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CANONICAL DISCRIMINANT ANALYSIS PROJECTED IN STANDARD METRIC SPACE AS AN OPTIMAL METHOD FOR DETERMINING DIFFERENCES IN MOTOR DIMENSIONS BETWEEN JUDO AND KARATE ATHLETES

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Abstract. *The motor tests, as standardized procedures, represent the most important source of information about the level and development of motor abilities of a subject, which is needed in the process of talent identification and selection. The main aim of the current research was to determine the differences in motor dimensions between judo and karate athletes. The sample of participants consisted of 200 athletes (100 judokas and 100 karatekas of both sexes) aged 18 to 27. To assess motor abilities, the researchers used 15 motor tests defined as the mechanism for movement structuring, mechanism for muscle tone regulation and synergistic regulation, mechanism for regulation of excitation intensity, and the mechanism for the regulation of excitation duration. The results of the discriminant analyses of motor variables indicate that the tested athletes in relation to the preferred branch of sport differ significantly. Based on the values and signs of the centroids of the groups, it can be concluded that judokas have greater strength and coordination, while karatekas have better segmentary speed of the arms and flexibility, which is consistent with the requirements of the two sports.*

Key words: *Canonical variables, matrix, singular transformation, judokas, karatekas*.

INTRODUCTION

Motor skills are usually considered to be directly responsible for solving tasks in sport and physical education, regardless of whether these tasks are related to educational, competitive or recreational activities. The measurement of motor skills is the starting point in all the processes of the mentioned fields of physical education because it is impossible to imagine the management of the process without information about the

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initial transformational and final states of the system to be managed (Winter, 2009). Determining the level of the individual dimensions of motor space is recent and falls into the domain of motor diagnostics. Since the abilities that define motor space are not given directly but as latent dimensions whose quantity and quality are concluded about on the basis of outputs of the system, their measurement is not feasible with direct methods. Therefore, motor skills are measured indirectly via conventional motor manifestations called motor tests. In addition, latent dimensions of motor space do not manifest themselves as pure properties but they are usually combined in a variety of variations, and it further increases difficulties in measuring the dimensions (Malacko & Popović, 2001, in Badrić, Sporiš, Trklja, & Petrović, 2012). Motor tests are used as the instruments of motor space and represent a set of tasks for which previous studies determined a way of stating and assessing results, as well as their measured characteristics. The motor tests, as standardized procedures, represent the most important source of information about the level and development of the motor abilities of a subject, which is needed in the process of talent identification and selection (Lidor et al., 2005).

The main aim of the current research was to determine differences in motor dimensions between judo and karate athletes.

METHODS

Participants

Based on the selected statistical-mathematical model, as well as the program, objectives and the stated hypothesis, it was decided to include a sample of 200 athletes (100 male judokas and 100 male karatekas) aged 18 to 27. Most of the sample must meet the following criteria:

- the effective sample size should be large enough to provide as many degrees of freedom for the consideration of any coefficient in the pattern matrix, or any correlation coefficient equal or greater than .21, different from zero with an inference error less than 01;
- in order to apply the appropriate statistical methods effectively, according to the latest findings, the number of participants must be five times bigger than the number of the applied variables.

In addition, the participants had to fulfill the following specific requirements:

- the participants' age was defined on the basis of chronological age, so that the research included participants aged 18 to 27±0,5;
- during the research, the respondents regularly underwent a training process in their clubs or the national team of Serbia, which was determined by checking the club`s records of training attendance and the monthly number of training hours;
- the participants had no somatic deformities and aberrations, and were physically and mentally healthy.

In defining the population from which the sample of participants was drawn, except the abovementioned, no other restrictions were applied (Popović, 1980).

Sample of variables

To assess motor abilities, the researchers used 15 motor tests selected according to the structural model of Gredelj, Metikoš, Hošek, & Momirović (1975) and Popović (1990),

defined as the mechanism for movement structure, mechanism for muscle tone regulation and synergistic regulation, mechanism for regulation of excitation intensity, and the mechanism for regulation of excitation duration:

Movement structure:
- bending and skipping (BENSKIP);
- tennis ball target kicking (TARKICTB, frequency);
- figure eight with bending (FIGEIBEN, in s);
- backward obstacle course(BACKPOL, in s).

Muscle tone regulation and synergistic regulation
- dominant hand tapping test (TAPDH, frequency);
- 20 m standing start running (STASTRUN, in s);
- deep forward bend on the bench (DEFBEBEN, in cm).

Regulation of excitation intensity
- standing long jump (STALJ, in cm);
- standing high jump (STAHJ, in cm);
- standing triple long jump (STATRLJ, in cm);
- seated medicine ball throw forward with both hands, back against the wall (SMEDB, in m).

Regulation of excitation duration
- chin-ups (CHUP, in s);
- supine leg lift (SULELIF, in s);
- 60-second supine trunk lift (SUTRLIF, frequency);
- 60-second prone trunk lift (PROTRLIF, frequency).

Statistical analyses

The value of a study depends not only on the sample of participants and the sample of variables, that is, the value of basic information, but also on the applied methods for transformation and condensation of this information. Some scientific problems can be solved with the help of a number of different, and sometimes equally valuable methods. However, with the same basic data, and based on the results of different methods, different conclusions can be drawn. Therefore, the problem of selection of some data processing methods is rather complex (Momirović, Knežević, Tenjović, & Bogdanović, 1999).

In order to arrive at satisfactory scientific solutions, the researchers used, in the first place, correct, then adequate, impartial and comparable procedures, which met the nature of the stated problem and ensured the extraction and transformation of the appropriate dimensions.

Taking that into account, for the purpose of this study the researchers selected those procedures that were considered to correspond to the nature of the problem and that did not leave too big restrictions on the basic information and were based on the following assumptions:
- The latent dimensions which were the subject of measurement performed with the applied measuring instruments had multivariate normal distribution;
- The relations between manifest and latent variables could be approximated by the Gauss-Markov-Rao generalized linear model.

All the results obtained in this study were analyzed using SPSS 11.

RESULTS

The results of discriminant analysis of motor variables indicate that the tested athletes in relation to the preferred branch of sport differ significantly. Analyzing the values in Table 1, it can be concluded that the agreement between the results of the registered indicators of the first and second groups of athletes is very high. Only one significant discriminant function and one canonical correlation (.83) have been obtained. This indicates a correlation of the discriminant functions and is the main indicator of quantitative structure. The significance of the differences between the groups is presented with Wilks lambda, and the significance of Canonical Correlations is tested with Bartlett`sX^2test.

Table 1 Discriminant analysis of motor variables

F	Can. R.	λ	χ2	df	Sig.
1	.83	.37	217.30	15	.00

Table 2 shows the structure of discriminant functions of motor variables which shows the contribution of each variable to the general separation of group centroids.

Table 2 Canonical factor structure in H and Z space

Variables			
H space	D1	Z space	D1
STALJ	.24	TAPDH	-.45
STAHJ	.21	STASTRUN	.39
STATRLJ	-.38	SUTRLIF	-.29
SMEDB	-.29	BACKPOL	.23
CHUP	.44	DEFBEBEN	.24
SULELIF	.46	BENSKIP	.19
SUTRLIF	-99	PROTRLIF	-.16
PROTRLIF	.28	STATRLJ	-.19
TAPDH	-.72	FIGEIBEN	.17
STASTRUN	.41	SULELIF	-.12
DEFBEBEN	1.00	SMEDB	-.09
BENSKIP	-.18	TARKICTB	.07
TARKICTB	.22	STALJ	-.07
FIGEIBEN	-.15	STAHJ	-.06
BACKPOL	.39	CHUP	-.02

Table 3 shows the structure of discriminant functions of motor variables which indicates the contribution of each variable to the general separation of centroids of the groups. After examining the coefficients of the first discriminant function, it is clear that this discriminant function is best defined by the tests for assessing segmentary speed of the arms, repetitive strength, coordination and flexibility.

Table 3 Group centroids

Groups	D1
Judokas	-1.44
Karatekas	1.56

DISCUSSION

Motorics, or anthropomotorics, is a system of motor manifestations by means of which a person interacts with his/her surroundings. This system is generally defined as the ability to move the whole body or its parts in space with a certain amplitude, rhythm, direction, intensity and, of course, purpose. Knowing that the number of manifest motor activities, or combinations, is practically infinite, the orientation to identification of the structure of motor abilities as a system which is the base of these manifestations and which is, with respect to motor manifestations, reasonably reduced and limited by the available number of latent dimensions, is logical, or even the only possible one.

Planned, systematic and programmed training also causes changes in the anthropological status of athletes. These changes mostly manifest themselves in the field of some abilities and characteristics, especially in the domain of motor abilities and motor skills. Anthropological characteristics appear, develop and change in quantitative and qualitative terms. Quantitative changes are the ones that are expressed in space or the reduction of the efficacy of an ability, characteristic, or motor information. Qualitative changes imply changing relations among characteristics. Both types of change are inevitable. Changes in general can significantly be affected by various means and in different ways. So, they are under the visible influence of exogenous factors, i.e. the influence of the surroundings on the formation and expression of changes in motor space is very important.

Although it is well known that the practice of a particular sport produces general short and long term physiological and morphological adaptations, if the sport consists of different competitive specialties, it is critical and appropriate to analyse the impact of each one of them individually in order to further clarify the relationships between the activity performed and the related physiological adaptations (Filingeri, Bianco, Zangla, Paoli, & Palma, 2012).

According to World Karate Federation (2005), karate is dominated by anticipatory actions, very fast, based feints, kicking and touching, but the hands are not used as much as in judo, in a way that the development of resistance force is not so marked. Speed and anticipation are important for success, although an adequate level of development of basic resistance is needed to ensure a speedy recovery between bouts, several times a day in order to obtain a degree.

According to Almenares et al. (2006), judokas prepare for “body to body” combat, they plan or control the movements of theirs opponents and their defense, over a period of time that may end in a few seconds or, take five or more minutes. This regime demands preparation work to realize intensive efforts, or withstand a lower but prolonged effort intensity in relation to karatekas and to maintain a submaximal work supported by the specific resistance.

CONCLUSION

Based on the values and signs of the group centroids, it can be concluded that judokas have greater strength and coordination, while karatekas have better segmentary speed of the arms and flexibility, which is consistent with the requirements of the two sports.

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KANONIČKA DISKRIMINATIVNA ANALIZA PROJEKTOVANA U STANDARDNOM METRIČKOM PROSTORU KAO OPTIMALNA METODA ZA UTVRĐIVANJE RAZLIKA U MOTORIČKIM DIMENZIJAMA IZMEĐU DŽUDISTA I KARATISTA

Motorički testovi kao standardizovane procedure, predstavljaju najvažniji i zvor informacija o nivou i razvoju motoričkih sposobnosti ispitanika, neophodan u procesu identifikacije i selekcije talenata. Glavni cilj aktuelnog istraživanja bio je da se utvrde razlike u motoričkim dimenzijama između džudista i karatista. Uzorak ispitanika sačinjavalo je 200 sportista (100 džudista i 100 karatista oba pola) uzrasta od 18 do 27 godina. Da bi se procenile motoričke sposobnosti, istraživači su koristili 15 motoričkih testova, definisanih kao mehanizam za strukturiranje kretanja, mehanizam za regulaciju tonusa mišića i sinergijske regulacije, mehanizam za regulaciju intenziteta ekscitacije i mehanizam za regulaciju trajanja ekscitacije. Rezultati diskriminativne analize motoričkih varijabli ukazuju na to da se testirani sportisti značajno razlikuju u odnosu na odabranu sportsku granu. Na osnovu vrednosti centroida grupa, može se zaključiti da džudiste odlikuje veća snaga i bolja koordinacija, dok karatisti poseduju bolju segmentalnu brzinu ruke i fleksibilnost, što je u skladu sa zahtevima ova dva sporta.

Ključne reči: *kanoničke varijable, matrica, pojedinačna transformacija, džudisti, karatisti*