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# The Impact of Basic Motor Abilities on the Specific Motoricity Performance in Elite Karateka

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**A B S T R A C T**

*The aim of the study was to identify motor structures that determine high performance in karate. The study included a group of 85 karateka aged 18–29 years, competing as senior category athletes within the Croatian Karate Society. A battery of 22 motor tests (9 basic motoricity tests and 13 specific motoricity tests) were used. Factor analysis of the basic motor variables pointed to the existence of three significant factors: coordination, explosive strength and movement frequency; whereas factor analysis of the specific motoricity area indicated two significant factors, i.e. factor of technical efficiency and factor of specific agility. Canonical correlation analysis showed the isolated set of basic motor factors to significantly determine both technical efficiency and specific agility – mobility of the karateka, with a predominance of the explosive strength (force) factor, followed by the speed and coordination factors.*

***Key words:*** *elite karateka, basic and specific motor factors, canonical relations*

## Introduction

Mastering motor skills (techniques) in karate and their efficient use in fight require longstanding, strenuous training. The fight dynamics and movement frequency are especially emphasized, necessitating from a karateka a high level of motor and functional abilities, speed and strength[1], and coordination[2] in particular. Although of a relatively short duration, karate fights are characterized by maximal intensity, thus only the entities capable of enduring these demanding conditions can hold out in elite karate contests. Quite frequently, persistent and persevering training may prove inadequate, as specific predisposition is also needed to achieve top results. These features reflect on the formation of an appropriate anthropologic complex of a karateka. Karate training leads to adjustment of the morphological subsegment of the anthropologic complex optimizing the morphological structure according to the requirements of this particular sport[3]. As for the genetic determination of the skeleton longitudinal as well as transverse dimensions, karate training will result in an optimal muscle mass increase relative to the level of skeleton development, along with adipose tissue reduction[3].

High quality and elite karate selections are predominated by the karateka of the mesomorphic and ectomorphic constitution types[4,5], whereas endomorphic somatotype is rarely found, even in the heavyweight category.

In karate, only the karateka with potentially above-average motor abilities, primarily explosive strength, speed and coordination, can achieve top results[6]; it is especially pronounced in karate blows performed in combination, such as *jaku zuki-mawashi geri* and *kizame zuki-jaku zuki*[3]. It is just the speed and quality of performing these actions (techniques) that influence directly the attack efficiency in karate.

Specific agility, i.e. mobility of the karateka in various directions, is of high importance for successful fight performance in karate. Appropriate mobility enables the karateka to avoid the opponent's attacks and to assume optimal position for efficient performance of karate techniques[3,6].

Sforza et al.[7,8] analyzed the quality, i.e. technique efficiency on the basis of deviation-variability in the repeat technique performance monitored by a photoelectronic

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instrument. The method can be useful in learning, i.e. in acquiring and subsequent mastering particular karate techniques. In young karateka, karate training influences the development of flexibility, muscle strength and equilibrium[9].

Upon achievement of high quality performance in particular karate techniques, the speed of reaction and the skill of predicting the opponent's attack are crucial for success in karate[10].

The aim of the study was to identify the motor structures that determine achievement of top results in karate. Therefore, motor structures were identified in the area of basic motoricity and specific motoricity in karateka, and correlation between the basic motoricity factors and specific motoricity factors was determined in order to get comprehensive information on the issue.

## Material and Methods

The study included a sample of 85 karateka aged 18–29 years, at least brown-belt owners competing as senior category athletes as members of the Croatian Karate Society. Measuring instruments covering specific psychomotor space segments were used to assess primary motor abilities: explosive strength (standing long jump, standing high jump, and supine med-ball throw); movement frequency (hand tapping, foot tapping, and hand rotation); coordination (figure eights with bending, hand and foot tapping); and equilibrium (transverse bench standing with eyes closed).

On choosing tests for assessment of the situation motor abilities, due care was taken to select the tests that provide best estimate of the most important factors of fight performance, i.e. specific agility-mobility and specific speed, i.e. speed of technique performance[6,11]:

1) Sidesteps on taking guard with hands lifted up; the test is used to estimate specific movement speed. The task was to pass the four-meter distance as fast as possible by side steps in both directions six times. The test was repeated three times with due time allowed for rest in-between, and the result was measured in tenths of second.
2) Speed of movement in a triangle; the test is used to estimate specific movement speed. The task was to move as fast as possible in fighting guard along the sides of an equilateral triangle of 3 m in dimensions, marked on the floor. The subject moved fast from one vertex along the side to another vertex, around the medicine ball placed there, then turning back sidewise towards the third vertex, again around the medicine ball placed there, to move sidewise back to the initial site. Then he had to move back sidewise, sidewise forward and sidewise back to the start position. The speed of moving along the triangle sides was measured in tenths of second, and the task was repeated three times.
3) Speed of the *gedou barai* blockade technique performance. The task was to perform as many blockades during 30 seconds from the initial fighting posture as possible, in three repeats; test result was recorded as the sum of overall correctly performed blockades.
4) Speed of the *mawashi geri* foot kick technique performance; the task was to perform as many *mawashi geri* kicks against the punch bag during 30 seconds from the initial fighting posture. The kick level was determined according to the subject's body height, whereby each subject was to reach at least his own neck level. The respective level to be reached was marked by a belt above which the kick had to be performed. The task was repeated three times, and the result was recorded as the overall number of properly performed *mawashi geri* kicks against the punch bag.
5) Speed of blockade performance and hand blow as a combined technique; the task was to perform the *gedou barai – jaku zuki* combination five times consecutively at maximal speed. In order to ensure identical test conditions to all study subjects, the tall and short ones alike, the distance of the target to be hit by *jaku zuki* blow was measured by the subject's distance from the target, defined by the extended arm performing *jaku zuki*. On the sign given by the timekeeper, the subject started performing the *gedou barai – jaku zuki* combination from the fighting posture as fast as possible. The combination had to be performed five times, the last *jaku zuki* blow against the wall *makiwara* or vertically placed gym mattress denoting the task completion. The task was repeated three times, and test result was measured in tenths of second.

Technical efficiency was determined on the basis of subjective evaluation by four judges scoring 8 karate techniques. The following techniques were evaluated individually: *jaku zuki, kizame zuki, ushiro mawashi geri* and *mawashi geri*; and in combinations: *jaku zuki – mawashi geri, jaku zuki – uraken, ashi barai – ushiro mawashi* and *kizame zuki – jaku zuki.*

Factor analysis was used to determine the karateka motor structures and specific motoricity structures. The algorithm consisted of oblimin transformation of latent dimensions obtained by orthoblique transformation of the characteristic vectors of the variable intercorrelation matrix.

Canonical correlation analysis was employed to determine relationships between the manifest and latent motor variables, and the set of variables assessing specific motor skills (techniques) and specific motor abilities in karate.

Basic statistical parameters of the variables (X±SD) and oblimin factors (OBL) for the basic motor variables and specific variables are presented in Tables 1 and 2, respectively. The canonical variable structure (CAN) and canonical coefficient of correlation (Can R) are shown in Table 3.

**TABLE 1**
DESCRIPTIVE STATISTICS (X±SD) AND STRUCTURE OF OBLIMIN FACTORS (OBL) IN THE SPACE OF BASIC MOTOR VARIABLES (N=85)

| Variable | $\overline{X}$±SD | OBL1 | OBL2 | OBL3 |
|---|---|---|---|---|
| Standing long jump (cm) | 231.8±18.2 | 0.18 | 0.63 | –0.13 |
| Standing high jump (cm) | 47.48±9.31 | 0.21 | 0.73 | –0.17 |
| Medicine ball throw (m) | 9.46±2.99 | –0.16 | 0.90 | 0.22 |
| Hand tapping (f) | 39.47±3.30 | 0.15 | –0.13 | –0.82 |
| Foot tapping (f) | 22.49±2.15 | –0.02 | –0.06 | –0.79 |
| Hand rotation (f) | 39.07±2.93 | –0.18 | 0.31 | –0.66 |
| Hand and foot tapping (f) | 10.95±2.44 | 0.84 | –0.07 | 0.15 |
| Standing on equilibrium bench (s) | 30.34±15.3 | 0.85 | 0.13 | –0.01 |
| Figure eight with bending (s)# | 18.34±1.70 | –0.62 | –0.10 | 0.32 |
| LAMBDA | | 3.13 | 1.56 | 1.28 |
| Variance % | | 34.76 | 17.31 | 14.22 |

#variable with opposite metric orientation
LAMBDA – characteristic values, Variance % – percentage of variance explained by a particular factor

## Results

Factor analysis of the general motor tests yielded three significant factors, the first of them explaining the highest percentage (34%) of total valid variance (Table 1). The first factor was predominantly defined by high projections of three tests, including two tests assessing coordination and one test assessing equilibrium. These tests are underlain by the ability of coordination in terms of both fine synergistic regulation of the effectors and integration of different movements into an integral movement structure. Thus, it is a factor of whole body coordination.

The following tests showed highest projections upon the second factor: supine med-ball throw, standing high jump and standing long jump. This factor explained 17% of total valid variance. This factor defined by the tests of explosive strength can be termed explosive strength factor and/or force factor[12].

The third factor explained 14% of total valid variance in the general motoricity tests applied. The tests of foot tapping, hand tapping and hand rotation, used to assess the frequency of alternative movements, showed highest projections upon this factor. Therefore, this factor can be interpreted as a speed factor.

Factor analysis of the specific motoricity area (Table 2) revealed two significant factors: factor of technical efficiency and factor of specific agility.

The first oblimin factor as a factor of general technical efficiency is defined by the quality and speed of performing all karate techniques. Technical efficiency re-

**TABLE 2**
DESCRIPTIVE STATISTICS (X±SD) AND STRUCTURE OF OBLIMIN FACTORS (OBL) IN THE SPACE OF SPECIFIC MOTOR VARIABLES (N=85)

| Variable | $\overline{X}$±SD | OBL1 | OBL2 |
|---|---|---|---|
| Sidesteps (s)# | 9.84±1.88 | –0.06 | 0.90 |
| Movement in triangle (s)# | 9.46±0.84 | –0.37 | 0.65 |
| *Gedon barai* (f) | 54.08±3.85 | 0.91 | 0.18 |
| *Mawashi geri* (f) | 24.21±2.85 | 0.79 | 0.12 |
| Block-blow (s)# | 4.82±0.83 | –0.87 | –0.25 |
| *Jaku zuki* | 5.66±2.46 | 0.76 | –0.32 |
| *Kizame zuki* | 5.54±2.21 | 0.84 | –0.21 |
| *Ushiro mawashi geri* | 4.59±2.10 | 0.81 | –0.14 |
| *Mawashi geri* | 5.74±2.07 | 0.88 | –0.12 |
| *Jaku zuki – mawashi geri* | 4.95±2.30 | 0.87 | –0.16 |
| *Jaku zuki – uraken* | 5.60±2.40 | 0.79 | –0.22 |
| *Ashi barai – ushiro mawashi* | 4.67±2.06 | 0.87 | –0.07 |
| *Kizame zuki – jaku zuki* | 5.41±2.37 | 0.85 | –0.22 |
| LAMBDA | | 9.41 | 1.02 |
| Variance % | | 72.40 | 7.86 |

#variable with opposite metric orientation
LAMBDA – characteristic values, Variance % – percentage of variance explained by a particular factor

**TABLE 3**
RESULTS OF CANONICAL CORRELATION ANALYSIS BETWEEN BASIC MOTOR FACTORS AND SPECIFIC MOTOR FACTORS

| Variable | CAN 1 | |
|---|---|---|
| Coordination | –0.485 | |
| Force (explosive strength) | –0.895 | |
| Speed (movement frequency)# | 0.513 | |
| Technical efficiency | –0.978 | |
| Specific agility# | 0.618 | |
| Can R | 0.838 | *** |

#variable with opposite metric orientation, ***p<0.001
CAN – canonical variable, Can R – canonical correlation

quires coordination in the manifestation of force, speed, muscle tone and movement amplitude. This integration makes the basis of karate technique efficiency.

The second oblimin factor, defined by high projections of the tests of specific mobility-agility, is the second general factor of specific motor efficiency in karate. In karate, general/specific motor efficiency means integration of quality technique (kicks and blockades) performance and speed of movement.

Canonical correlation analysis produced a significant linear combination of latent variables (factors) of basic motor abilities and latent variables (factors) of specific motor abilities and motor skills (Table 3). Significant correlation ($p<0.001$) was recorded between canonical factors and a very high canonical correlation coefficient of 0.84.

Canonical factor of the predictor set of variables was defined by the extremely high projection of the latent motor variable (factor) for explosive strength assessment and latent motor variables, i.e. factors assessing movement frequency and coordination/agility. It is general basic motor efficiency defined by the factors of explosive strength, psychomotor speed and coordination.

The structure of the canonical factor of criterion variables was characterized by extremely high projections of latent variables assessing the factors of technical efficiency and specific agility. It is a general factor of specific motor efficiency, which integrates specific motor ability and motor skills in karate.

Canonical correlation is based on general efficiency of specific motor abilities and skills determined by basic motor abilities of explosive strength, movement frequency and coordination.

Explosive strength as the ability of maximal mobilization energy intensity has a predominant impact on technical efficiency in elite karateka. In addition, this ability is considerably saturated by all other motor abilities due to their interaction, coordination and speed in particular.

## Discussion

Mastering karate techniques is a long-term process that depends on both basic motor abilities and specific motor abilities. With time, motor skills in karate as well as general and specific motor abilities are integrated into the morphological system[10–13] through optimization of the size and relations of the karateka somatotype components.

Study results revealed the karate techniques to be predominantly determined by explosive strength, followed by coordination, i.e. the basic motor abilities regulated by the cortical mechanisms, which are innate and therefore cannot be significantly influenced by any kinesiologic treatment. That is why top results in karate can only be achieved by the karateka with potentially above-average motor abilities, primarily explosive strength, speed and coordination, which are then integrated in the general motor efficiency through karate training. This integration is the basis for the development of motor functioning in kinesiologic education[13–21] and sports[22–27].

Technique performance is considerably saturated by cognitive abilities because a karateka has to identify current situation in the shortest time possible, and to choose the reaction that is most appropriate to achieve the objective, i.e. to defend the opponent.

According to Katić et al.[3], the best predictors of general fighting efficiency are karate blows performed in combination: *jaku zuki-mawashi geri* and *kizame zuki-jaku zuki*. This means that the ability of integrating different motor skills, i.e. acquired routines, into a unique structure is the major precondition for a karateka fighting success. In contrast, fighting success is warranted by the ability to perform a combination-series of blows rather than by quality performance of individual blows. Furthermore, Katić et al.[3] point to *kizame zuki* as the only one of individually performed blows that has a certain favorable impact on the fighting success. Similar to straight blow in boxing, *kizame zuki* enables control of the opponent's attack, i.e. interferes with and prevents the opponent's attack, at the same time allowing for more appropriate preparation of one's own attack or counterattack.

The tests of specific, i.e. situation motoricity of the karateka are to a great extent saturated with the level of motor skill acquisition, and estimate specific speed (kick and blockade performance) and specific agility. Accordingly, specific speed is the ability of fast performance of as a rule multiple blows and blockades (in a series), whereas specific agility is the ability of using controlled explosive strength and/or force for efficient karateka mobility. These two specific abilities of the karateka also integrate all other basic abilities, explosive strength, speed and coordination in particular. Explosive strength will thereby influence performance of all tests of situation motoricity. Besides explosive strength, the speed of technique-blow performance and specific agility will also be influenced by the ability of movement frequency and coordination, respectively.

Generally, the level of performance in karate is predominantly influenced by explosive strength, speed and coordination. Achievement of top results in karate requires above-average motor abilities as inborn, genetically determined traits including explosive strength, speed and coordination. Therefore, selection of potential karateka should rely on these abilities.

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## UTJECAJ BAZIČNIH MOTORIČKIH SPOSOBNOSTI NA REALIZACIJU SPECIFIČNE MOTORIKE VRHUNSKIH KARATISTA

## SAŽETAK

Cilj rada je bio da se izvrši identifikacija motoričkih struktura koje determiniraju postizanje vrhunskih rezultata u karateu. U tu svrhu istraživanje je izvršeno na uzorku od 85 karatista, natjecatelja u borbama seniorske kategorije Hrvatskog karate saveza, a starosna dob ispitanika kretala se u granicama 18–29 godina. Na ispitanicima su primijenjena 22 motorička testa (9 testova bazične i 13 testova specifične motorike). Faktorska analiza bazičnog skupa motoričkih varijabli utvrdila je postojanje tri značajna faktora i to: koordinacije, eksplozivne snage i frekvencije pokreta, dok je faktorska analiza prostora specifične motorike utvrdila postojanje dva značajna faktora i to: faktor tehničke efikasnosti i faktor specifične agilnosti. Kanonička korelacijska analiza je pokazala da izolirani skup bazičnih motoričkih faktora značajno determinira kako tehničku efikasnost tako i specifičnu agilnost-pokretljivost karatista, a najviše faktor eksplozivne snage (sile), a zatim faktor brzine i faktor koordinacije.