretation of the results, it was proven that karate players are more flexible than judo players.

Table 4 ANOVA, statistical significance of motor tests in relation to sport

		Sum of Squares	df	Mean Square	F	Sig.
MSK	Between Groups	8438,664	1	8438,664	4,378	,046
	Within Groups	53971,508	28	1927,554		
	Total	62410,172	29			
MSSIZ	Between Groups	1284,849	1	1284,849	6,323	,018
	Within Groups	5689,271	28	203,188		
	Total	6974,120	29			
MRSPTL	Between Groups	32,033	1	32,033	,867	,360
	Within Groups	1034,933	28	36,962		
	Total	1066,967	29			
MBM	Between Groups	30,000	1	30,000	6,006	,021
	Within Groups	139,867	28	4,995		
	Total	169,867	29			
MSDM	Between Groups	14,700	1	14,700	,010	,920
	Within Groups	40049,600	28	1430,343		
	Total	40064,300	29			
MXT	Between Groups	3370,800	1	3370,800	,442	,512
	Within Groups	213503,067	28	7625,110		
	Total	216873,867	29			
MFR	Between Groups	3678,118	1	3678,118	,534	,471
	Within Groups	192968,615	28	6891,736		
	Total	196646,733	29			
MDUPRKL	Between Groups	54,675	1	54,675	,937	,341
	Within Groups	1634,167	28	58,363		
	Total	1688,842	29			
TRC10X5	Between Groups	12,753	1	12,753	6,245	,019
	Within Groups	57,178	28	2,042		
	Total	69,931	29			
TRC20VS	Between Groups	,337	1	,337	3,368	,077
	Within Groups	2,802	28	,100		
	Total	3,139	29			

Legend: Sum of Squares - sum of squares, df - degrees of freedom, Mean Square - mean value, F - f test, Sig. - level of significance

CONCLUSION

The goal of this research was to show how the morphological profile of members of different martial arts makes a difference in the performance of motor tests. Through the statistical analysis of the results, we came to the conclusion that judokas are significantly heavier and have a larger chest and waist circumference compared to karate fighters who are significantly taller, lighter and have smaller circumferences. In the motor tests, judokas achieved better results in all strength tests, while they achieved statistically significant results in the tests: withstand the pull-up (MSSIZ) and burpee (MBM). In tests of speed, balance and flexibility, the karate players were better, while the statistically significant result was achieved in the test of running 10x5 meters (TRC10x5). Taking into account the results, we can conclude that even if they belong to the same group of sports, different motor skills develop, which further has an impact on the appearance of differences in the morphological profile between athletes.

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RAZLIKE U MORFOLOŠKOM PROFILU I IZVOĐENJU MOTORIČKIH TESTOVA U ODNOSU NA BORILAČKI SPORT

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Sažetak: *Cilj istraživanja je bio da se utvrde razlike u morfološkom profilu i izvođenju motoričkih testova između karatista i džudista. U istraživanju je učestvovalo 30 ispitanika, podjeljenih u dvije grupe, na karatiste i džudiste. Varijable za procjenu motoričkih sposobnosti prilagođene su uzrastu i čine ih 12 varijabli (6 varijabli snage, 2 brzine, 1 ravnoteže, 1 fleksibilnosti, 2 brzine), dok je za procjenu morfolološkh karakteristika primjenjeno* 8 *varijabli. Na osnovu rezultata mjerenja, došli smo do zaključka da su džudisti superiornije rezultate ostvarili u testovima statičke snage dok su karatisti ostvarili bolje vrijeme u testovima brzine. Samim tim došli smo do zaključka da morfološki profil u odnosu na borilački sport pravi statistički značajnu razliku u izvođenju motoričkih testova koji su prikazani u rezultatima istraživanja. U nekim od narednih istraživanja bilo bi zanimljivo izvršiti testiranje drugih populacija borilačkih sportova na iste varijable i ustanoviti da li će se pojaviti razlika u varijablama u kojima se sada nije pojavila.*
Ključne riječi: *snaga, vještina, borilački sportovi, brzina, antropometrija*