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The Influence of the Practiced Karate Style on the Dexterity and Strength of the Hand

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Abstract: Background: The need for a strong grip in 'ground' martial arts is undisputed, but it is not obvious in karate. It may be expected that in the case of advanced karate fighters where dynamic combat movements dominate, the level of speed skills will be high. However, does the karate style affect the Ditrich rod dexterity and the strength of the players' handshake? Methods: 39 participants were analyzed, all of whom were elite karate fighters—21 in the Kyokushin style (age: 31.4 ± 6.3; body weight: 77.2 ± 18.2 kg) and 18 in the Shotokan style (age: 23.3 ± 11.8 years; body weight: 70.9 ± 14.2 kg). They performed the following: a test of reaction speed and dexterity with a Ditrich rod, and a hand grip strength test with a dynamometer. Results: The data shows that there is no difference in the Ditrich rod test for both the left and right hand among the analyzed Kyokushin and Shotokan fighters. Significant differences were recorded in the grip strength of both hands ($p < 0.05$). There is a positive correlation between the strength of the grip on both hands (r = 0.593; $p < 0.05$). Discussion: Kyokushin-style karate players have a higher grip strength than those trained in the Shotokan style. Perhaps this is due to differences in the preparation for fights. The analysis showed no statistical significance in the Ditrich rod test. It is probable that the level of dexterity in karate is independent of the training canon.

Keywords: karate; hand grip; reaction time; Kyokushin; Shotokan; motor-ontrol test

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1. Introduction

The hand is a complex anatomical system designed to grasp and apply force to objects of various shapes and sizes as well as to perform a combination of intricate fine movement controls [1].

During a number of sport-specific movements, the hand is the only point of physical contact between the athlete and the implement and/or object, hence the function of the hand is important to sport performance [2].

Most sports-specific actions involving the hand is related to the precision grip, power grip, or a variation of these grips. Handgrip strength is believed to be an essential attribute for throwing (e.g., baseball, softball, cricket, American football, European football, rugby, handball, water polo, javelin, hammer throw, discus throw, and shot put), bowling (e.g., overhand and underhand), punching, clinching, paddling (e.g., rowing, canoeing, and kayaking), and swinging a racket, stick, bat, or club (e.g., cricket, baseball, golf, tennis, squash, lacrosse, field hockey, and ice hockey) [3–8].

In combat sports, possessing a high level of hand endurance is also believed to be vital, especially when the fight progresses enter into the later rounds [9]. Therefore, it is recommended to include measures of hand performance evaluation in the physical assessment battery of hand-to-hand combat sports [10].

Martial arts and combat sports can be divided into the so-called grasped sports (e.g., jujitsu, judo, wrestling, sambo, etc.) and contact sports (e.g., karate, taekwondo, kickboxing, boxing, etc.) [11,12]. The former focus on takedowns, throws, joint levers and chokes to defeat the rival [13]. The latter, on the other hand, are based on strikes with hands and feet performed individually, or in various combinations. These different combat strategies have consequences in training, combat tactics and self-defense philosophy. This forces the players to have a different form of preparation, and thus different skills and efficiency.

The need for a strong grip in "single-story" martial arts is not questioned [13,14], but it is not obvious in karate. It is a complex matter to evaluate the level of coordination skills, the speed of a simple or complex reaction, and manual skills known as dexterity. It seems that all types of martial arts and combat sports should be characterized by a high level of dexterity and speed of reaction [15,16]. However, we do not know if and how the type of karate style in training determines grip strength and reaction time. However, different rules require the appropriate specialization based on a specific technique [17].

There are many different styles under the concept of karate, the training of which and preparation for a fight differ significantly [18]. However, the road to mastery in combat sports or martial arts is a long one, and the successes are the result of many factors, and we only have influence on some of them. The training process should be conducive to the development of trainable abilities and the improvement of appropriate skills enhancing effectiveness. Combat sports fighters require a high level of fitness [19], which is sustained by routine general development training. The general fitness requirements are as follows: flexibility, speed, power, endurance and muscle strength, aerobic capacity, agility, balance, coordination, etc. [20]. The development of these elements should support and not interfere with the development and practice of combat techniques [21]. Therefore, it is important to know what elements of training are important. It can be expected that in the case of advanced karate fighters, where dynamic combat movements dominate, the level of speed skills will be high. However, does the training of a certain karate style affect the aspects of motor coordination and the strength of the players' handshake? The two most popular styles of Japanese "sports" karate, in which sports competition follows different conventions, are Shotokan (*non-contact*) and Kyokushin (*knock-down*) [22]. This begs the question as to how the type of karate style being trained causes differences in athletes' hand motor skills. Two fundamental questions should be addressed: (1) is there a difference in the grip strength and the Ditrich rod dexterity test between Kyokushin and Shotokan karate fighters; and (2) how are the grip strength and the dexterity correlated to other chosen indexes?

The research results would be useful for trainers and researchers, as they present a tool that is easy to be applied in the training environment and in a short training unit time. The ease of testing strength and dexterity as well as their connection with combat sports constitute a valuable resource for the coaching practice. As such, this knowledge can be used in the preliminary selection process of karate fighters.

2. Materials and Methods

2.1. Subject

A total of 39 participants were analyzed, all of whom were elite karate fighters: 21 Kyokushin style (age: 31.4 $\pm$ 6.3; body weight: 77.2 $\pm$ 18.2 kg) and 18 Shotokan style (age: 23.3 $\pm$ 11.8 years; body weight: 70.9 $\pm$ 14.2 kg).

All participants had at least 5 years of experience and trained three to five times per week. The inclusion criteria were as follows: minimal age of 18 years, mastery level of at least 1st dan (black belts). The data was collected in December 2018 and January 2019, i.e., during the pre-race season.

The Human Subjects Research Committee of the University scrutinized and approved the test protocol as meeting the criteria of Ethical Conduct for Research Involving Humans. All subjects in the study were informed of the testing procedures and voluntarily participated in the data collection.

2.2. Protocol

Two essential functions (i.e., reaction speed and squeezing force) of hand motor control were tested with well-established methods:

Hand reaction speed/dexterity is tested by Ditrich's method [23]. The reaction-speed quantification is obtained by Ditrich rod (a half-meter cylindrical stick with a centimeter scale on the rod). The test needs a tester and a subject. During the test, the sitting posture of the subject is: facing the back of a chair, with a leg on each side of the chair, and placing the midpoint of the test forearm on the back of the chair. The test-ready shape of the test hand is: hand-open, with four fingers straightened and tightened, and the thumb abducted. The tester holds the Ditrich rod vertically, with the 0 cm end at the level of the lower edge of the subject's hand, approximately 1 cm from his hand. When the above procedures are finished, the tester will release the Ditrich rod without warning. The subject should grasp the stick as fast as he can. After the grasping, the distance from point 0 to the grip point (bottom edge) is recorded.

The hand squeezing force was tested using a dynamometer (model: KERN MAP 130K1, measured in kilograms). The dynamometer was adjusted to the size of the hand of each test subject with the distal finger joints fit in its handle. The following standard test procedures were applied: the wrist lay in the extension line of the forearm, the test hand had not to touch any part of the body, hand swings during measurements were not allowed. Subjects were asked to focus mentally on the task in order to produce the maximum handgrip force [24].

For the above two motor function tests, each subject performed them 5 times/function test, and the 2 extreme results of each were rejected. The arithmetic mean was calculated from the remaining trials.

2.3. Statistical Analysis

The mean and standard deviations were calculated for all the obtained indexes. The correlations between the variables were determined by the Pearson correlation coefficient. The normality of the distribution was checked by the Shapiro–Wilk test. The equivalence of the variance was analyzed by Levene's test. The one-dimensional analysis of variance (ANOVA) was used to check the significance of differences between the groups. The significance level was set at $p < 0.05$. Statistical calculations were performed using the Statistica 13 and JASP 0.16 software.

3. Results

Table 1 contains the average values of the indicators revealed. The data shows that there is no difference in training experience and the Ditrich rod test for both the left (Ditrich rod L) and right hand (Ditrich rod R) between the tested Kyokushin and Shotokan fighters ($F = 1.741$; $p = 0.090$). Clear differences were registered in the grip strength of the left (Hand grip L) ($F = 2.147$; $p = 0.038$) and the right (Hand grip R) ($F = 2.837$; $p = 0.007$) hand. Pearson's correlation tables between the recorded parameters are summarized in Table 2. A positive correlation can be noticed between the strength of the grip of both hands ($r = 0.593$; $p < 0.05$). Figure 1 shows the mean values of hand strength in graphic form with regard to selected karate styles. In analyzing the average results characterizing this parameter, higher results were obtained by the Kyokushin fighters, namely, 75.52 ± 20.87 kg, whereas lower values by Shotokan fighters 57.39 ± 23.96 kg ($p < 0.05$).

Table 1. Selected indicators of karate fighters.

Variable	Style	Mean	SD	Range	F	*p*
Training practice (years)	Kyokushin Shotokan	17.1 13.1	5.4 8.7	8.0–27.0 4.0–40.0	1.741	0.090
Hand grip L (kg)	Kyokushin Shotokan	74.5 59.3	20.6 23.7	26.0–100.0 24.0–100.0	2.147	0.038 *
Hand grip R (kg)	Kyokushin Shotokan	76.5 55.5	21.6 24.7	22.0–102.0 10.0–90.0	2.837	0.007 *
Ditrich rod L (cm)	Kyokushin Shotokan	14.8 14.8	4.9 4.5	1.0–22.0 6.0–26.0	−0.016	0.988
Ditrich rod R (cm)	Kyokushin Shotokan	15.3 13.7	4.2 6.4	8.0–23.0 0.0–25.0	0.909	0.369

L—left hand; R—right hand; F—Fisher factor; * $p < 0.05$.

Table 2. Summary of Pearson's correlation between selected indices.

Variable	Training Practice	Body Mass	Age	Hand Grip L	Hand Grip R	Ditrich Rod L
Age	0.793 *	0.437 *	—			
Hand grip L	0.223	0.713 *	0.297	—		
Hand grip R	0.267	0.427 *	0.268	0.593 *	—	
Ditrich rod L	−0.056	0.078	−0.094	0.279	0.074	—
Ditrich rod R	−0.050	0.123	0.057	0.187	0.119	0.146

L—left hand; R—right hand, * $p < 0.05$.

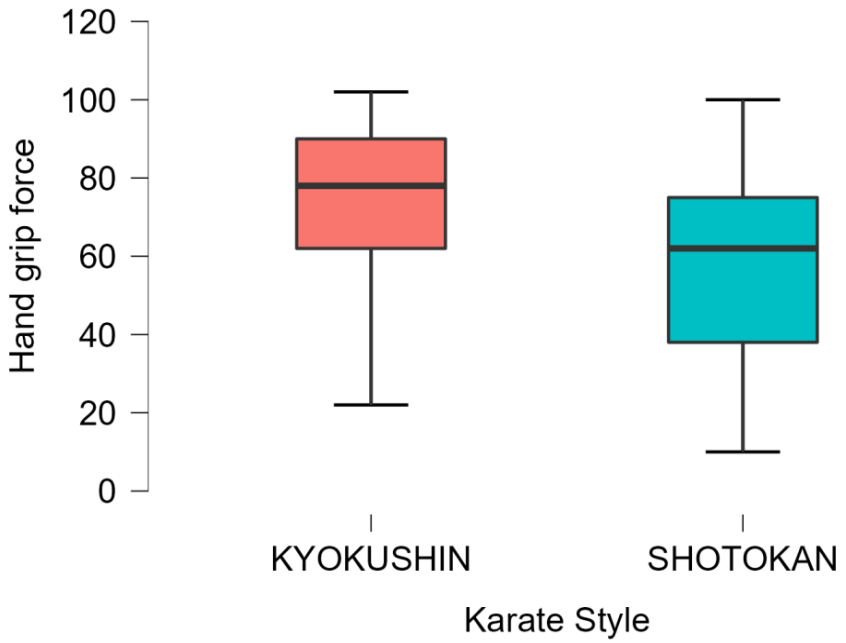

Figure 1. Graphic interpretation of mean values of handshake strength in selected karate styles ($p < 0.05$).

4. Discussion

On the basis of the analysis of variance, it can be noticed that the training experience does not differentiate the studied karate group in terms of style (Table 1). A similar lack of statistical significance occurs in the Ditrich rod test. The level of dexterity in karate is probably similar, regardless of the canon. This may be due to the fact that the level of technical skills in both groups is similar.

Karate fighters achieve much lower hand strength values than judo athletes in the same test [24]. For comparison, adult basketball players obtained values of about 66 kg [25], kayakers about 50 kg [26], gymnasts about 61 kg [27], American football players 57 kg [28]. However, the specificity of combat sports is significantly different from these sports. There is a clear difference in this parameter between the fighters of the studied styles. Kyokushin karate fighters obtained higher grip strength values than the Shotokan style (Figure 1). Perhaps this is due to differences in fight preparation. Kyokushin-style fighters conduct full-contact fights (in the knock-down system) without the use of hand protectors. This requires proper fist preparation. In martial arts, the mechanism of loading the limbs is common and can cause fractures and sprains [29,30]. Therefore, the muscles and bones of the hand must be constantly stimulated to be "strong" to reduce the risk of injury [31]. In the Shotokan style, the rules of combat sports do not allow for a knockout of the rival, moreover, the so-called "kata" are an important element of the sports competition. This makes the training of players in terms of mobility and strength different [32]. The strength of the grip in this case does not determine the effectiveness in sports, thus it does not activate the systematic strengthening of the hands [14]. Therefore, the preparation of this segment of the upper limb of these athletes is not an essential part of practice. The disclosed data provides scientific evidence for the correlation of the strength of the grip on the left and right hands (Table 2). This informs us about the harmonious distribution of the power of the hands of karate fighters. This is understandable because most of the Far Eastern martial arts training is carried out traditionally in a symmetrical fashion, i.e., exercising on both sides of the body. Researchers confirm that this type of exercise is accompanied by positive changes in the structure of the brain [33]. This strengthens coordination skills and dexterity, which is confirmed by our research. It is natural that there is a relationship between body weight and grip strength. Scientific literature indicates that the phenomena of body mass and strength are positive [34]. This confirms the sense of dividing sports rivalry in combat sports into specific weight categories.

Sample size and difference athletes' age were obvious limitations in this study. For generalizing the research results, more future studies are needed. In addition, the current findings could be used for knowledge background to design further research in biomechanics of martial arts.

Our work is part of the problem. The results and considerations presented here may serve as a reference point for other researchers and may indeed pave the way for further research. Perhaps the reported findings may be useful in the early selection of karate players. We hope that this study broadens our understanding of the biomechanical dependencies of martial arts performance.

5. Conclusions

The results of the applied motor tests in both Kyokushin and Shotokan karate groups show the following: the type of karate style differentiates in terms of the strength of the handshake, but this does not affect the level in the agility test. With the help of these two tools, we were able to establish the difference in the result of people practicing karate. The simple research tools of the Ditrich rod and hand grip dynamometer can still be very useful in the practice of sport, particularly in the fighting arts analyzed here. Ease of use is an advantage here. This knowledge can be applied in the preliminary selection process of karate fighters.

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