

RELATIONSHIP BETWEEN KINEMATIC CHARACTERISTICS AND MORPHOLOGICAL PARAMETERS IN SHOTOKAN KARATE ATHLETES

(Original scientific paper)

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Abstract

The aim of an already conducted experiment was given to represent the relationship between kinematic and anthropometric parameters and the effectiveness of selected combat techniques in a representative study group of elite athletes with specialized measuring equipment and methods and subsequent aim-related analysis of execution, seeking the most significant deviations and dependencies from sport and pedagogical view point. As morphology parameters we chose indicators of body composition (such as body weight, %water content, % body fat, muscle mass, index of internal organs adipose tissue, index of physical condition, bone mass, basic metabolic rate and metabolic age) derived by a body composition scale-analyzer (Tanita BC-533), using skin bioimpedance (single-frequency electric current with impedance of 20-2000ohms, and up to 50 kHz frequency and 500 μ A). The kinematic parameters were registered through a high-speed CASIO-EX-ZR200 video camera with recording frequency of 120 fps using specialized software: SkillSpector. In the initial menu we choose graphics of speed, trajectories or travel time. The experiment was conducted with 22 elite athletes in Shotokan – Karate, the chosen techniques were Gyaku-Tsuki for upper, and Mae-Geri and Yoko-Geri for lower extremity. The correlation analysis showed significant dependencies in karate athletes between body mass, percentage of muscle mass and bone mass and metabolic rate as much as negative correlation between adipose mass and percentage water content-which is understandable. Higher sports qualification defines higher execution speed of specified techniques, in relation to greater height of the athlete. As a result we can summarize a tendency in the physical development of Bulgarian karate athletes-aimed search and development of athletes with optimized height, controlled muscle mass and reduced adipose mass.

Keywords: *kinematic characteristics, morphological parameters, correlation analysis, combat techniques, index of internal organs adipose tissue, index of physical condition, basic metabolic rate, metabolic age*

INTRODUCTION

Shotokan karate is regarded as a martial art requiring strength and high coordination. Anthropometric characteristics and morphological dimensions play a basic role in evaluation of the success of an athlete (Keogh, 1999). Physical characteristics such as body composition, size, type and structure are considered to be some of the key factors for high level performance in various sports events (kinanthropometry). These parameters are affected by the environmental and genetic factors. Body composition of athletes is an important tool to evaluate their health, to monitor the effects of a training program, to determine the optimal body weight and composition (Prior, et al., 2001).

In karate subcutaneous adipose tissue slows down the movement. Top-level male karate athletes are with

low body fat and mesomorphic-ectomorphic somatotype. There is no data for the body composition and somatotype of females (Chaabene, Hachana, Franchini, Mkaouer, & Chamari, 2012). Muscle mass and body mass on the other hand are substantial for bouts with the opponent, and for performing throws and fast movements on attacks, defense or counterattack. A proportional constitution with pronounced extremity musculature is characteristic of the elite karateka (Katić, Blazević, Krstulović, & Mulić, 2005).

Besides the morphological parameters, the effectiveness of a technique also depends on the correct movement trajectory. Analysis of the kinematic characteristics allow indirect assessment of the skeletomuscle system. Execution and duration of the kick, as well as the kinematics of the lower limb are especially impor-

tant parameters for the performance of Shotokan karate athletes. According to Pozo, Bastien & Dierick, (2011) the duration of the kick and repeatability of lower limb kinematics could be useful in selecting top-level karate athletes and monitoring their training status.

Competitiveness and the demands of high level performance lead to long term and exhausting training. Understanding the effect of training on body composition as well as the correlations between kinematic characteristics and morphological parameters will help athletes control weight, alter body composition safely, enhance their performance and reduce the injuries.

The aim of our study is to investigate the correlations between the measured kinematic characteristics and morphological parameters in Shotokan Karate athletes.

METHODS

The kinematic parameters which we measure were obtained from the motor structure of sport techniques. They were registered through a high-speed CASIO-EX-ZR200 video camera with recording frequency ranging from 30 to 1000 fps. The frequency of recording was 120 fps (Gikova, & Tishinov, 2014). All recordings were entered into a computer and we marked the observed points – in this case these were: the toe and knee of lower extremity executing the kick, shoulder and hand of upper extremity for the punch. By means of consecutive framing processing, the coordinates of the trajectory points were registered in the computer using SkillSpec specialized software. In the initial menu graphics of speed, trajectory or travel time were chosen. For obtaining additional accuracy in the statistical analysis can be used the digital equivalent of the graphics obtained from the initial menu of the analyzing software.

The examined morphological characteristics were indicators of body composition - body mass (BM), muscle mass (ABM or MM), body mass index (BMI), body fat (BF), index of fat around the internal organs (VF), physical condition assessment (Phys), bone mass (Bone), basic metabolism and metabolic age. These characteristics were observed with a Tanita body composition analyzer, scale BC-533 using skin

bioimpedance (impedance measurement scale of 20-2000ohms, with an accuracy of 6 ohms, frequency up to 50 kHz and 500 μ A current). The detailed definitions and descriptions of these morphological indices were made in our previous work.

Our experimental model group included 22 athletes in Shotokan – Karate, 16 male and 6 female, ranging from 20- 29 years old, 9 persons with higher I – II dan and 13 persons from 1 to 7 qu. They performed a series of kicks – a Mae Geri straight front kick, and a Yoko Geri side kick and Gyako-Zuki strike with upper limb.

RESULTS

By observing tables 1 and 2, certain number of conclusions can be made: There is no significant difference between the years of practice in male and female karatekas; 2. Gender comparison of height, muscle and bone mass shows no unexpected deviation-in advantage for the male athletes, which weight is greater with an average of 12kg, probably as a result of greater muscle development. Although there is a marked mean BMI equality between genders, males tend to have an advantage in fatty mass-a mean of 13,1 kg compared to 24,4 kg for the female karate athletes. Such a deviation from the presumed criterion for harmonic/proportional development in females (Max for the female group is 87,6 kg and 38,6% fatty mass) takes notice. Also males tend to have greater muscle mass-an average 18 kg higher than females.

After the statistical analysis there is a noted small range compact structure based on height- the shortest to the highest athletes are in the range of 169 up to 172 cm as a mean value, and much better presented based on muscle mass, whether a male or a female-62,6 and 44,8 kg on the average accordingly. These results are confirmed too in the research of Katic and Blazevic specifics in the characteristics of a Karate athlete: higher BMI based on greater muscle and reduced fatty mass (Katić, et al., 2005). Additionally we can observe inner group specifics for the male karatekas: athletes with greater level of qualification mark even better on average values- over an average BMI of 24,4 kg/m² fatty mass is only 12,6 kg while muscle mass is 62,3 kg. Furthermore

Table 1. Morphology parameters of the male Karate athletes (where: X – average; S - mean square; V - coefficient of variation; As - asymmetry; Ex - excess; Max - maximum value in the study sample; Min - minimum value in the study sample; R (span) - the difference between the maximum and minimum values)

Male	Years of Practice	HIGHT (cm)	WEIGHT (Kg)	BMI	Water content	FAT tissue (%)	VISCE RAL fat	MUSCLE mass (Kg)	Phys condit	Bone matter mass (Kg)	Metabolic rate (Kcal)	Metab. AGE
X	11,5	170,5	74,7	24,6	61,5	13	2	62,6	5,4	3,3	1943,6	16,6
S	4,4	1	9,8	2,9	4,5	5,1	1,8	5,1	1,5	0,2	176,2	7,7
V	38%	1%	13%	12%	7%	39%	90%	8%	29%	8%	9%	46%
As	-0,77	0	1,53	0,86	1,19	0,22	1,97	0,49	0,34	0,72	1	1,55
Ex	1,51	-1,2	3,93	-0,04	2,12	-1,35	2,74	1,17	-0,74	1,45	2,3	0,78
Max	19	172	101,8	31	73	24,4	6	76	8	3,9	2434	32
Min	1	169	60,5	21	56,1	6,7	1	55,6	3	2,9	1718	12
R	18	3	41,3	10	16,9	17,7	5	20,4	5	1	716	20

Table 2. Morphology parameters of the female Karate athletes (where: X – average; S – mean square; V – coefficient of variation; As – asymmetry; Ex – excess; Max – maximum value in the study sample; Min – minimum value in the study sample; R (span) – the difference between the maximum and minimum values)

Female	Years of Practice	HIGHT (cm)	WEIGHT (Kg)	BMI	Water content	FAT tissue (%)	VISCERAL fat	MUSCLE mass (Kg)	Phys condit	Bone matter mass (Kg)	Metabolic rate (Kcal)	Metab. AGE
X	12	159	62,9	23,9	55,4	24	1,8	44,8	5,8	2,4	1449	18,7
S	4,2	3	13,8	5	3,6	6,4	2	6,8	1,9	0,4	216,7	13,5
V	35%	2%	22%	21%	6%	27%	111%	15%	33%	15%	15%	72%
As	-1,76	0	1,08	1,51	-1,54	1,45	2,45	0,09	-0,15	0,12	0,1	2,38
Ex	3,66	3,7	2,01	2,13	3	2,73	6	-1,46	-0,85	-1,37	-1,07	5,75
Max	16	162	87,2	33	59,1	35,8	6	53,1	8	2,8	1739	46
Min	4	156	46,3	19,4	48,8	17,9	1	35,7	3	1,9	1155	12
R	12	6	41	14	10	18	5	17	5	1	584	34

there is a close equality between water content and muscle mass, resulting in even more optimized somatotype – a predisposition for a better athletic performance compared to females. Basic metabolic rate for both gender are not represented on the graphic, yet their average values are 1943,6 Kcal for males, and 1449,0 Kcal for females.

Based on correlation analysis higher dependencies between weight (0,862), muscle and bone mass (0,864), basic metabolic rate (0,910), were found in karatekas. Although there is a negative correlation between fatty mass and water content, this is hardly surprising. Of further interest is the shown greater dependence between bone and muscle mass (0,996), bone mass and basic metabolic rate (0,986). This leads to the review of a pur-

poseful tendency in the physical development of the Karate-Shotokan athletes in Bulgaria.

Kinematic parameters, registered with video capturing equipment support, include velocity and trajectory. Graphical representation (figures 1, 2, 3), show

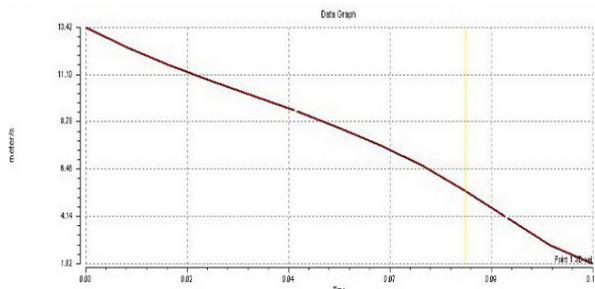


Fig. 1. Foot velocity of Mae-Geri technique

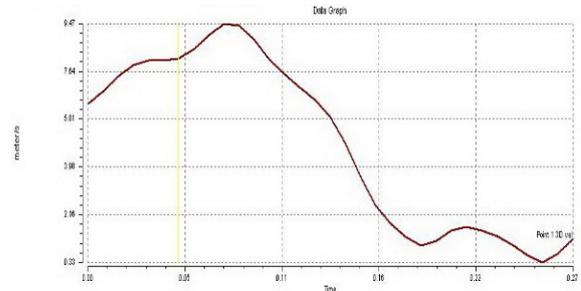


Fig. 2. Foot velocity of Mae-Geri technique

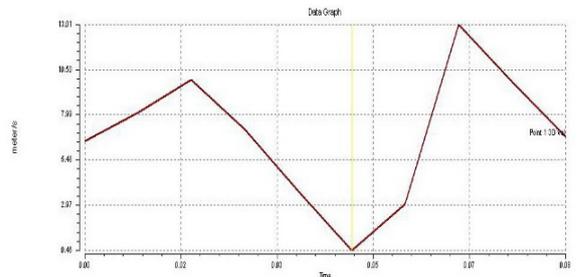


Fig. 3. Hand velocity of Gyaku-Tsuki technique

Table 3. Maximal execution velocity and morphology parameters in athletes with different sports qualification and practice (Q – qu, D – dan)

Sp. Qual.	Yoko-geri	Mae Geri	Tzuki	HIGHT (cm)	WEIGHT (Kg)	BMI	Water content	FAT tissue (%)	VISCERAL fat	MUSCLE mass (Kg)	Phys condit	Bone matter mass (Kg)	Metabolic rate (Kcal)	Metab. AGE
1 D	4	8	5.44	172	70.2	28.0	62.2	10.0	1.0	59.4	5.0	3.1	1844	12
3 Q	5	7	6.52	178.8	70.5	22.0	60.8	11.0	1.0	59.6	5.0	3.1	1837	12
1 D	6.5	4	6	179.5	72.5	22.7	65.0	6.8	1.0	64.2	8.0	3.3	1993	12
1 Q	8	7	9.15	169	82.9	29.0	56.4	21.0	1.0	62.2	3.0	3.2	1954	32
3 Q	8.6	6	6.3	156	63.4	26.0	55.7	24.0	1.0	45.7	6.0	2.4	1481	15
1 D	4	6.5	4.4	175.8	78.6	25.0	60.1	13.40	2.0	64.7	5.0	3.4	2010	12
7 Q	9.3	6.7	6.25	180.1	78.6	24.4	60.5	11.80	1.0	66.9	5.0	3.4	2036	12
1 Q	10.4	6.2	6.6	179.5	101.8	31.0	56.1	21.40	6.0	76.0	3.0	3.9	2434	28
2 D	9.47	8.78	13	170	79.7	28.0	56.1	19.60	6.0	60.9	5.0	3.2	1882	31

exemplary velocity of lower and upper extremity, while executing Mae- and Yoko-Geri and Gyaku-Tsuki techniques.

There is a marked tendency for the athletes with higher qualification to have higher technique execution velocity, related to greater muscle mass in comparison to statistically indifferent bone mass. Greater sport qualification results in higher execution velocity of a chosen technique with a direct correlation to the athlete's height. The single exception is SK20, with the lowest qualification (7th qu), yet he is the highest of the group of analyzed athletes.

CONCLUSION

The resulting kinematic and morphological data will ensure a clearer understanding of the factors defining sport technique effectiveness in Shotokan Karate and its dynamic evolution based on sport qualification and years of practice of the athletes. Furthermore-through longitudinal observation that can help us to create a more realistic and accurate model of karateka's physical abilities, tailored and guided accordingly to the needs of his field of specialization, aiming at a better selection process of high performance athletes.

ACKNOWLEDGEMENTS

This study was conducted on the basis of financial support with Grant No.293/08.06.2012, with the continuation of an ongoing project: „Perfecting the complex method of biomechanical analysis in different sport disciplines” Entry No. 66, with NSA Academic Council decree 02.04.2015, Protocol No. 29, №3II – 684/07.04.2015

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