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Canonic discriminative analysis in Mahalanobis'space as a method for determining differences between conative dimensions of athletes who practice judo and karate

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Abstract

Canonic discriminative analysis can be defined as a solution of quazi canonic problem $\mathbf{Mx}_k = \mathbf{k}_k$, $\mathbf{Gy}_k = \mathbf{l}_k| \ c_k = \mathbf{k}_k{}^t\mathbf{l}_k$ = maximum, $\mathbf{x}_k{}^t\mathbf{x}_q = \mathbf{y}_k{}^t\mathbf{y}_q = \delta_{kq}$ k = 1,...,s; s = min((g - 1), m) = m where δ_{kq} is Kroneker's symbol, and $\mathbf{x}_k$ and $\mathbf{y}_k$ are unknown m-dimensional vectors. As $c_k = \mathbf{x}_k{}^t\mathbf{Ay}_k$, the function which is to be maximized is, for k = 1, $f(\mathbf{x}_k, \mathbf{y}_k, \lambda_k, \eta_k) = \mathbf{x}_k{}^t\mathbf{Ay}_k - 2^{-1}\lambda_k(\mathbf{x}_k{}^t\mathbf{x}_k - 1) - 2^{-1}\eta_k(\mathbf{y}_k{}^t\mathbf{y}_k - 1)$. Differentiating this function by the elements of vector $\mathbf{x}_k$ $\partial f/\partial\mathbf{x}_k = \mathbf{Ay}_k - \lambda_k\mathbf{x}_k$, and differentiating by the elements of vector $\mathbf{y}_k$ $\partial f/\partial\mathbf{y}_k = \mathbf{Ax}_k - \eta_k\mathbf{y}_k$; after equaling it with zero

$$\mathbf{Ay}_k = \lambda_k\mathbf{x}_k \text{ and } \mathbf{Ax}_k = \eta_k\mathbf{y}_k.$$

Differentiating by λ_k and η_k, and from the condition $\mathbf{x}_k{}^t\mathbf{x}_k = 1$ and $\mathbf{y}_k{}^t\mathbf{y}_k = 1$, it is easily obtained that $\lambda_k = \eta_k$. As $\mathbf{A}^t = \mathbf{A}$, by multiplication of the first result with $\mathbf{x}_k{}^t$, and the second result with $\mathbf{y}_k{}^t$

$$\mathbf{x}_k{}^t\mathbf{A}\mathbf{y}_k = \lambda_k \text{ and } \mathbf{y}_k{}^t\mathbf{A}\mathbf{x}_k = \lambda_k$$

with $\mathbf{x}_k = \mathbf{y}_k$, the problem is reduced to a simple problem of eigenvalues and matrix **A** vectors, that is to the solution of the problem $(\mathbf{A} - \lambda_k\mathbf{I})\mathbf{x}_k = \mathbf{0}$, k = 1,..., m so $c_k = \rho_k^2 = \mathbf{x}_k{}^t\mathbf{A}\mathbf{x}_k = \lambda_k$, k = 1,..., m are squares of canonic correlations betweel linear combinations of variables from **M** and **G** which are proportional to the differentiation of centroides of subsamples defined by the selective matrix **S** in the space between vectors of the variables from **M.**

Key words: canonic/discriminant/quasi/function/correlation/eigenvalues/

1. Introduction

The reason for the increased number of researches of the athletes' personalities should be searched for in the characteristics of sports, which imposes exclusive and different requests not only in respect to motor abilities, but personality as well. This justifies the assumption that active and successful participation in certain sports, including martial arts (judo and karate), demands for spscific personality dimensions which are the most appropriate for those sports, or personality dimensions suitable for sports, and not some other activities too.

Observing the technique of judo in general, it is noticed that it is made of numerous simple and complex movements. All of them demand certain speed, coordination, pliability, precision and strength of the performer. Considering that they are performed in a close contact (guard) with the oponent, it largely makes them harder to be performed correctly and accurately. That is why it can be stated that judo technique is the most abundant one compared to all other sports. In this sport, it is possible to perform more than 1,500 different movements. For this reason, it is characterized by a great number of technical elements and even greater number of different versions they can be performed in, and also by innumerable structures of movement which are performed in order to conduct tactical idea. The great richness of movements in judo is also shown by the need to perform greater part of technique making movements which are coordinated and combined with other movements and actions. All of them are aimed towards different directions of the frontal, sagittal and horizontal plane. The fact that it is often necessary to make, at least a little change in the adopted dynamic stereotype when the opponent changes, makes the technique of this sport even more varied. During a judo match, changeable conditions which can be defined as a typical bulid of the opponents body, typical guard, fighting style (offensive or defensive), the way of moving in new situations, repertoire of techniques occur and demand creativity from a judoist so that he can instantly modify dynamic stereotype and react properly according to the opponent's activity. Judo, as a sport discipline, is limited by the rules and consequently the techniques (movements) have to be practised to perfection since only then they can be valued (Popović D. 2004.) During the practice and matches, within the unit of time, mobilization of the large quantity of energy is required. Proper and quantitatively sufficient nutrition ensures optimal quantity of energy necessary for the judoist at any time.

Judo technique can be divided into seven groups:

1. Posture technique (Shizen hon tai)
2. Movement technique (Tai sabaki)
3. Falling technique (Ukemi waza)
4. Throwing technique (Nage waza)
5. Joint locks technique (Kansetsu waza)
6. Choking technique (Shime waza)
7. Pinning technique (Osaekomi waza)
8. Kata technique (Kata waza)

While this sport was developing, a group of striking techniques (Atemi waza) was discarded. Performing Kappo technique (first aid technique) and Kuatsu (healing technique) are separate.

Karate has been rooted worldwide for a long time now. It consists of complex motor activities with one single goal – efficiency. Unlike judo, karate allows strokes with the compulsory use of protective equipment from injury. It is characterized by movements in sagittal, frontal and horizontal plane. To perform karate techniques properly, speed, strength and pliability are necessary along with maximum concentration of both physical and mental energy.

Karate technique implies external elements of karate in a narrow sense. It is a set of mostly physical karate components, although the division on physical and other components is not possible. Karate is integral martial art and each attempt do divide it as well as the strive to be sustained, would immediately lead to an impoverishment, and that is the point where the significance is lost. It is necessary to make a distinction between Karate wasa and Gokataken. Gokataken is a complete set of techniques, methods, praxis, experiences, kata, tradition, legends, basic ideas and the spirit of a school and it comprises esoteric parts of karate such as massage and self-massage (Katsu), healing with herbs, some kinds of acupuncture and methods of special impact (Gigov, V. 1988). It could be said that Karate wasa is only integral part of Gokataken wasa without which the latter one would be incomplete.

Karate techniques are divided into following groups:

1. Posture technique (Shizen hon tai)
2. Movement technique (Tai sabaki)
3. Hand technique (Te waza)
4. Leg technique
5. Blocking techniques
6. Joint locks technique (Kansetsu waza)
7. Self-defense elements (Jiu-jutsu)
8. Kata technique (Kata waza)

When we speak about Kata techniques, we refer to the series of karate techniques, most often performed in the form of stylized fights against imaginary opponents during which the postures, blocks and strokes are arranged in a certain manner and in a certain order, and due to those established forms, only the authentic karate skills are successful way of learning them.

During the development of this martial art, some of the technical elements were discarded or added. Yet, it did not decrease the attractiveness of this sport but, in a way, made it closer to the ordinary person.

2. Methods

2.1 Test group

On the basis of the chosen statistical-mathematical model, i.e. program, goals and hypothesis, it was decided that the sample consists of about 200 athletes (about 100 judoists and about 100 karatists of both sexes) aged between 18 and 27. The majority of this sample had to meet the following criteria:

- that the effective of the sample was so large that it permited so many degrees of autonomy that any coefficient in the matrix assembly or any correlation coefficient equal to or larger than .21 could be considered different from zero with the conclusion deviation les than 01;

- the number of the subjects in the sample had to be five times larger than the number of applied variables so that, according to the recent principles, adequate statistical methods could be applied successfully;

Apart from the aforementioned, the subjects had to meet the following conditions:

- subjects were male;
- age was defined on the basis of chronological age, so that the research was performed on subjects from 18 to 27 years of age plus-minus 0.5 years;
- subjects had regular trainings in their clubs or national team of Serbia, which was confirmed by the evidence of attendance and number of trainings per month;
- subjects did not have any somatic deformity or aberrations and were physically and mentally healthy.

No other exclusion criteria were used in defining of the population from which the sample of subjects was taken apart from the listed ones.

2.2 Sample of the variables for determining conative characteristics

Measuring instrument CON6 was chosen for assessing conative characteristics by which the following conative regulators were assessed:

- the regulator of activity (EPSILON),
- the regulator of biological functions (XI),
- the regulator of defense reactions (ALPHA),
- the regulator of attack reactions (SIGMA),
- system for coordination of regulative functions (DELTA),
- system for integration of regulative functions (ETA).

2.3 Methods of data processing

CANONIC DISCRIMINANT ANALYSIS IN MAHALANOBIS' SPACE

Canonic discriminant analysis can now be defined as a solution of quazi canonic problem

$$Mx_k = k_k,\ Gy_k = l_k | c_k = k_k^t l_k = \text{maximum},\ x_k^t x_q = y_k^t y_q = \delta_{kq}$$

$$k = 1,...,s;\ s = \min((g - 1), m) = m$$

where δ_{kq} is Kroneker's symbol, and $\mathbf{x}_k$ and $\mathbf{y}_k$ are unknown m-dimensional vectors.

As $c_k = \mathbf{x}_k^t \mathbf{A} \mathbf{y}_k$, the function which is to be maximized is, for k = 1

$$f(\mathbf{x}_k, \mathbf{y}_k, \lambda_k, \eta_k) = \mathbf{x}_k^t \mathbf{A} \mathbf{y}_k - 2^{-1}\lambda_k(\mathbf{x}_k^t \mathbf{x}_k - 1) - 2^{-1}\eta_k(\mathbf{y}_k^t \mathbf{y}_k - 1).$$

Differentiating this function by the elements of vector $\mathbf{X}_k$

$$\partial f/\partial \mathbf{x}_k = \mathbf{A}\mathbf{y}_k - \lambda_k \mathbf{x}_{k,}$$

and differentiating by the elements of vector $\mathbf{y}_k$

$$\partial f/\partial \mathbf{y}_k = \mathbf{A}\mathbf{x}_k - \eta_k \mathbf{y}_k;$$

after equaling it with zero

$$\mathbf{A}\mathbf{y}_k = \lambda_k \mathbf{x}_k$$

and

$$\mathbf{A}\mathbf{x}_k = \eta_k \mathbf{y}_{k.}$$

Differentiating on λ_k and η_k, and from the condition $\mathbf{x}_k^t\mathbf{x}_k = 1$ and $\mathbf{y}_k^t\mathbf{y}_k = 1$, it is easily obtained that $\lambda_k = \eta_k$. As $\mathbf{A}^t = \mathbf{A}$, multiplication of the first result with $\mathbf{x}_k^t$, and the second result with $\mathbf{y}_k^t$

$$\mathbf{x}_k^t\mathbf{A}\mathbf{y}_k = \lambda_k$$

and

$$\mathbf{y}_k^t\mathbf{A}\mathbf{x}_k = \lambda_k$$

with $\mathbf{x}_k = \mathbf{y}_{k\,,}$ the problem is reduced to a simple problem of eigenvalues and matrix **A** vectors, that is to the solution of the problem

$$(\mathbf{A} - \lambda_k\mathbf{I})\mathbf{x}_k = \mathbf{0},$$

k = 1,..., m

so

$$c_k = \rho_k^2 = \mathbf{x}_k^t\mathbf{A}\mathbf{x}_k = \lambda_k,$$

k = 1,..., m

are squares of canonic correlations between linear combinations of variables from **M** and **G** which are proportional to the differentiation of centroides of subsamples defined by the selective matrix **S** in the space between vectors of the variables from **M.**

If $\boldsymbol{\rho}^2 = (\rho_k^2)$, k = 1,..., m diagonal matrix of which the elements are the squares of canonic correlation, if $\mathbf{X} = (\mathbf{x}_k)$, k = 1,..., m is matrix of eigenvectors obtained by solving canonic discriminant problem, if

$$\mathbf{K} = \mathbf{M}\mathbf{X}$$

is matrix of discriminant functions and if

$$L = GX = PMX$$

matrix of discriminant functions projected in hypercube defined by vectors of matrix S.

As

$$\mathbf{K}^t\mathbf{L} = \mathbf{X}^t\mathbf{A}\mathbf{X} = \boldsymbol{\rho}^2$$

and if $\mathbf{K}^t\mathbf{K} = \mathbf{I}$ and $\mathbf{L}^t\mathbf{L} = \boldsymbol{\rho}^2$, canonic discriminant analysis makes two biorthogonal sets of variable vectors by such a transformation of variable vectors from M and G which orthogonalizes those vectors and maximises cone angles between correspondent vectors from K and L under the additional condition that the cone vectors of non-correspondent vectors from K and L equal zero because the correlations between variables K and L are

$$\mathbf{K}^t\mathbf{L}\boldsymbol{\rho}^{-1} = \mathbf{X}^t\mathbf{A}\mathbf{X}\boldsymbol{\rho}^{-1} = \boldsymbol{\rho}.$$

Vectors $\mathbf{x}_k$ from X are, obviously, vectors of standardized partial regression coefficients of variables from **M** which generate discriminant functions $\mathbf{k}_k$ which, together with discriminant functions $\mathbf{l}_k$ and vectors formed from standardized partial regression coefficients $\mathbf{x}_k$ from variables G, have maximum correlation. But, as

$$\mathbf{M}^t\mathbf{K} = \mathbf{X},$$

elements of matrix X are, at the same time, correlations of the variables from M and discriminant variables from K which, unlike standard canonic discriminant model, allows simple testing of hypotheses about partial influence of variables on formation of discriminant functions. The elements of cross-structural matrix, defined as correlations between variables M and L, can be of a certain importance for identification of discriminant functions, so the elements of matrix

$$\mathbf{Y} = \mathbf{M}^t\mathbf{L}\boldsymbol{\rho}^{-1} = \mathbf{A}\mathbf{X}\boldsymbol{\rho}^{-1} = \mathbf{X}\boldsymbol{\rho};$$

observe that Y is factorial matrix of matrix A because

$$\mathbf{Y}\mathbf{Y}^t = \mathbf{X}\boldsymbol{\rho}^2\mathbf{X}^t.$$

As the elements x_{jk} of the matrix X and the elements y_{jk} of the matrix Y are ordinary correlations, their asymptotic variances are

$$\sigma_{xjk}^2 = (1 - x_{jk}^2)^2 n^{-1},$$

that is

$$\sigma_{yjk}^2 = (1 - y_{jk}^2)^2 n^{-1},$$

the hypotheses such as H_{0xjk} or H_{0yjk} can be tested on the basis of the functions

$$f_{xjk} = x_{jk}^2((n - 2)(1 - x_{jk}^2)),$$

or

$$f_{yjk} = y_{jk}^2((n - 2)(1 - y_{jk}^2)),$$

because with such hypotheses these functions have Fisher - Snedecorovu F distribution with the degrees of autonomy $\nu_1 = 1$ and $\nu_2 = n - 2$.

Unfortunately, when the standard canonic discriminant analysis is applied, the main, and usually the only set of hypotheses related to parameters of the model is

$$H_0 = \{\varphi_k = 0, k = 1,..., m\}$$

in which φ_k are hypothetical values of the canonic correlations within population P.

For testing of the hypotheses type

$$H_{0k}: \varphi_k = 0$$

k = 1,..., m

one function of the well known Wilks' formula is applied

$$\lambda_k = \Sigma_{t+1}^{s} \log_e (1 - \rho_{t+1}^{2})$$

k = t + 1, t = 0, 1,..., m – 1

which was suggested by Bartlett (1941) who discovered that under hypothesis H_{0k}: $\varphi_k = 0$ function

$$\chi_k^2 = -(n - (m + g + 3)/2)\lambda_k$$

k = 1,..., m

have, approximately, χ^2 distribution with

$$\nu_k = (m - k + 1)(g - k)$$

degrees of autonomy.

But, the outcomes of Bartlett test are not, even if the large samples are in question, in complete accordance with the outcomes of the tests as

$$z_k \rho =_k / \sigma_k$$

k = 1,...,s

which are based on the fact that canonic correlations also have asymptotic normal distributions with parameters φ_κ and

$$\sigma k^2 \sim (1 - \varphi_\kappa^{\ 2})^2 n^{-1}$$

(Kendall and Stuart, 1976; Anderson, 1984).

Centroids of subsamples E_p, p = 1,..., g from E on discriminant functions, necessary in order to identify the content of discrimnant functions, are naturally the elements of the matrix

$$\mathbf{C} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{K} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{MX} = (\mathbf{S}^t\mathbf{S})^{-1}\mathbf{S}^t\mathbf{ZR}^{-1/2}\mathbf{X}$$

And thus it is evident that they are, in fact, centroids of subsamples on variables transformed into Mahalanobis' shape projected in discriminant space.

3. Results

The reason for the increased number of the reasearches of athletes' personality should be searched for in the characteristics of sport activity, which imposes different requests not just in respect to motor ability, but personality, too. This justifies the assumption that active and successfull participation in sports, including martial arts (judo and karate) demands for specific personality traits which are the most convenient for those sports, or personality traits suitable for sport, and not some other activities too.

Results of the discriminant analysis in conative space are presented in Tables 1-4, and careful anaysis shows that only one canonic correlation was discvered (.34) which is significant at level .04.

The first discriminant function is defined by mechanism for integration of regulatory functions, mechanism for coordination of regulatory functions, mechanism for control of defence and mechanism for control of organic functions, and finally activity regulator, which at the same time models activating part of reticular formation, which is itslef responsible for energy level at which other systems, including cognitive and motor processors, function.

Based on the size and precursors of the centroids for the first discriminant function of groups, we can conclude that: judoists are able to adequatly model tonic excitement on the basis of programs transfered by genetic code or formed by learning, which are located in centres for regulation and control of reactions of defence and attack. They are capable to coordinate functionally and hierarhically different subsystems, both cognitive and conative. Karatists are capable of adequately modelling excitatory-inhibitory processes because control of strikes is necessary for that sport and it is required by strict rules of this sport.

Table 1 DISCRIMINANT ANALYSIS OF CONATIVE VARIABLES

F	Kan. R.	Λ	$\chi 2$	df	Sig.
1	.34	,97	12,98	6	,04

Table 2 STRUCTURE OF CANONIC FACTOR IN H SPACE

Variables	D1
EPSILON	,43
XI	-,67
ALPHA	,17
SIGMA	-,39
DELTA	,38
ETA	,99

Table 3 GROUP CENTROIDS

Grups	D1
Judo	-.34
Karate	.31

Table 4 STRUCTURE OF CANONIC FACTOR IN Z SPACE

Variables	D1
ETA	,85
DELTA	,59
ALPHA	,48
XI	,37
EPSILON	,33
SIGMA	,07

4. Conclusion

The research was conducted with the aim to investigate specificities of conative dimensions in athletes who practice judo and karate and to determine the difefrences between them.

In order to determine specificities of the structure of tested anthropologic dimensions, 200 judoists and karatists, members of judo and karate clubs in Serbia (around 100 judoists and around 100 karatists), between 18 and 27 years of age, were tested.

Measuring instrument KON6 was chosen for evaluation of conative characteristcs, and by means of it the following conative regulators were tested: activity regulator, organic function regulator, defence reaction regulator, attack reaction regulator, system for coordination of regulatory functions and system for integration of regulatory functions.

All the data in this research were processed in the Centre for Multidisciplinary Research of the Faculty of Sport and Physical Education, University in Priština, by means of the system of programs for data processing developed by Popović, D. (1980), (1993) and Momirović, K. and Popović, D. (2003).

Complete algorythms and programs from this dissertation have been presented, and the results of those programs analyzed.

Results of the discriminant analysis in conative space are presnted in Tables 1-4, and a carefull analysis of them shows that only one significant canonic correlation was observed (.34), which was significant at level .04.

The first discriminant function is defined by mechanism for integration of regulatory functions, mechanism for coordination of regulatory functions, mechanism for control of defence and mechanism for control of organic functions, and finally activity regulator, which at the same time models activating part of reticular formation, which makes it responsible for energy level at which all other systems function, including cognitive and motor processors.

According to the size and precursors of centroids for the firs discriminant function of groups we can conclude that: judoists are capable of adequately modelling tonic excitement based on the programs transfered by genetic code or formed under the influence of learning, whicih are located in centers for regulation and control of reactions of defence and attack. They are capable of ccordinating functionally and hierarhically different subsystems, both cognitive and conative. Karatists are capable of adequately modelling excitatory-inhibitory processes since that sport control of strikes is necessary, which is also required by strict rules in this sport.

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Canonic discriminative analysis in Mahalanobis'space as a method for determining differences between conative dimensions of athletes who practice judo and karate

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Summary

The research was conducted with the aim to investigate specificities of conative dimensions in athletes who practice judo and karate and to determine the difefrences between them.

In order to determine specificities of the structure of tested anthropologic dimensions, 200 judoists and karatists, members of judo and karate clubs in Serbia (around 100 judoists and around 100 karatists), between 18 and 27 years of age, were tested.

Measuring instrument KON6 was chosen for evaluation of conative characteristcs, and by means of it the following conative regulators were tested: activity regulator, organic function regulator, defence reaction regulator, attack

reaction regulator, system for coordination of regulatory functions and system for integration of regulatory functions.

All the data in this research were processed in the Centre for Multidisciplinary Research of the Faculty of Sport and Physical Education, University in Priština, by means of the system of programs for data processing developed by Popović, D. (1980), (1993) and Momirović, K. and Popović, D. (2003).

Complete algorythms and programs from this dissertation have been presented, and the results of those programs analyzed.

Results of the discriminant analysis in conative space are presnted in Tables 1-4, and a carefull analysis of them shows that only one significant canonic correlation was observed (.34), which was significant at level .04.

The first discriminant function is defined by mechanism for integration of regulatory functions, mechanism for coordination of regulatory functions, mechanism for control of defence and mechanism for control of organic functions, and finally activity regulator, which at the same time models activating part of reticular formation, which makes it responsible for energy level at which all other systems function, including cognitive and motor processors.

According to the size and precursors of centroids for the firs discriminant function of groups we can conclude that: judoists are capable of adequately modelling tonic excitement based on the programs transfered by genetic code or formed under the influence of learning, whicih are located in centers for regulation and control of reactions of defence and attack. They are capable of ccordinating functionally and hierarhically different subsystems, both cognitive and conative. Karatists are capable of adequately modelling excitatory-inhibitory processes since that sport control of strikes is necessary, which is also required by strict rules in this sport.

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High limit measures of reliability of tests with a singular covariance matrix in determination of the structure of cognitive dimensions of selected football players

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Abstract

If ξ^2 is a variance of any defined total result, if τ^2 is a variance of thus defined true result, and if ε^2 is a variance of the variation mistake of some composite measuring instrument.
As

$$\mathbf{G}^t\mathbf{E} = \mathbf{U}^2 - \mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2$$

For tests with regular, and

$$\mathbf{G}^t\mathbf{E} = \mathbf{U}^2 - \mathbf{U}^2\mathbf{R}^{-}\mathbf{U}^2$$

For tests with singular matrix of particles' covariance, two theoretical definitions of reliability

$$\alpha_1 = \tau^2\sigma^{-2}$$

and

$$\alpha_2 = 1 - \varepsilon^2\sigma^{-2}$$

are not equivalent when it comes to measuring model based on Guttman image theory. Let us first consider λ_6 measure type (Guttman, 1945.) defined by functions α_1 and α_2. For the result defined by function **b**, those measures will be

$$\lambda_{61} = \eta^2\sigma^{-2},$$

and

$$\lambda_{62} = 1 - \theta^2\sigma^{-2}.$$

β_6 measure types (Momirović, 1996.) defined by functions α_1 i α_2, for the result defined by function **h**,

$$\beta_{61} = \gamma^2\lambda^{-2}$$

and

$$\beta_{62} = 1 - \delta^2\lambda^{-2}.$$

It is not hard to demonstrate that, for the regular particle clusters, α_1 type measures of low reliability limit of λ_6 i β_6 measure types, and that α_2 type measures of low reliability measures type λ_6 i β_6.

Key words: variance, matrix, covariance, singular, function, measure

1. Introduction

In researches in applied psychology as well as other anthropological sciences, latent dimensions, as a rule, are estimated on the basis of groups of variables formed within theoretical models which were verified in previous, explorative or confirmative analyses of latent structure of manifested anthropological variables.

Hypothetical latent structure in applied researches is therefore explicitly defined, while hypothetical latent dimensions covered by a greater number of noticeable variables, the subjects of which measurements are known from previous analyses or they can be assumed with high probability based on theoretical, as a rule cybernetically formulated models.

In psychological literature, most often three types of definitions of intelligence are mentioned. In biheviorístic circles intelligence is frequently identified as a "learning capacity", i.e. capability for acquiring new knowledge. Intelligence is less frequently equated with "capability for abstract thinking". Definition of intelligence as a "capability for adaptation to new situations" requires particular attention. It is rather frequent in animal psychology. Adaptation here is not referred to as a tolerance to exogenous factors, or as to adaptation in clinical terms.

Central nervous system has primarily integrative function, thus enabling purposeful and adaptable behavior of human being. Integration on cortical level is of the greatest importance since purposeful behavior is directly related to intelligence on cortical level, but it is less flexible. Integration of function on subcortical level enables reacting in standard situations, the situations which demand for routine performance. Cognitive processes and cognitive functioning are central mechanisms of cortical integration.

2. Methods

2.1. Sample of subjects

Sample of subjects depended on organizational and financial resources required for the research. Sufficient number of qualified and trained personnel performing measurements, defined instruments and standardized conditions of the research planned were provided. Measurements were performed on the sample which is representative for the whole Republic of Serbia.

-subjects were male

-age was defined on the basis of chronological age, so that the research was performed on subjects from 18 to 27 years of age plus-minus 0.5 years

-subjects were registered players of the national competition rank (two highest levels of competition)

-subjects had regular trainings, which was confirmed by evidence kept by coaches

-we chose a sample of 107 subjects based on statistical-mathematical model and program, aims set by hypotheses.

No other exclusion criteria or stratification variables were used in defining of the population from which the sample of subjects was taken apart from the listed ones.

2.2 Sample of the variables

SAMPLE OF THE VARIABLES FOR EVALUATION OF COGNITIVE CAPACITIES

IT-1 test was chosen for evaluation of efficiency of input processors, i.e. perceptive reasoning.

S-1 test was chosen for evaluation of efficiency of parallel processor, i.e. identification of relations and correlates.

Measurement instrument AL-4 was chosen for evaluation of efficiency of serial processor, i.e. symbolic reasoning.

2. 3. Methods of processing of the results

Value of a research does not depend only on the sample of subjects and the sample of variables, that is on value of basic information, but also on the applied procedures for transformation and condensation of those information. Some scientific problems can be solved by multiple different, and sometimes equally trustworthy methods. However, with the same basic data and based on results of different methods, different conclusions can be drawn. Therefore the problem of selection of particular methods for data processing is rather complex.

In order to reach satisfactory scientific solutions, the research was based on, primarily acceptable, adequate, unbiased and comparable procedures, which were appropriate to the nature of the problem posed and which enabled extraction and transformation of appropriate dimensions, hypotheses testing of those dimensions, defining differences, relations, prognosis and diagnosis, as well as definition of principles within the research field.

Taking all this into account, for the purpose of this research we chose procedures which are considered to be appropriate to the nature of the problem which do not impose too severe restrictions on the basic information.

If ξ^2 is variance of any defined total result, if τ^2 is variance of thus defined accurate result, and if ε^2 is variance of measurement deviation of some composite measurement instrument.

As

$$\mathbf{G}^t\mathbf{E} = \mathbf{U}^2 - \mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2$$

Is for tests with regular, and

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For tests with singular matrices of particle covariance, two theoretical definitions of reliability,

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are not equivalent when it comes to the measurement model based on Guttman image theory.

Let us first consider λ_6 measurements (Guttman, 1945) defined by functions α_1 i α_2. For the result defined by function **b**, those measures will be

$$\lambda_{61} = \eta^2\sigma^{-2},$$

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β_6 measure types (Momirović, 1996.) defined by functions α_1 i α_2 for the result defined by function **h** will be

$$\beta_{61} = \gamma^2\lambda^{-2}$$

and

$$\beta_{62} = 1 - \delta^2\lambda^{-2}.$$

It is not hard to prove that for regular particle clusters α_1 measure types of the estimated low limit of reliability of λ_6 i β_6 measure types, and that $\alpha_2$measure types are estimates of high level of reliability of λ_6 i β_6 measure types.

Hypothesis 1

Coefficients γ_π vary in the range (0,1) and can reach value 1 only if **P** = **I**, if all the variables are measured correctly, and value 0 only if both **P** = **0** and **P** = **I**, that is if the entire variance of all variables consists only of variance of measurement deviation, and variables from V have spherical normal distribution.

Proof:

If the whole variance of each variable from some variable cluster consists only of variance of measurement deviation, then $\mathbf{E}^2 = \mathbf{I}$ and **P** = **I**, so all coefficients γ_π equal zero. The first part of hypothesis is obvious from the definition of coefficient γ_π; this means that reliability of each latent dimension, regardless of how that latent dimension was determined, equals 1 if all variables from which the dimension was deduced were measured correctly.

However, reliability coefficient matrix **P** = (ρ_j) is frequently unknown, so that matrix of measurement deviation variance $\mathbf{E}^2$ is also unknown. But, if variables from V are selected to represent some range of U variables with the same array of importance, high limit of measurement deviation variances is defined by elements of $\mathbf{U}^2$ matrix (Guttman, 1945, 1953), that is by unique variances of those variables. This is why, in that case, low limit of reliability of latent dimensions can be estimated by coefficient

$$\beta_p = 1 - (\mathbf{q}_p^t\mathbf{U}^2\mathbf{q}_p)(\mathbf{q}_p^t\mathbf{R}\mathbf{q}_p)^{-1} \qquad p = 1,...,k$$

which were reached by the procedure identical to the one used for reaching coefficients γ_π with definition of $\mathbf{E}^2 = \mathbf{Y}^2$, that is the same way Guttman reached his measure λ_6 .

Hypothesis 2

Coefficients β_π vary in the range of (0,1), but they cannot reach value 1.

Proof:

If $\mathbf{P} = \mathbf{I}$, then also $\mathbf{Y}^2 = \mathbf{I}$, so that all coefficients β_π equal zero. However, as $\mathbf{Y}^2 = \mathbf{0}$ is not possible if matrix $\mathbf{P}$ is regular, all coefficients β_π are necessarily less than 1 and tend towards 1when unique variance of variables from which latent dimensions are deduced inclines towards zero.

By means of the same technique it is easy to determine measures of absolute low limit of reliability of latent dimensions defined by this procedure the same way Guttman determined his measure λ_1. For that purpose, we will assume that $\mathbf{E}^2 = \mathbf{I}$. In that case

$$\alpha_p = 1 - (\mathbf{q}_p^t\mathbf{R}\mathbf{q}_p)^{-1}$$

will be measures of absolute low limit of reliability of latent dimensions, as, obviously, $\mathbf{\Theta}^\tau\mathbf{\Theta} = \mathbf{I}$.

Hypothesis 3

All the coefficients α_π are always less than 1.

Proof:

It is obvious that all the coefficients must α_π be less than 1, and that they all incline towards 1 when m, number of variables in V cluster, inclines towards infinity, since in that case square form of matrix $\mathbf{P}$ inclines towards infinity. If $\mathbf{P} = \mathbf{I}$, then, obviously, all the coefficients α_π equal zero. However, low limit of coefficient α_π needs not to be zero, since it is possible, but not for all α_π coefficients, that variance σ_π^2 of some latent dimension is less than 1. Certainly, latent dimension which provides less information than any variable from which it was derived makes no sense, and the best way to show that is by coefficient α_π.

Measure types β_6 defined by α_1 i α_2 functions (Momirović, 1996) will be, for the result defined by function $\boldsymbol{\eta}$,

$$\beta_{61} = \gamma^2\lambda^{-2}$$

and

$$\beta_{62} = 1 - \delta^2\lambda^{-2}.$$

It is not hard to prove that, for regular particle clusters, measure types α_1 are estimated low limits of reliability of measures type λ_6 ι β_6, while α_2 measure types are estimated high limits of measure types λ_6 ι β_6.

Hypothesis 4

If $m \geq 2$, $|\mathbf{R}| \neq 0$ and $T \subset \boldsymbol{\alpha}$, where $\boldsymbol{\alpha}$ is cluster of all vectors which are in the positive hyperquadrant R^m of the space, so that $r_{jk} \geq 0 \ \forall \ t_j, t_k; j,k = 1,...,m$, then, for $\mathbf{x}$: $\mathbf{x}^t\mathbf{x} = 1$ is such that $\mathbf{x}^t\mathbf{R}\mathbf{x} = \lambda^2 =$ maximum,

$$0 \leq \lambda_{61} \leq \beta_{61} < 1.$$

Proof:

Obviously, $0 = \lambda_{61} = \beta_{61}$ only when $\mathbf{C} = \mathbf{0}$, i.e. $\mathbf{R} = \mathbf{I}$. Ako $\mathbf{x} \neq \mathbf{e}$, $\lambda^2 \geq \sigma^2$, which is why it is crucial to determine what is the difference between functions $(\mathbf{x}^t\mathbf{C}\mathbf{x})(\mathbf{x}^t\mathbf{R}\mathbf{x})^{-1}$ and $(\mathbf{e}^t\mathbf{C}\mathbf{e})(\mathbf{e}^t\mathbf{R}\mathbf{e})^{-1}$. As

$$(\mathbf{x}^t\mathbf{C}\mathbf{x})(\mathbf{x}^t\mathbf{R}\mathbf{x})^{-1} - (\mathbf{e}^t\mathbf{C}\mathbf{e})(\mathbf{e}^t\mathbf{R}\mathbf{e})^{-1} = (\mathbf{x}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{x})\lambda^{-2} - 2(\mathbf{x}^t\mathbf{U}^2\mathbf{x})\lambda^{-2} - (\mathbf{e}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{e})\sigma^{-2} + 2(\mathbf{e}^t\mathbf{U}^2\mathbf{e})\sigma^{-2}$$

and as

$$(2(\mathbf{e}^t\mathbf{U}^2\mathbf{e})\sigma^{-2} - 2(\mathbf{x}^t\mathbf{U}^2\mathbf{x})\lambda^{-2}) > ((\mathbf{e}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{e})\sigma^{-2} - (\mathbf{x}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{x})\lambda^{-2}),$$

since matrix elements outside diagonal $\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2$ are negative if $\mathsf{T} \subset \alpha$ and x vector elements in the negative correlation with matrix elements $\mathbf{U}^2$, then $\lambda_{61} \leq \beta_{61}$, which is exactly what needed to be proved.

In a similar manner we can demonstrate that relations defined by hypotheses 1, 2, 3 i 4 stand in case if $|\mathbf{R}| = 0$ and $\mathbf{U}^2 = (\text{diag } \mathbf{R}^-)^{-1}$, taking into account that $\mathbf{R}\mathbf{R}^- = \mathbf{X}\mathbf{X}^t$, where $\mathbf{X}$: $\mathbf{X}^t\mathbf{X} = \mathbf{I}$ and matrices typical of vectors of matrix $\mathbf{R}$ coupled with typical values of that matrix other than zero. However, in that case, due to inflation of uniqueness in the zone of singularity, there will almost always occur reduction of all measures of reliability which are based on estimation of unique particle variance (Momirović, 1999).

3. Results

Factorial structure of intellectual capabilities was analyzed based on all information provided by matrix of significant main components (Table 1). Based on $\boldsymbol{\alpha}_2$ Guttman measure only one latent dimension which marks the entire space of the three cognitive tests with around 69.97% of common variance. This can be appropriate for this kind of research. Communalities of variables of all estimated capabilities by these tests are relatively high and can be taken as appropriate.

The strongest connection with the isolated cognitive dimension has the variable for estimation of perceptive capabilities IT1. Several authors discovered the positive connection between perceptive capabilities and motor abilities, (Boli. 1996). Although perceptive measurement instruments are significantly saturated by cognitive factors (literature frequently mentions cognitive functioning on perceptive level), it would have been unsupported to call them cognitive measurement instruments, although that is what they are in a way. Positive connection, most frequently average, between perceptive capabilities and motor abilities was discovered by Horne, Fitts, Harison, Fleishman, Neeman, Hempel etc. authors have also discovered that motor activity positively influences development of perceptive capabilities. Cognitive dimension was clearly defined by test AL4 with relatively low projection for estimation of serial processor which corresponds to Cattell's factor of crystallized intelligence and test for estimation of efficiency of parallel processor, i.e. spotting relations and correlates of S-1.

Connection between cognitive capabilities and success in football was proven in numerous researches. It is assumed that better adaptation of cognitive capabilities to specific life conditions of players of all levels, and particularly of those of highest level influences connection of cognitive capabilities and success in football. For that reason recognizing cognitive structure of footballers is of particular importance for planning and reorganization of training and prognosis of success in game and in football itself.

Obtaining of this result is understandable if we take into account that football is characterized by variety and abundance of technical elements, whole body and extremities movements into different directions with varying pace. During a game, dynamic situations constantly change depending on movement of players with different techniques.

Taking all into account, we can conclude that basic cognitive processes are functions of perceptive, parallel and serial processor, which are probably under control of some central processor in charge of coordination of all cognitive functions.

MAIN COMPONENTS OF FOOTBALLERS' COGNITIVE VARIABLES

Table 1.

	FAC1	h2
IT-1	.93	.88
AL-4	.89	.79
S-1	.81	.69
Typical values	2.53	
% Variance	69.97	
Cummulative.%	69.97	

4. Conclusion

The research was conducted in order to determine structure of cognitive capabilities of sportsmen playing football. In order to discover structure of the treated anthropological dimensions, the research was conducted on 107 football players.

For investigation of cognitive capabilities measurement instrument CON3 was chosen, which estimates the following cognitive mechanisms: for estimation of input processors, i.e. perceptive reasoning, IT-1 was chosen. For evaluation of efficiency of parallel processor, i.e. identification of relations and correlates, S-1 test was used. For evaluation of efficiency of serial processor, i.e. symbolic reasoning, measurement instrument AL-4 was chosen.

All the data in this research were processed in the Center for Multidisciplinary Researches of the Faculty of Sports and Physical Education, University of Priština, by means of the system of programs for data processing developed by Popović, D. (1980), (1993) and Momirović, K. and Popović, D. (2003).

Factorial structure of intellectual abilities was analyzed based on all information provided by matrix of significant main components (Table 1). Based on Guttman $\boldsymbol{\alpha}_2$ measure only one latent dimension was isolated, which marks the entire space of the three cognitive tests with around 69.97% of common variance. This can be accepted as appropriate for a research of this type. Communalities of variables of all the estimated abilities by the tests used are relatively high and can be considered to be satisfactory.

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For investigation of cognitive capabilities measurement instrument CON3 was chosen, which estimates the following cognitive mechanisms: for estimation of input processors, i.e. perceptive reasoning, IT-1 was chosen. For evaluation of efficiency of parallel processor, i.e. identification of relations and correlates, S-1 test was used. For evaluation of efficiency of serial processor, i.e. symbolic reasoning, measurement instrument AL-4 was chosen.

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Discriminant analysis in space with standard metric

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Abstract

The resulting solution is very easily to convert into a form which is obtained under the canonical model of discriminant analysis. Discriminant coefficient matrix can be defined as a matrix of partial regression coefficients. It is obtained by solving the problem $\mathbf{ZW} = \mathbf{K} + \mathbf{E} \mid trag(\mathbf{E}^t\mathbf{E}) = minimum$.As , in fact, $\mathbf{K} = \mathbf{ZR}^{-1/2}\mathbf{X}$, it is immediately evident that $\mathbf{E} = \mathbf{0}$ and $\mathbf{W} = \mathbf{R}^{-1/2}\mathbf{X}$.Therefore, $\mathbf{w}_k$ vectors of W are proportional to the coordinates of the vector of discriminant functions in the oblique coordinate system consisting of vectors of Z with cosines of the angles between the coordinate axes equal to the elements of the correlation matrix R. As discriminant analysis can also be interpreted as a special case of component analysis with principal components transformed by an admissible singular transformation to maximize distance between the centroids of E_p subsets, or canonical correlation ρ_k (Cooley and

Lohnes , 1971 ; Hadžigalić 1984 ; Momirović and Dobrić , 1984), identification of the content of discriminant functions is customarily based on structural vectors $\mathbf{f}_k$ of matrix $\mathbf{F} = \mathbf{Z}^t\mathbf{K} = \mathbf{RW} = \mathbf{R}^{1/2}\mathbf{X} = (\mathbf{f}_k) = (\mathbf{Rw}_k)$, analogous to the identification of the content of canonical variables obtained using Hotelling method of biorthogonal canonical correlation analysis, because by easy calculations it can be shown that **F** is a factor matrix of R matrix (Zorić and Momirović 1996 ; Momirović , 1997) . In this metric, the cross structure of discriminant functions will be $\mathbf{U} = \mathbf{Z}^t\mathbf{L}\rho^{-1} = \mathbf{Z}^t\mathbf{PZW}\rho^{-1} = \mathbf{W}\rho$ because, naturally, $\mathbf{W}^t\mathbf{Z}^t\mathbf{PZW} = \rho^2$, and it is immediately clear that **U** is a factor matrix of matrix $\mathbf{Z}^t\mathbf{PZ}$, or matrix of intergroup covariances defined in a space with the standard **I** metric.As f_{jk} elements of F matrix and u_{jk} elements of matrix **U** in act as ordinary product-moment correlation coefficients, and since they are a function of normally distributed variables, therefore they themselves are asymptotically normally distributed, their asymptotic variances are, of course, $\sigma_{jk}^2 \sim (1 - \phi_{jk}^2)^2 n^{-1}$ j = 1,..., m; k = 1,..., s , or $\xi_{jk}^2 \sim (1 - \upsilon_{jk}^2)^2 n^{-1}$ j = 1,..., m; k = 1,..., s, and can be used to test hypotheses of type H_{jk}: $f_{jk} = \phi_{jk}$, or H_{jk}: $u_{jk} = \upsilon_{jk}$, where ϕ_{jk} and υ_{jk} are some hypothetical correlations between variables of **V** and discriminant functions in population P because asymptotic distribution of f_{jk} coefficients is $f(f_{jk}) \sim N(\phi_{jk}, \sigma_{jk}^2)$, and asymptotic distribution of u_{jk} coefficients is $f(u_{jk}) \sim N(\upsilon_{jk}, \xi_{jk}^2)$ where N is a mark for normal distribution.

Keywords:/distribution/correlation/dimension/matrix/coefficients/discriminant analysis/

1. Introduction

Dance, as a type of human activity associated with music, is a form of rich tradition and artistic creativity of people. It is part of their spirit, perceptions and aspirations, a mirror of human life, thinking and actions in general. Dance originated with the man, followed him in life and work and developed in accordance with the development of human society; at different levels of development it changed, modified, enriched, until the final form of stylized artistic dance. Conceptually it can be characterized as a structure of specific elements of motion composed in a visible form by which the complexity of man's inner life is expressed. Dances, first of all, express the idea of a creator through various structures of motion and movement as well as gestures, or expression of imaginations through dancers` body activities. It is composed of free or specially structured movements and motion joined in certain figures, wholes, which alternate in the same or a different sequence, in the same or different rhythm and tempo. Motion and movements are generally emphasized by the lower extremities, while the whole body follows the expression shaping the story into a whole. The particularly large contribution of dance elements refers to improvement of movement coordination, creation of movement habits, development of motor memory, musical hearing, rhythm and memory, physical development, development of functional skills, increase of neuromuscular coordination and, it is very important that in combination with music or a song they create an optimistic, joyful atmosphere, strengthen friendship and cooperation in a group, develop a sense of socialization and cooperation between the sexes, and represent an excellent tool in physical education instruction. Aesthetic formation of personality carried out through a body exercise process with the use of aesthetic regularities, or aesthetic education, is very close to these activities. The role of aesthetic education is to teach performers to recognize the beauty in body exercise and sports activities through which they will go, express themselves, and which they will creatively introduce into all spheres of life.

The content of aesthetic education in a body exercise process is formation of human body beauty which implies proportional harmony, proper posture, formation of body shapes, harmonious development of movement skills and physical properties of the body, formation of knowledge, habits and skills which are a precondition for the beauty of movement expression which implies unity of technical perfection and style when creating movement habits and skills in body exercise and sports activities, as well as development of sense of rhythm with musical expression through movement in everyday locomotion.

2. The research methods

2.1. The sample of respondents

In order to carry out the research correctly and get results stable enough in terms of sampling error, it was necessary to take a sufficient number of respondents in the sample. The sample size for this nature of research was conditioned by the research objectives and tasks, population size and degree of variability of the applied parameter system.

In addition, the number of respondents in the sample depends on the level of statistical inference and the choice of mathematical and statistical models. Based on the chosen statistical-mathematical model and programs, goals and tasks, the sample included 257 respondents divided into two subsamples (male dancers n = 130 and female dancers n = 127). During all factor procedures, it should constantly be kept in mind that the analysis results depend on three main systems which determine selection and transformation of information: from the sample of variables, sample of respondents and selected extraction, and rotary methods.

Bearing these criteria in mind, based on the experience from previous studies, it is believed that the sample of 257 respondents was sufficient for this research. In defining the population from which the sample was drawn, except for the above, no other restrictions or stratification of the target variable were applied.

The population from which the sample was drawn for this study can be defined as a population of male and female folk dancers of folk dance ensembles of Serbia aged 15-18 years.

Based on the formulated problems, subject and objectives of the research, and taking into consideration the organizational and financial capabilities necessary to carry out the research procedure, an optimal number of subjects were taken in the sample in order to do research correctly and get exact results.

The research was conducted in the following Folk Dance Ensembles:

- Niš
- Leposavić

2.2. The sample of variables

2.2.1.The sample of motor variables

It was not possible to cover the entire motor space by this research. Therefore, a certain reduction of tests was made and only those segments were taken that would provide adequate information relevant to the research.

As already mentioned, when selecting tests to define the motor space, it was taken into account that they had been verified by previous studies on the Yugoslav population as relevant to this age group. The battery of tests was designed to meet, first of all, the requirements arising from the subject, goals and tasks of the research. The final formation of the test battery was greatly influenced by the intention to make the obtained results comparable with the results obtained by the group of the following authors: Kurelić et al. (1971 and 1975), Momirović et al. (1969) and Gredelj et al. (1975).

For the evaluation of motor skills, 20 motor tests were used. They were selected according to the structural model designed by Gredelj, Metikos, Hošek and Momirović in 1975 and defined as a mechanism for movement structuring (MSK), a mechanism for functional synergies and tonus regulation (SRT), a mechanism for regulating excitation intensity (RIE), and as a mechanism for regulating duration of excitation.

2.4. The data processing methods

In order to get satisfactory scientific solutions, the researchers used, in the first place, correct, then adequate, impartial and comparable procedures which conformed to the nature of the given problem and made it possible to extract and transform the appropriate dimensions, test hypotheses about these dimensions, identify differences, relations, predictions and diagnoses as well as formulate regularities within the research area.

Taking that into account, the procedures selected for the purpose of this research were to conform to the nature of the problem, not to leave too great restrictions on general information, and to be based on the assumptions that

- latent dimensions subject to measurement with the applied measuring instruments have multivariate normal distribution;

- relations between manifest and latent variables can be approximated by the generalized Gauss-Markov-Rao linear model. In recent years, a big number of researchers have been misusing their position and publishing a growing number of quasi-scientific works which are based primarily on mathematical artifacts. In addition, they have been using the existing statistical products and have never basically understood the logic of most multivariate models. Therefore in this paper, special attention is paid to statistical analysis and selection of those algorithms and programs that actually have a use value and the data will not be analyzed by any of the poorly conceived and even worse written commercial statistical software packages, such as, but not limited to, SPSS, CSS, Statistica, BMDP and Statgraphics, not to mention other products whose popularity is much lower, but not necessarily because they are substantially weaker than those now applied almost exclusively by ignorant scientists and a special sort of people called the processor strain.

All the data in this study were processed at the Center for Multidisciplinary Studies, Faculty of Sports and Physical Education, University of Priština, by means of the system of software programs for data processing developed by Popović, D. (1980), (1993) and Momirović, K. and Popović, D. (2003).

2.4.1. Discriminant analysis in a space with the standard metric

The resulting solution is very easy to convert into a form which is obtained under the canonical model of discriminant analysis.

Discriminant coefficient matrix can be defined as a matrix of partial regression coefficients obtained by the solution to the problem

$$\mathbf{ZW} = \mathbf{K} + \mathbf{E} \mid \text{trag}(\mathbf{E}^t\mathbf{E}) = \text{minimum}.$$

As, in fact,

$$\mathbf{K} = \mathbf{ZR}^{-1/2}\mathbf{X},$$

it is immediately clear that $\mathbf{E} = \mathbf{0}$ and that

$$\mathbf{W} = \mathbf{R}^{-1/2}\mathbf{X}.$$

Therefore, $\mathbf{w}_k$ vectors of $\mathbf{W}$ are proportional to the coordinates of the vectors of discriminant functions in the oblique coordinate system made by the vectors of Z with the cosines of the angles between the coordinate axes equal elements of the correlation matrix R. As discriminant analysis can be interpreted as a special case of component analysis with principal components transformed, by a permissive singular transformation, so that they could maximize the distance between the centroids of E_p subsets, that is ρ_k canonical correlations (Cooley and Lohnes, 1971; Hadžigalić 1984; Momirović Dobrica, 1984), it is customary that identification of the content of discriminant functions is based on $\mathbf{f}_k$ structural vectors from the matrix

$$\mathbf{F} = \mathbf{Z}^t\mathbf{K} = \mathbf{RW} = \mathbf{R}^{1/2}\mathbf{X} = (\mathbf{f}_k) = (\mathbf{Rw}_k),$$

analogous to identification of the content of the canonical variables obtained using Hotelling biorthogonal canonical correlation analysis, because it is possible to show, through easy calculations, that $\mathbf{F}$ is a factor matrix of the R matrix (Zorić and Momirović 1996; Momirović, 1997).

In this metric the cross structure of discriminant functions will be

$$\mathbf{U} = \mathbf{Z}^t\mathbf{L}\boldsymbol{\rho}^{-1} = \mathbf{Z}^t\mathbf{PZW}\boldsymbol{\rho}^{-1} = \mathbf{W}\boldsymbol{\rho}$$

because, certainly, $\mathbf{W}^t\mathbf{Z}^t\mathbf{PZW} = \boldsymbol{\rho}^2$, and it is immediately clear that $\mathbf{U}$ is a factor matrix of $\mathbf{Z}^t\mathbf{PZ}$ matrix, or the inter-group covariance matrix defined in the space with standard $\mathbf{I}$ metrics.

Since f_{jk} elements of the $\mathbf{F}$ matrix and u_{jk} elements of the $\mathbf{U}$ matrix act as ordinary product-moment correlation coefficients, and since they are a function of normally distributed variables, and therefore they themselves are asymptotically normally distributed, their asymptotic variances are, of course,

$$\sigma_{jk}^2 \sim (1 - \varphi_{jk}^2)^2 n^{-1}$$
$$j = 1,..., m; k = 1,..., s$$

respectively

$$\xi_{jk}^2 \sim (1 - \upsilon_{jk}^2)^2 n^{-1}$$
$$j = 1,..., m; k = 1,..., s$$

and may be used to test the hypotheses of the type H_{jk}: $f_{jk} = \varphi_{jk}$, respectively H_{jk}: $u_{jk} = \upsilon_{jk}$, where φ_{jk} and υ_{jk} are some hypothetical correlations between the variables from V and discriminant functions the P population because the asymptotic distribution of f_{jk} coefficients is

$$f(f_{jk}) \sim N(\phi_{jk}, \sigma_{jk}^2),$$

and the asymptotic distribution of u_{jk} coefficients is

$$f(u_{jk}) \sim N(\upsilon_{jk}, \xi_{jk}^2),$$

where *N* denotes normal distributions.

2.4.2. Reliability, informativeness and significance of discriminant functions

Let

$$\mathbf{V}^2 = (\text{diag } \mathbf{R}^{-1})^{-1}$$

is a diagonal matrix whose elements are unique variance estimates of variables from V. Now, reliability, or, more precisely, generalizability of discriminant functions can be estimated, as demonstrated by Momirović and Zoric (1996), on the basis of the diagonal element values of the matrix

$$\alpha = (\text{diag } (\mathbf{W}^t(\mathbf{R} - \mathbf{V}^2)\mathbf{W}))(\text{diag } (\mathbf{W}^t\mathbf{R}\mathbf{W}))^{-1},$$

relative informativeness based on the elements of the diagonal matrix

$$\iota^2 = (\mathbf{I} - \alpha)^{-1} m^{-1}$$

and redundancy of these functions on the basis of the elements of the diagonal matrix

$$\zeta = \iota^2 \rho.$$

Of course, in making judgments about what is the real meaning of discriminant functions, these data may be of much greater importance than the outcome of significance tests of canonical correlations.

3. Research results and discussion

In kinesiological anthropology the subject of interest is sporting groups, their structure, development and breakup, interaction within the groups, values and motives of the groups, as well as their relations with certain kinesiological (sport) phenomena. When elite sporting groups are concerned, of the greatest importance are, on the one hand, the relations between the group and the quality of individual group members, and, on the other hand, the group and its success in competitions.

Upon entering a sport organization, an athlete must accept certain patterns of behavior, since each sporting group has its own specific patterns of behavior and relationships as well as relationships and processes that characterize it at a given moment. Each sporting group has its own history built by generations of athletes and coaches, as well as its symbols, its rituals and its own style which are a reflection of social relations in the past and at present. An individual has relatively little opportunity for variability in individual behavior, as far as it doesn`t undermine the intergrity and success of the group.

Nevertheless, individuals contribute to dynamic process of social transformation bringing to sport teams a certain personal feature, which, on the one hand, contains social standards of another society, and on the other hand, intellectual (cognitive) abilities and personality (conative) characteristics of each individual, his or her goals, motives, and evaluation. Accordingly, the group dynamics, the nature of relationships and processes, evaluation and motivation of elite sport teams, can not be considered separately, but only, on the one hand, as a result of social determinateness of relationships and processes in elite sport, and on the other hand, relatively independent participation of individuals and groups in the formation of these relationships and processes.

Sport itself is neither good nor bad, it really is what people are engaged in it, whether they that he use it or misuse, because it is a reflection of the time and society, its morality and immorality. In this paper, the specifics of the structure of social variables and their differences with respect to the preferred sporting discipline will be determined.

Motorics, or anthropomotorics, is a system of motor manifestations by means of which a person interacts with his or her environment. This system is generally defined as the ability to move the whole body or its particular parts in space with a certain amplitude, rhythm, direction, intensity, and goal, of course.

Knowing that the number of manifest motor actions, or combinations, is virtually infinite, there is a logical, or even the only possible, orientation on the identification of the motor skill structure as a system which is a base of all these manifestations and which is, in relation to motor manifestations, reasonably reduced and limited to the available number of latent dimensions.

Planned, systematic and program-aimed training causes changes in the anthropological status of athletes. These changes are most frequently manifested in the area of some abilities and characteristics, especially in the field of motor abilities and motor skills. Anthropological characteristics arise, develop and change in quantitative and qualitative terms. Quantitative changes are those changes which are expressed in a space or decrease of an ability efficiency, trait or motor information.

Qualitative changes include changes in the relationship between characteristics. Both types of change are inevitable. It is possible to influence substantially on changes in general by a variety of means and in different ways. So, they are under visible influence of exogenous factors, namely, the influence of the environment on formation and expression of changes in a motor space is very important.

The results of the discriminant analysis of motor variables show that statistically the tested athletes in relation to the preferred sport field differ significantly. Analyzing the values of Table 1 it can be concluded that the agreement of the results between the two groups of athletes of the registered indicators is high. Two significant discriminant functions and two significant canonical correlations (.99 and .82). This suggests an association of the discriminant functions and this is the main indicator of the quantitative structure. The significance of differences between the groups is presented by Wilks`s lambda, and the significance of canonical correlations was tested by means of Bartlett`s X^2 test for each correlation separately.

Table 1 presents the structure of discriminant functions of motor variables which indicates the contribution of each variable in the general centroid distance of the groups.

The first discriminant function is best defined by the tests for estimation of speed, jumping ability, hand segment motion speed, coordination, accuracy, flexibility, and repetitive force. Based on of the values and sign of the group centroid, it can be concluded that these abilities belong to the male dancers.

The second discriminant function is best defined by the tests for the assessment of coordination, static strength, flexibility, segment motion speed, accuracy, and explosive power.

Based on the values and sign of the group centroids, it can be concluded that these abilities belong to the female dancers. If all the data are summed up, it necessarily follows that female dancers are far more versatile in motor skills in relation to the male dancers. That was expected because female dancers perform complex dance movements better and more beautifully than male dancers, therefore athletes have better expressed motor skills mentioned above, (Boli, E., 2011).

DISCRIMINANT ANALYSIS OF MOTOR VARIABLES

Table 1

Func.	Svojstv.vr	% Varian.	Cumula. %
1	50,43	95,2	95,2
2	2,12	4,0	99,2

STRUCTURE OF MOTOR VARIABLES

	FUN1	FUN2
MPSG	,04	,00
MZGP	,73	,39
MPTR	,24*	-,04
M20VS	,23*	-,13
MSVIS	-,17*	,04
MINP	,14*	,06
MISP	,11*	,02
MTAN	-,09*	,03
MS3M	,06*	,05
MGHCR	,04*	,02
MDNL	,03*	,03
MDŠAK	-.33	.58*
MSDM	-.22	.39*
MBMLP	.04	-.31*
MCDŠ	.01	-.25*
MTAR	.04	,17*
MDPK	.06	.11*
MITP	-.09	.09*
MKOOP	.04	-.08*

CENTROIDS GROUP

	FUN1	FUN2
MALE DANCERS	2.17	-.99
FEMALE DANCERS	3.93	1.05

4. Conclusion

The research was conducted in order to determine differences in the structure of motor dimensions with male and female folk dancers.

In order to determine differences in the structure of motor dimensions, 257 male and female dancers, members of Serbian folk dance ensembles were examined.

To estimate motor skills 20 motor tests were used. They were selected according to the structural model designed by Gredelj, Metikoš, Hošek and Momirović in 1975. It was defined as a mechanism for movement structuring, mechanism for functional synergies and tone regulation, mechanism for excitation intensity regulation, and a mechanism for regulation of excitation duration.

All the data in this research were processed at the Center for Multidisciplinary Studies, Faculty of Sports and Physical Education, University of Priština, by the system of software programs for data processing developed by Popović, D. (1980), (1993) and Momirović, K. and Popović, D. (2003).

To determine differences between the male and female folk dancers, a modified method of canonical discriminant analysis in Mahalanobis space.

The algorithms and programs used within this research are presented in full and the results of the programs are analyzed.

The results of the discriminant analysis of motor variables show that statistically the tested athletes in relation to the preferred sport field differ significantly. Analyzing the values of Table 1 it can be concluded that the agreement of the results between the two groups of athletes of registered indicators is high. Two significant discriminant functions and two significant canonical correlations (.99 and .82) were obtained. This suggests an association between discriminant functions and is the main indicator of the quantitative structure. The significance of differences between the groups is presented by Wilks`s lambda, and the significance of canonical correlations was tested by means of Bartlett`s X^2 test for each correlation separately.

Table 1 presents the structure of discriminant functions of motor variables which indicates the contribution of each variable in the general centroid distance of the groups.

The first discriminant function is best defined by the tests for estimation of speed, jumping ability, hand segment motion speed, coordination, accuracy, flexibility, and repetitive force. Based on the values and sign of the centroids of the groups it can be concluded that these abilities belong to the male dancers.

The second discriminant function is best defined by the tests for the assessment of coordination, static strength, flexibility, segment speed, accuracy, and explosive power.

Based on the values and sign of the centroids of the groups it can be concluded that these abilities belong to the female dancers. If all the data are summed up, it necessarily follows that the female dancers are far more versatile in motor skills than the male dancers. This was expected because female dancers perform the complex dance movements better and more beautifully than male dancers, therefore athletes have better expressed motor skills mentioned above, (Boli, E.: 2011).

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Discriminant analysis in space with standard metric

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Summary

The research was conducted in order to determine differences in the structure of motor dimensions with male and female folk dancers. In order to determine differences in the structure of motor dimensions, 257 male and female dancers, members of Serbian folk dance ensembles were examined.To estimate motor skills 20 motor tests were used. They were selected according to the structural model designed by Gredelj, Metikoš, Hošek and Momirović in 1975. It was defined as a mechanism for movement structuring, mechanism for functional synergies and tone regulation, mechanism for excitation intensity regulation, and a mechanism for regulation of excitation duration.All the data in this research were processed at the Center for Multidisciplinary Studies, Faculty of Sports and Physical Education, University

of Priština, by the system of software programs for data processing developed by Popović, D. (1980), (1993) and Momirović, K. and Popović, D. (2003).To determine differences between the male and female folk dancers, a modified method of canonical discriminant analysis in Mahalanobis space.The algorithms and programs used within this research are presented in full and the results of the programs are analyzed. The results of the discriminant analysis of motor variables show that statistically the tested athletes in relation to the preferred sport field differ significantly. Analyzing the values of Table 1 it can be concluded that the agreement of the results between the two groups of athletes of registered indicators is high. Two significant discriminant functions and two significant canonical correlations (.99 and .82) were obtained. This suggests an association between discriminant functions and is the main indicator of the quantitative structure. The significance of differences between the groups is presented by Wilks`s lambda, and the significance of canonical correlations was tested by means of Bartlett`s X^2 test for each correlation separately.Table 1 presents the structure of discriminant functions of motor variables which indicates the contribution of each variable in the general centroid distance of the groups. The first discriminant function is best defined by the tests for estimation of speed, jumping ability, hand segment motion speed, coordination, accuracy, flexibility, and repetitive force. Based on the values and sign of the centroids of the groups it can be concluded that these abilities belong to the male dancers.The second discriminant function is best defined by the tests for the assessment of coordination, static strength, flexibility, segment speed, accuracy, and explosive power.Based on the values and sign of the centroids of the groups it can be concluded that these abilities belong to the female dancers. If all the data are summed up, it necessarily follows that the female dancers are far more versatile in motor skills than the male dancers. This was expected because female dancers perform the complex dance movements better and more beautifully than male dancers, therefore athletes have better expressed motor skills mentioned above,(Boli, E.: 2011).

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Evaluation of thr Physical Fitness test in children and youth with in tellectual disabilities in special Elementary and Secondary school classes

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Background. Earlier studies have demonstrated poor physical fitness outcomes and reduced level of physical activity in children and youth with intellectual disabilities compared with their peers within general population.

Objective. The main aim of this study was to examine how physical fitness developed over time in 4 groups of children and youths: those in upper elementary school classes, and those in special secondary school classes.

Design and Methods. From an initial sample of 129 participants, a group of elementary and secondary school students was grouped in 4 sub-samples, according to class levels. A transversal design was implemented (Cross-sectional), and Test of physical fitness in the four groups was evaluated by measuring different fitness components: explosive strength (jumping, throwing, pushing) running speed, agility, climbing and endurance.

Results. A mixed-effects analysis of variance point out on significant differences among examines groups. Elementary school students in both groups performed less well on all physical fitness measures than the secondary school students.

Conclusions. The differences in physical fitness outcomes between the groups were relatively constant over the time. Given that various physical fitness components are linked to different health outcomes, these consequences are matters of concern for both current health status and later health status in children and youth with intellectual disabilities.

Key Words: PF Test, Children/Youth, Intellectual disability, Motor Development

Introduction

In accordance with the previously established study design in this part of the study the thematic part *"motor development"* in Elementary and Secondary school participants relative to grades/classes was analyzed.

In the first part the basic descriptive statistical parameters (central and dispersive) measures of the Skewness and Kurtosis, relative to the observed variables are presented. Analysis of the within classes differences, relating to the acceptance or rejection of stated hypotheses, regarding the evaluation of estimated results and their application for further consideration, and the estimation of directions and methodological priorities of the data procession, are presented in the second part.

After that the characteristics and homogeneity of every group of the participants relative to the grade/class are defined, and the distance between them is estimated. Finally the graphical presentation of the established results is performed.

Analysis is elaborated on the battery of Physical Fitness Test (PFT), in order to evaluate the motor development in elementary and secondary school participants in 9 items:

(StBJ) standing broad jump, (2S7m) jumping on two feet a distance of 7m, (1S7m) jumping a distance of 7m on one foot, (TenB) throwing a tennis ball with one hand, (MedB) pushing a medicine ball with two hands as far as possible, (Clmb) climbing wall bars, (10X5) shuttle run, (R20m) running 20m as fast as possible, (RCT6) reduced Cooper test.

The sample of 129 participants was divided in 4 sub-samples, according to the grade/class of the Elementary school: (1) grades (V-VI) (n=37), (2) grades (VII-VIII) (n=40), and Secondary school (3) grades (I-II) (n=33), (4) grade (III-IV) (n=19).

Results and interpretation

BASIC STATISTIC PARAMETERS OF MOTOR DEVELOPMENT IN ELEMENTARY AND SECONDARY SCHOOL PARTICIPANTS RELATIVE TO THE GRADE/CLASS

Table 1-2. *Basic statistics and measures of Skewness and Kurtosis of Physical Fitness in Upper Elementary school students [V-VI (n=37); VII-VIII (n=40)]*

(PFT)	Group	Mean	SD	Min	Max	CV%	CI		Skw	Kur	p
StBJ	V-VI	101.65	23.37	27.0	150.0	22.99	93.86	109.44	-.70	1.40	.927
	VII-VIII	109.05	35.94	15.0	178.0	32.96	97.55	120.55	-.18	.33	.444
2S7m	V-VI	5.39	1.52	3.2	8.9	28.30	4.88	5.90	.59	-.42	.419
	VII-VIII	5.37	2.21	2.6	14.1	41.16	4.66	6.08	1.75	4.50	.507
1S7m	V-VI	5.01	1.61	2.8	8.8	32.16	4.47	5.54	1.01	-.01	.029
	VII-VIII	4.36	1.59	2.2	8.3	36.39	3.86	4.87	.61	-.56	.429
TenB	V-VI	13.15	4.75	2.7	23.0	36.14	11.57	14.74	.34	-.40	.502
	VII-VIII	11.75	5.86	3.2	26.4	49.90	9.88	13.63	.86	-.12	.175
MedB	V-VI	4.98	1.34	1.8	8.4	26.79	4.54	5.43	-.25	.69	.945
	VII-VIII	5.43	1.53	1.9	9.1	28.12	4.95	5.92	.24	.45	.957
Clmb	V-VI	20.70	7.80	7.7	50.0	37.71	18.10	23.30	1.04	3.69	.668
	VII-VIII	18.44	12.61	4.0	60.0	68.38	14.41	22.48	2.07	4.11	.022
10X5	V-VI	29.16	3.65	24.7	43.6	12.52	27.94	30.37	2.29	6.41	.044
	VII-VIII	32.95	19.08	22.7	114.5	57.90	26.85	39.06	3.81	13.41	.000
R20m	V-VI	7.45	3.51	4.3	17.5	47.17	6.28	8.62	1.67	2.02	.053
	VII-VIII	8.01	4.95	2.8	18.7	61.76	6.43	9.60	.89	-.58	.058
MCT6	V-VI	659.11	167.02	450.0	1080.0	25.34	603.41	714.81	1.21	1.15	.247
	VII-VIII	655.92	184.15	330.0	1010.0	28.07	597.02	714.83	.02	-.89	.251

Note: *Values of **Skewness** and **Kurtosis** in interval up -.04 to .04 are not interpreted/ discussed*

***Legend (Table 1-2 and Table 3-4): Mean**-mean value; **SD**–standard deviation; **Min**–minimal value; **Max**–maximal value; CV% - coefficient of variation – **CI** (**C**onfidence **I**nterval)–range of mean; **Skw**–skewness; **Kur**–kurtosis; **(PFT)** variables: **StBJ-**standing broad jump (cm); **2S7m-**jumping on 2 feet (s); **1S7m**-Jumping on 1 foot (s); **TenB**-Throwing tennis ball (m); **MedB**-Putting medicine ball (m); **Clmb-**Climbing wall bars (s); **10X5- S**huttle sprint (s); **R20m-**running 20m (s); **MCT6-**Reduced Cooper test (m).*

Minimal (Min) and **maximal** (Max) values of the Physical Fitness Tests in Upper Elementary school students within grades (V-VI) and (VII-VIII) point out that the values are placed in the inspected interval.

Higher values of the **Variation coefficient** (CV%) point at the differences of both (V-VI) and (VII-VIII) grades according to: standing broad jump [StBJ - *(22.99), (32.96)*] jumping on two feet a distance of 7m [2S7m *(28.30), (41.16)*] jumping a distance of 7m on one foot [1S7m *(32.16)*, *(36.39)*] throwing a tennis ball with one hand [TenB *(36.14), (49.90)*] pushing a medicine ball with two hands as far as possible [MedB *(26.79), (28.12)*] climbing wall bars, [Clmb *(37.71), (68.38)*] running 20m, as fast as possible [R20m *(47.17), (61.76)*] reduced Cooper test [MCT6 *(25.34), (28.07)*].

Lower values of **Skewness** (Skw) point out that the distribution is *positive asymmetrical*, which means that the curve of results distribution incline to low values, or has more low values relative to normal distribution at variables: standing broad jump [StBJ *(-.70), (-.18)*] pushing a medicine ball with two hands as far as possible [MedB *(-.25)*]. Reduced Cooper test [MCT6) *(.02)]* has normal distribution.

A higher values of the **Skewness** (skw) point out that the distribution is *negative asymmetrical,* which means that curve of the results distribution inclines to the high values, or has more high values relative to normal distribution in the following variables: jumping on two feet a distance of 7m (2S7m) *(1.75),* jumping a distance of 7m on one foot (1S7m) *(.61),* throwing a tennis ball with one hand (TenB) *(.86),* pushing a medicine ball with two hands as far as possible (MedB) *(.24),* climbing wall bars, (Clmb) *(2.07),* shuttle run (10X5) *(3.81),* running 20 m as fast as possible (R20m) *(.89).*

Higher values of the **Kurtosis** (Kur) point out that the curve is leptosome-type for these variables: standing broad jump [StBJ *(1.40)*, *(.33)*] pushing a medicine ball with two hands as far as possible [MedB *(.69), (.45)*] climbing wall bars, [Clmb *(3.69), (4.11)*] shuttle run [10X5 *(6.41), (13.41)*] running 20m as fast as possible [R20m *(2.02)*] reduced Cooper test [MCT6 *(1.15)*] jumping on two feet a distance of 7m [2S7m *(4.50)*].

Negative values of **Kurtosis** (kur) point on plato-type curve of distribution at these variables: jumping on two feet a distance of 7m [S7m *(-.42)*], throwing a tennis ball with one hand [TenB) *(-.40), (-.12)*] jumping a distance of 7m on one foot [1S7m *(-.56)*] running 20m as fast as possible [R20m *(-.58)*], reduced Cooper test [MCT6 *(-.89)*].

Distribution values are mainly placed in the range of normal distribution (p) in these variables: standing broad jump [StBJ *(.93), (.44)*] jumping on two feet a distance of 7m [2S7m *(.42), (.51)*] throwing a tennis ball with one hand [TenB *(.50) (.17)*], jumping a distance of 7m on one foot [1S7m *(.43)*] pushing a medicine ball with two hands as far as possible [MedB *(.94), (.96)*] climbing wall bars, [Clmb *(.67)*], reduced Cooper test [MCT6 *(.25), (.25)*].

The values distribution declines from the normal distribution (*p)* in these variables: jumping a distance of 7m on one foot [1S7m *(.03)*], shuttle run [10X5 *(.04),* (.00)] climbing wall bars, [Clmb *(.02)*] running 20m as fast as possible [R20m *(.05), (.06)*].

Table 3-4. *Basic statistics and measures of Skewness and Kurtosis of Physical Fitness in Secondary school students [I-II (n=33); III-IV (n=19)]*

(PFT)	Group	Mean	SD	Min	Max	CV%	CI		Skw	Kur	p
StBJ	I-II	135.39	40.86	69.0	205.0	30.18	120.90	149.88	-.17	-1.20	.932
	III-IV	130.05	38.38	74.0	214.0	29.51	111.55	148.56	.52	-.51	.775
2S7m	I-II	3.88	2.09	1.7	13.0	53.83	3.14	4.62	2.88	9.56	.012
	III-IV	3.61	1.24	2.4	7.8	34.35	3.01	4.21	2.10	4.62	.251
1S7m	I-II	3.65	2.11	1.9	13.0	57.71	2.90	4.40	2.86	9.83	.042
	III-IV	3.55	.95	2.0	5.2	26.93	3.09	4.01	.00	-.97	.946
TenB	I-II	20.56	11.32	4.0	40.0	55.07	16.54	24.58	.37	-.86	.860
	III-IV	19.88	5.41	13.0	30.0	27.23	17.27	22.49	.49	-.88	.536
MedB	I-II	7.42	2.23	3.0	13.2	30.04	6.63	8.21	.15	.06	.959
	III-IV	6.65	2.12	2.8	11.0	31.85	5.63	7.67	.26	-.38	.683
Clmb	I-II	12.15	4.23	4.2	23.6	34.82	10.65	13.65	.44	.12	.943
	III-IV	14.37	7.61	4.4	30.4	52.94	10.70	18.04	.68	-.84	.232
10X5	I-II	27.90	4.22	20.6	39.0	15.12	26.41	29.40	.63	-.04	.498
	III-IV	27.56	3.73	23.2	36.7	13.56	25.76	29.36	1.00	.51	.812
R20m	I-II	4.24	1.25	3.1	10.2	29.59	3.79	4.68	3.39	13.73	.058
	III-IV	4.21	.77	3.2	6.3	18.32	3.84	4.58	1.05	1.03	.637
MCT6	I-II	713.82	227.52	132.0	1182.0	31.87	633.13	794.51	-.47	-.08	.515
	III-IV	764.84	128.52	462.0	1056.0	16.80	702.88	826.80	-.21	1.33	.409

Minimal (Min) and M**aximal** (Max) values of variables for the evaluation of Physical Fitness Tests in Secondary school students within group of (I-II) and (III-IV) grades point out that the values are placed in the inspected range/interval.

Higher values of the **Variation coefficient** (CV%) point out on heterogeneity of grades (I-II) and (III-IV) according to: standing broad jump [StBJ *(30.18), (29.51)*] jumping on two feet a distance of 7m [2S7m *(53.83*), *(34.35)*] jumping a distance of 7m on one foot [1S7m *(57.71), (26.93)*] throwing a tennis ball with one hand [TenB *(55.07), (27.23)*] pushing a medicine ball with two hands as far as possible [MedB *(30.04), (31.85)*] climbing wall bars, [Clmb *(34.82),(52.94)*] running 20m as fast as possible [R20m *(29.59)*] reduced Cooper test [MCT6 *(31.87)*] climbing wall bars, crossing over two columns to the right, and down the fourth column as fast as possible [Clmb *(52.94)*].

The values of the **Variation coefficient** (CV%) point out on homogeneity of the variable shuttle run [10X5 *(15.12), (13.56)*] running 20m as fast as possible [R20m *(18.32)*] reduced Cooper test [MCT6 *(16.80*].

Higher values of **Skewness** (skw) point out that the distribution is *negative asymmetrical*, which means that curve of results distribution inclines to the higher values, respectively that it has more of the higher values, relative to normal distribution in these variables: jumping on two feet a distance of 7m [2S7m *(2.88), (2.10)*] jumping a distance of 7m on one foot [1S7m *(2.86)*] throwing a tennis ball with one hand [TenB *(.37), (.49)*] pushing a medicine ball with two hands as far as possible [MedB *(.15), (.26)*] standing broad jump [StBJ *(.52)*] climbing wall bars, [Clmb) *(.44), (.68)*] shuttle run [10X5 *(.63), (1.00)*] running 20m as fast as possible [R20m *(3.39), (1.05)*]. Lower values of the **Skewness** (skw) point out that the distribution is *positive asymmetrical*, which means that the *curve* of the results distribution inclines toward lower values, respectively that has more of the lower values relative to *normal distribution* in: standing broad jump [StBJ *(-.17)*] reduced Cooper test [MCT6 *(-.47), (-.21)*]. Values of the **Skewness** (skw) point out that the distribution is not asymmetrical in: jumping a distance of 7m on one foot [1S7m *(.00)*].

Higher values of the **Kurtosis** (Kur) point out that that *curve* is leptosome-type in: jumping on two feet a distance of 7m [2S7m *(9.56), (4.62)*] jumping a distance of 7m on one foot [1S7m *(9.83)*] pushing a medicine ball with two hands as far as possible [MedB *(.06)*] climbing wall bars, [Clmb *(.12)*] running 20m as fast as possible [R20m *(13.73) (1.03)*] shuttle run [10X5 *(.51)*] reduced Cooper test [MCT6 *(1.33)*]. Negative values of the **Kurtosis** (kur) point out that the *curve* is plato-type in: standing broad jump [StBJ *(-1.20), (-.51)*] throwing a tennis ball with one hand [TenB) *(-.86)*, *(-.88)*] reduced Cooper test [MCT6 *(-.08)*] jumping a distance of 7m on one foot [1S7m *(-.97)*] pushing a medicine ball with two hands as far as possible [MedB *(-.38)*] climbing wall bars, crossing [Clmb *(-.84)*].

The values' distribution is mainly placed in a range of *normal distribution* ***(p)*** in: standing broad jump [StBJ *(.93), (.77)*] throwing a tennis ball with one hand [TenB) *(.86), (.54)*] pushing a medicine ball with two hands as far as possible [MedB *(.96), (.68)*] climbing wall bars, [Clmb *(.94)*, *(.23)*] shuttle run [10X5 (.50), (.81)] reduced Cooper test [MCT6 *(.51)*] jumping on two feet a distance of 7m [2S7m *(.25)*] jumping a distance of 7m on one foot [1S7m *(.95)*] running 20 m as fast as possible [R20m (.64)] reduced Cooper test [MCT6 *(.41)*]'

The values of results distribution decline from *normal distribution* ***(p)*** in: jumping on two feet a distance of 7m [2S7m *(.01)*] jumping a distance of 7m on one foot [1S7m *(.04)*] running 20m as fast as possible [R20m *(.06)*].

Discussion

ANALYSIS OF THE BETWEEN GRADES DIFFERENCES IN PHYSICAL FITNESS TEST WITHIN UPPER ELEMENTARY AND SECONDARY SCHOOL STUDENTS

In this part of study the procedure in regard to the acceptance or rejection of the statements that there are evidently significant between grades differences, relative to the motor development in elementary and secondary school participants has to be provided.

Table 5. *Significance of the between grades difference in Physical Fitness Test of the Upper Elementary and Secondary school students*

Analysis	**n**	**F**	**p**
MANOVA	9	3.736	.000
DISCRA	9	4.044	.000

Legend: MANOVA – *Multivariate Analysis of Variance;* DISCRA – *Discriminative analysis*; **n –** *number of variables*; **F-***ratio****;*** **p -** *probability*

On the bases of the p = .000 value of (MANOVA) and p = .000 of (DISCRA) analyses, hypothesis H_1 and hypothesis H_2 has to be rejected and an alternative hypothesis $A_{1,}$ as well as A_2 have to be accepted which means that there are evidently significant between grades differences and clearly defined range of the Upper Elementary and Secondary school students.

Table 6. *Significance of the between-grades differences in Physical Fitness Tests in Upper Elementary and Secondary school students*

(PFT)	**F**	**p**	**c.disc**
StBJ	7.123	.000	.059
2S7m	7.592	.000	.048
1S7m	5.108	.002	.068
TenB	12.121	.000	.090
MedB	13.245	.000	.245
Clmb	6.223	.001	.023
10X5	1.686	.173	.050
R20m	11.115	.000	.245
MCT6	2.007	.116	.000

Legend: (PFT) *variables:* ***StBJ-****standing broad jump (cm);* ***2S7m-****jumping on 2 feet (s);* ***1S7m****-Jumping on 1 foot (s);* ***TenB****-Throwing tennis ball (m);* ***MedB****-Putting medicine ball (m);* ***Clmb-****Climbing wall bars (s);* ***10X5- S****huttle sprint (s);* ***R20m-****running 20m (s);* ***MCT6-*** *Reduced Cooper test (m);* ***c.disc*** *- discriminative coefficient*

While is ***(p<.1)*** an alternative hypothesis A_3 has to be accepted, which means that significant differences among some groups of grades exists in: standing broad jump *(.000),* jumping on two feet a distance of 7m *(.000),* jumping a distance of 7m on one foot *(.002),* throwing a tennis ball with one hand *(.000),* pushing a medicine ball with two hands as far as possible *(.000),* climbing wall bars *(.001),* running 20m as fast as possible *(.000).* While is ***(p>.1)*** there is no reason not to accept hypothesis $H_{3,}$ which means that there are no significant between grades differences in Upper Elementary and Secondary school students in: shuttle run *(.173),* and reduced Cooper test *(.116).* The Discrimination Coefficient points out that the highest contribution to the between grades discrimination (the highest differences) in Upper Elementary and Secondary school students relative to Physical Fitness Tests is as follows: pushing a medicine ball with two hands as far as possible *(.245),*running 20m as fast as possible *(.245),* throwing a tennis ball with one hand *(.090),* jumping a distance of 7m on one foot *(.068),* standing broad jump *(.059),* shuttle run *(.050),* jumping on two feet a distance of 7m *(.048),* climbing wall bars *(.023),* reduced Cooper test (.000).

It must be noted, that those latent variables, where between grades differences are not estimated, apart from the discriminative, which point at the structure with significant between grades differences, are: shuttle run *(.173),* reduced Cooper test *(.116).*

CHARACTERISTICS AND HOMOGENEITY OF THE GRADES, RELAVIVE TO THE PHYSICAL FITNESS TEST OF UPPER ELEMENTARY AND SECONDARY SCHOOL STUDENTS

On the bases of the presented consideration and analysis of the total sample of 129 participants, and in accordance with the applied methodology, logical order of the research is estimation of characteristics and homogeneity for every grade of Elementary and Secondary school participants and distance between them. The fact that is **(p=.000)** of the discriminative analysis means that clearly defined range between different grades of participants exists, respectively it is possible to establish the characteristics of every grade, relative to motor development in elementary and secondary school children. In ***standing broad jump*** (StBJ) is evident that *grade-1* and *grade-3* differ, while (p=.000), and *mean* (101.649cm) of the grade-1 is lower then *mean* (135.394cm) of the grade-3. Same applies for the elementary and secondary school participants in: ***standing broad jump*** between *grade-1* and *grade-4* (.007), *mean* (101.649) is lower then (130.053), ***standing broad jump*** between *grade-2* and *grade-3* (.005) *mean* (109.050) is lower then (135.394). In **jumping on two feet a distance of 7m** (2S7m) difference between *grade-1* and *grade-3* (.001) is evident, while *mean* (5.389) of the grade-1 is higher then (3.876) of the grade-3. The same applies for the evaluation of participants in **jumping on two feet a distance of 7m** between *grade-1* and *grade-4* (.000), *mean* (5.389) is higher then (3.609), **jumping on two feet a distance of 7m** between *grade-2* and *grade-3* (.004) *mean* (5.370) is higher then (3.876). In **jumping a distance of 7m on one foot** (1S7m) the difference between *grade-1* and *grade-2* (.082) is evident, while *mean* (5.005) of the grade-1 is higher then (4.363) of the grade-2. The same applies for the evaluation of participants in **jumping a distance of 7m on one foot** between *grade-1* and *grade-3* (.003), while *mean* (5.005) is higher then (3.650), and **jumping a distance of 7m on one foot** between *grade-1* and *grade-4* (.001), while *mean* (5.005) is higher then (3.546).

Table 7a. *Between-grades difference in PFT among Children and Youth*

PFT	sub-samples		Mean		t	p
StBJ	grade-1	grade-3	101.649	135.394	4.175	.000
StBJ	grade-1	grade-4	101.649	130.053	2.956	.007
StBJ	grade-2	grade-3	109.050	135.394	2.930	.005
StBJ	grade-2	grade-4	109.050	130.053	2.052	.045
2S7m	grade-1	grade-3	5.389	3.876	3.429	.001
2S7m	grade-1	grade-4	5.389	3.609	4.392	.000
2S7m	grade-2	grade-3	5.370	3.876	2.947	.004
2S7m	grade-2	grade-4	5.370	3.609	3.230	.002
1S7m	grade-1	grade-2	5.005	4.363	1.762	.082
1S7m	grade-1	grade-3	5.005	3.650	3.043	.003
1S7m	grade-1	grade-4	5.005	3.546	3.627	.001
1S7m	grade-2	grade-4	4.363	3.546	2.066	.043

Legend: (Table 7a,b): PFT - *variables:* ***StBJ-****standing broad jump (cm);* ***2S7m-****jumping on 2 feet (s);* ***1S7m****-Jumping on 1 foot (s);* ***TenB****-Throwing tennis ball (m);* ***MedB****-Putting medicine ball (m);* ***Clmb-****Climbing wall bars (s);* ***10X5- S****huttle sprint (s);* ***R20m-****running 20m (s);* ***MCT6-****Reduced Cooper test (m).*

Table 7b. *Between-grades difference in PFT among Children and Youth*

TenB	grade-1	grade-3	13.152	20.560	3.494	.001
TenB	grade-1	grade-4	13.152	19.879	4.783	.000
TenB	grade-2	grade-3	11.752	20.560	4.044	.000
TenB	grade-2	grade-4	11.752	19.879	5.094	.000
MedB	grade-1	grade-3	4.983	7.420	5.467	.000
MedB	grade-1	grade-4	4.983	6.647	3.123	.005
MedB	grade-2	grade-3	5.435	7.420	4.343	.000
MedB	grade-2	grade-4	5.435	6.647	2.507	.015
Clmb	grade-1	grade-3	20.699	12.150	5.599	.000
Clmb	grade-1	grade-4	20.699	14.373	2.896	.005
Clmb	grade-2	grade-3	18.444	12.150	2.739	.008
R20m	grade-1	grade-3	7.447	4.238	4.970	.000
R20m	grade-1	grade-4	7.447	4.208	3.954	.000
R20m	grade-2	grade-3	8.014	4.238	4.267	.000
R20m	grade-2	grade-4	8.014	4.208	3.318	.002
MCT6	grade-1	grade-4	659.108	764.842	2.413	.019

Table 8. *Characteristics and homogeneity of the different clases of Upper Elementary and Secondary school students, relative to (PFT) variables*

(PFT)	**grade (V-VI)**	**grade (VII-VIII)**	**grade (I-II)**	**grade (III-IV)**	**ctr %**
	Upper Elementary School Classes		Secondary School Classes		
MedB	the lowest	lower	the highest* 2	higher* 2	29.589
R20m	higher* 2	the highest* 2	lower	the lowest	29.589
TenB	lower	the lowest	the highest* 2	higher* 2	10.870
1S7m	the highest* 3	higher* 1	lower	the lowest	8.213
StBJ	the lowest	lower	the highest* 2	higher* 2	7.126
10X5	higher	the highest	lower	the lowest	6.039
2S7m	the highest* 2	higher* 2	lower	the lowest	5.797
Clmb	the highest* 2	higher* 1	the lowest	lower	2.778
MCT6	lower	the lowest	higher	the highest* 2	.000
n/m	23/37	26/40	28/33	17/19	
hmg%	62.16	65.00	84.85	89.47	

Legend: hmg% - homogeneity; ctr % - contribution of the variable to the grade's characteristics; ***(PFT)*** *variables:* ***StBJ****-standing broad jump (cm);* ***2S7m****-jumping on 2 feet (s);* ***1S7m****-Jumping on 1 foot (s);* ***TenB****-Throwing tennis ball (m);* ***MedB****-Putting medicine ball (m);* ***Clmb****-Climbing wall bars (s);* ***10X5- S****huttle sprint (s);* ***R20m****-running 20m (s);* ***MCT6****-Reduced Cooper test (m).*

Eigenvalue of every sub-sample of the **grade** is the highest defined with (MedB) *pushing a medicine ball with two hands as far as possible,* while the variable contribution to the characteristics is (29.59%) followed by: (R20m) *running 20m as fast as possible* (29.59%), (MedB) *throwing a tennis ball with one hand* (10.87%), (1S7m) *jumping a distance of 7m on one foot* (8.21%), (StBJ) *standing broad jump* (7.13%), (10X5m) *shuttle run* (6.04%), (2S7m) *jumping on two feet a distance of 7m* (5.80%), (Clmb) *climbing wall bars, crossing over two columns to the right, and down the fourth column as fast as possible* (2.78%) and (MCT6) *reduced Cooper test* (.00%). Homogeneity, within grade (V-VI) is 62.16%, within grade (VII-VIII) is 65.00%, within grade (I-II) is 84.85%, and within grade (III-IV) is 89.47%.

On the bases of presented data it is possible to say that characteristics of grade (V-VI) have 23/37 participants, homogeneity is 62.2 % (higher), which means that 14 participants have other characteristics, not those of their own group, and characteristics of grade (VII-VIII) have 26/40 participants, homogeneity is 65.0 % (higher) while 14 participants have other characteristics.

Characteristics of grade (I-II) have 28/33 participants, homogeneity is 84.8% (higher) while only 5 participants have other characteristics, also that characteristics of the grade (III-IV) have 17/19 participants, homogeneity is 89.5% (higher) while only 2 participants have other characteristics.

This means that participants whose characteristics are similar to those characteristics of grade (V-VI), and their grade orientation is anonymous, it is possible to expect with the confidence of 62.2 % that they belong to the grade (V-VI), respectively it is possible to estimate the prognosis with certain probability/confidence.

On the bases of the participants' motor development evaluation in elementary and secondary school the following statements are possible, relative to grades:

- **grade (V-VI)** has these Eigenvalues for: (MedB) pushing a medicine ball with two hands as far as possible is *the lowest*, for (R20m) running 20m as fast as possible is *Higher*[2]*, for (TenB) throwing a tennis ball with one hand is *lower*, for (1S7m) jumping a distance of 7m on one foot is *the highest*[3]*, for (StBJ) standing broad jump is *the lowest*, for (10X5m) shuttle run is *Higher*, for (2S7m) jumping on two feet a distance of 7m is *the highest*[2]*, for (Clmb) climbing wall bars is *the highest*[2]*, for (MCT6) reduced Cooper test is *lower*.

- **grade (VII-VIII)** has Eigenvalues for: (MedB) pushing a medicine ball with two hands as far as possible is *lower*, for (R20m) running 20 m as fast as possible is *the highest*[2]*, for (TenB) throwing a tennis ball with one hand is *the lowest*, for (1S7m) jumping a distance of 7m on one foot is *Higher*[1]*, for (StBJ) standing broad jump is *lower*, for (10X5m) shuttle run is *the highest*,

for (2S7m) jumping on two feet a distance of 7m is *Higher*[2]*, for (Clmb) climbing wall bars is *Higher*[1]*, for (MCT6) reduced Cooper test is *the lowest*.

- **grade (I-II)** have Eigenvalues for: (MedB) pushing a medicine ball with two hands as far as possible is *the highest*[2]*, for (R20m) running 20m as fast as possible is *lower*, for (TenB) throwing a tennis ball with one hand is *the highest*[2]*, for (1S7m) jumping a distance of 7m on one foot is *lower*, for (StBJ) standing broad jump is *the highest*[2]*, for (10X5m) shuttle run is *lower*,

for (2S7m) jumping on two feet a distance of 7m is *lower*, for (Clmb) climbing wall bars is *the lowest*, for (MCT6) reduced Cooper test is *Higher*.

- **grade (III-IV)** have Eigenvalues for: (MedB) pushing a medicine ball with two hands as far as possible is *Higher*[2]*, for (R20m) running 20m as fast as possible is *the lowest*, for (TenB) throwing a tennis ball with one hand is *Higher*[2]*, for (1S7m) jumping a distance of 7m on one foot is *the lowest*, for (StBJ) standing broad jump is *Higher*[2]*, for (10X5m) shuttle run is *the lowest*, for (2S7m) jumping on two feet a distance of 7m is *the lowest*, for (Clmb) climbing wall bars is *lower*, for (MCT6) reduced Cooper test is *the highest*[2]*.

Table 9. *Mahalanobis Distance in between-grades differences of Upper Elementary and Secondary school students, relative to (PFT) variables*

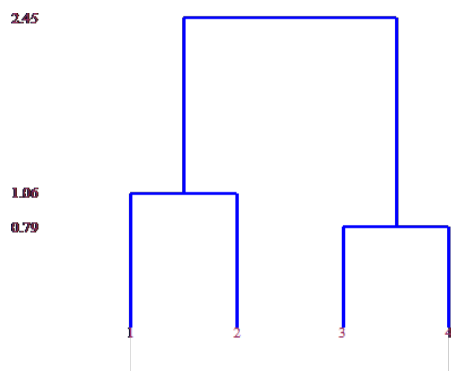
Elementary - **S**econdary	grade (V-VI)	grade (VII-VIII)	grade (I-II)	grade (III-IV)
grade (V-VI)	.00	1.06	1.96	1.51
grade (VII-VIII)	1.06	.00	1.92	1.69
grade (I-II)	1.96	1.92	.00	.79
grade (III-IV)	1.51	1.69	.79	.00

Calculating of the Mahalanobis distance between different grades of participants gave another single indicator of the similarity/closest or difference/distance. The distance of the different segments can be compared. The distance (Table 16) point out the lowest distance between grades: grade (III-IV) and grade (I-II) (.79) (moderate) and the highest distance is for grade: (I-II) and grade (V-VI) (1.96) (higher).

Table 10. *Grouping of the grades/classes relative to Physical Fitness Test in Upper Elementary and Secondary school students*

level	Closeness/distance
(3) grade (I-II), (4) grade (III-IV)	.79
(1) grade (V-VI), (2) grade (VII-VIII)	1.06
(1) grade (V-VI), (3) grade (I-II)	2.45

On the bases of presented data in Tab. 10, and dendogram it is evident that the closest are grades (I-II) and grades (III-IV) of the Secondary school students with the distance of (.79), and the highest difference is between group of upper elementary school grade (V-VI) and secondary school grade (I-II), with the distance of (2.45).

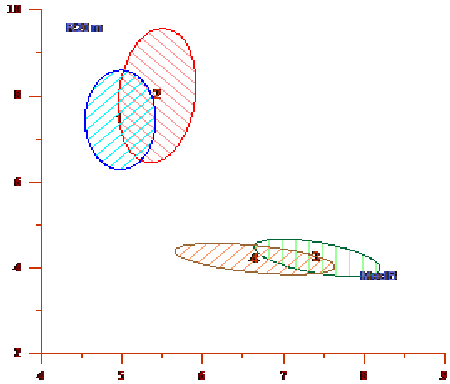


Legend: grade (V-VI) (1) grade (VII-VIII) (2) grade (I-II) (3) grade (III-IV) (4)

THE GRAPHICAL PRESENTATION OF BETWEEN GRADE DIFFERENCES, RELATIVE TO 3 THE MOST DISCRIMINATIVE VARIABLES OF MOTOR DEVELOPMENT IN ELEMENTARY AND SECONDARY SCHOOL PARTICIPANTS

On the bases of graphical presentation of ellipses (confidence interval) the scope illustrates mutual position and characteristics of participants in every of 4 grades of Elementary: **(1) grade (V-VI), (2) grade (VII-VIII), and Secondary School (3) grade (I-II), (4)**, **grade (III-IV),** relative to 3 (three) the most discriminative (variables) of motor development in: pushing a medicine ball with two hands as far as possible (MedB), running 20m as fast as possible (R20m), throwing a tennis ball with one hand (TenB).

Graph 1. *Ellipses (confidence interval) of the participants in variables: (MedB) and (R20m)in different grades*

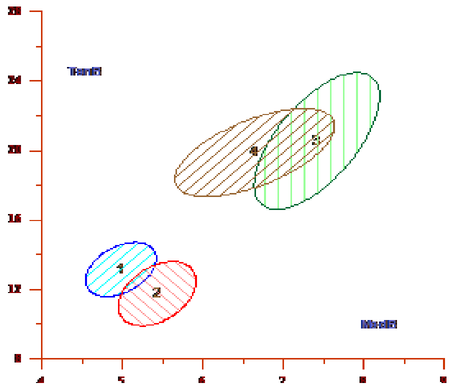


Legend: *grade (V-VI) (1); grade (VII-VIII) (2); grade (I-II) (3); grade (III-IV) (4);; pushing a medicine ball with two hands as far as possible (MedB); running 20m as fast as possible (R20m)*

On the Graph (1) abscise (horizontal axe) is pushing a medicine ball with two hands as far as possible (MedB), and ordinate (vertical axe) is running 20m as fast as possible (R20m).

It is possible to observe that variable **pushing a medicine ball with two hands as far as possible,** within grade (V-VI) (1) has the lowest value, relating to the evaluation of the motor development in elementary school children, and the highest value is in grade (I-II) of secondary school children (3). Observing variable **running 20m as fast as possible, within** grade (III-IV) (4) have the lowest value relating to the evaluation of the motor development in secondary school children, and the highest value is estimated within grade (VII-VIII) in elementary school participants (2).

Graph 2. *Ellipses (confidence interval), of the participants in variables: (MedB) and (TenB) in different grades*



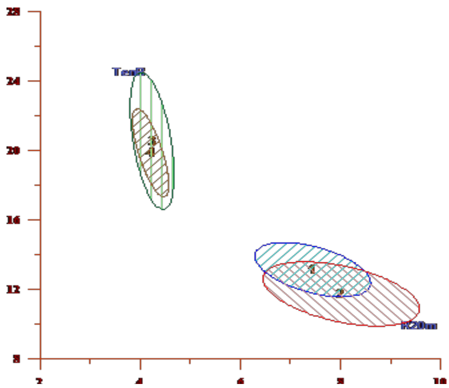
Legend: *grade (V-VI) (1); grade (VII-VIII) (2); grade (I-II) (3); grade (III-IV) (4);; pushing a medicine ball with two hands as far as possible (MedB); throwing a tennis ball with one hand (TenB)*

On the Graph (2) abscise (horizontal axe) is pushing a medicine ball with two hands as far as possible (MedB), and ordinate (vertical axe) is throwing a tennis ball with one hand (TenB).

It is possible to observe that variable **pushing a medicine ball with two hands as far as possible,** within grade (V-VI) (1) have the lowest value, relating to the evaluation of motor development in elementary school children, and the highest value is in grade (I-II) of secondary school children (3).

Observing variable **throwing a tennis ball with one hand,** grade (VII-VIII) (2) have the lowest value relating to the evaluation of motor development in elementary school children, and the highest value is in grade (I-II) of secondary school children (3).

Graph 3. *Ellipses (confidence interval), of the participants in variables (R20m) and (TenB) in different grades*

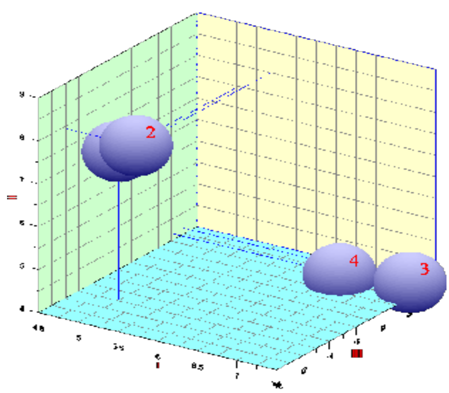


Legend: *grade (V-VI) (1); grade (VII-VIII) (2); grade (I-II) (3); grade (III-IV) (4);; running 20 m as fast as possible (R20m); throwing a tennis ball with one hand (TenB)*

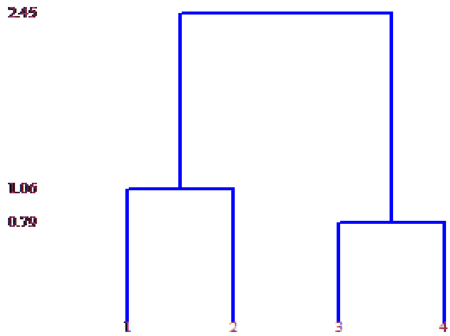
On the Graph (3) abscise (horizontal axe) is running 20m as fast as possible (R20m), and ordinate (vertical axe) is throwing a tennis ball with one hand (TenB).

It is possible to observe that variable **running 20m as fast as possible,** within grade (III-IV) (4) has the lowest value, relating to the evaluation of motor development in secondary school children, and the highest value has grade (VII-VIII) in elementary school participants (2). Observing variable **throwing a tennis ball with one hand,** within grade (VII-VIII) (2) participants of elementary school have the lowest value relating to the evaluation of motor development, and the highest value is estimated within grade (I-II) of secondary school children (3).

Graph 4. Three dimensional presentation of the distance/closeness of the different grade-levels of upper elementary and secondary school students



Legend: grade (V-VI) (1) grade (VII-VIII) (2) grade (I-II) (3) grade (III-IV) (4)

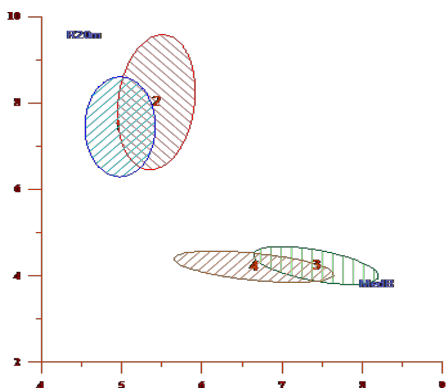


Legend: grade (V-VI) (1) grade (VII-VIII) (2) grade (I-II) (3) grade (III-IV) (4)

THE GRAPHICAL PRESENTATION OF BETWEEN GRADE DIFFERENCES, RELATIVE TO 3 THE MOST DISCRIMINATIVE VARIABLES OF MOTOR DEVELOPMENT IN ELEMENTARY AND SECONDARY SCHOOL PARTICIPANTS

On the bases of graphical presentation of ellipses (confidence interval) the scope illustrates mutual position and characteristics of participants in every of 4 grades of Elementary: **(1) grade (V-VI), (2) grade (VII-VIII), and Secondary School (3) grade (I-II), (4)**, **grade (III-IV),** relative to 3 (three) the most discriminative (variables) of motor development in: pushing a medicine ball with two hands as far as possible (MedB), running 20m as fast as possible (R20m), throwing a tennis ball with one hand (TenB).

Graph 4. *Ellipses (confidence interval), of the participants in variables – (MedB) and (R20m) of different grades*

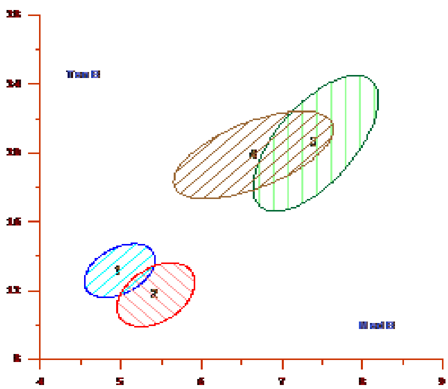


Legend: *grade (V-VI) (1); grade (VII-VIII) (2); grade (I-II) (3); grade (III-IV) (4);; pushing a medicine ball with two hands as far as possible (MedB); running 20m as fast as possible (R20m)*

On the Graph (4) abscise (horizontal axe) is pushing a medicine ball with two hands as far as possible (MedB), and ordinate (vertical axe) is running 20m as fast as possible (R20m).

It is possible to observe that variable pushing a medicine ball with two hands as far as possible, within grade (V-VI) (1) has the lowest value, relating to the evaluation of the motor development in elementary school children, and the highest value is in grade (I-II) of secondary school children (3). Observing variable running 20m as fast as possible, within grade (III-IV) (4) have the lowest value relating to the evaluation of the motor development in secondary school children, and the highest value is estimated within grade (VII-VIII) in elementary school participants (2).

Graph 5. *Ellipses (confidence interval), of the different participants in variables (MedB) and (TenB) in different grades*



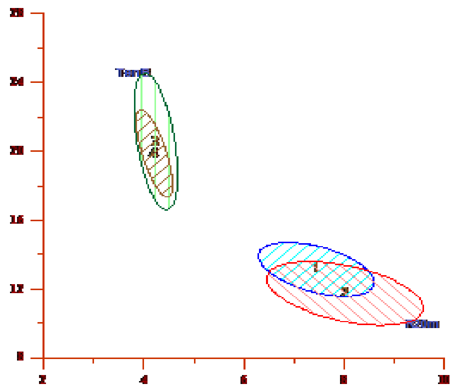
Legend: *grade (V-VI) (1); grade (VII-VIII) (2); grade (I-II) (3); grade (III-IV) (4);; pushing a medicine ball with two hands as far as possible (MedB); throwing a tennis ball with one hand (TenB)*

On the Graph (5) abscise (horizontal axe) is pushing a medicine ball with two hands as far as possible (MedB), and ordinate (vertical axe) is throwing a tennis ball with one hand (TenB).

It is possible to observe that variable **pushing a medicine ball with two hands as far as possible,** within grade (V-VI) (1) have the lowest value, relating to the evaluation of motor development in elementary school children, and the highest value is in grade (I-II) of secondary school children (3).

Observing variable **throwing a tennis ball with one hand,** grade (VII-VIII) (2) have the lowest value relating to the evaluation of motor development in elementary school children, and the highest value is in grade (I-II) of secondary school children (3).

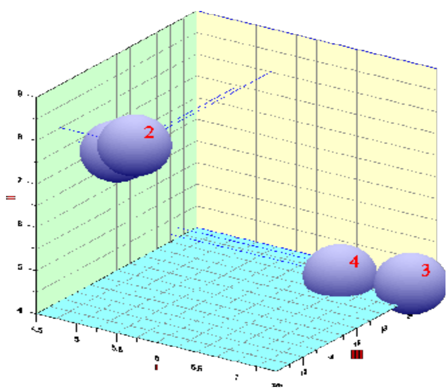
Graph 6. *Ellipses (confidence interval), of the participants in variables: (R20m) and (TenB) in different grades*



Legend: *grade (V-VI) (1); grade (VII-VIII) (2); grade (I-II) (3); grade (III-IV) (4);; running 20 m as fast as possible (R20m); throwing a tennis ball with one hand (TenB)*

On the Graph (6) abscise (horizontal axe) is running 20m as fast as possible (R20m), and ordinate (vertical axe) is throwing a tennis ball with one hand (TenB). It is possible to observe that variable **running 20m as fast as possible,** within grade (III-IV) (4) has the lowest value, relating to the evaluation of motor development in secondary school children, and the highest value has grade (VII-VIII) in elementary school participants (2). Observing variable **throwing a tennis ball with one hand,** within grade (VII-VIII) (2) participants of elementary school have the lowest value relating to the evaluation of motor development, and the highest value is estimated within grade (I-II) of secondary school children (3).

Graph 7. *Three dimensional presentation of the distance/closeness of the different IQ maturity sub-categories in motor development estimated with Physical Fitness Test (PFT)*



Legend: grade (V-VI) (1) grade (VII-VIII) (2) grade (I-II) (3) grade (III-IV) (4)

Final considerations

Evaluating motor development in elementary and secondary school participants with intellectual disabilities MANOVA (.00) and DISCRA (.000) point out that significant ***grade-level*** differences exist among 4 groups of grades/classe, relating to the following Physical Fitness Test variables: Standing broad jump (.000), Jumping on two feet a distance of 7m (.000), Jumping a distance of 7m on one foot (.002), Throwing a tennis ball with one hand (.000), Pushing a medicine ball with two hands (.000), Climbing wall bars (.001), Running 20m as fast as possible (.000). Differences are not estimated at: Shuttle run (.173), Reduced Cooper test (.116).

Order of discrimination: Pushing a medicine ball with two hands (.245), Running 20m as fast as possible (.245), Throwing a tennis ball with one hand (.090), Jumping a distance of 7m on one foot (.068), Standing broad jump (.059), Shuttle run (.050), Jumping on two feet a distance of 7m (.048), Climbing wall bars (.023), Reduced Cooper test (.000).

Referencess

Popović, Miloš (2011). *The Evaluation of Motor Development in Elementary and Secondary School Children with Intellectual Disabilities*. Unpublished master thesis, Palacky University in Olomouc: Faculty of Physical Culture (Chech Republic).

Complete List** of ***References is on disposal complimentary, by copy request to the leading author

Note:

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Lowest limit measures of reliability of tests with a particle covariance matrix in determination of the stucture of conative dimensions of selected volleyball players

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Abstaract

Hypothesis 2

Coefficients β_π vary in the range of (0,1), but they cannot reach value 1.

Proof:

If **P** = **I**, then also $\mathbf{Y}^2 = \mathbf{I}$, so that all coefficients β_π equal zero. However, as $\mathbf{Y}^2 = \mathbf{0}$ is not possible if matrix **P** is regular, all coefficients β_π are necessarily less than 1 and tend towards 1when unique variance of variables from which latent dimensions are deduced inclines towards zero.

By means of the same technique it is easy to determine measures of absolute low limit of reliability of latent dimensions defined by this procedure the same way Guttman determined his measure λ_1. For that purpose, we will assume that $\mathbf{E}^2 = \mathbf{I}$. In that case

$$\alpha_p = 1 - (\mathbf{q}_p{}^t\mathbf{R}\mathbf{q}_p)^{-1}$$

will be measures of absolute low limit of reliability of latent dimensions, as, obviously, $\mathbf{\Theta}^t\mathbf{\Theta} = \mathbf{I}$.

Key words: /variance/ matrix/ variable /universe /latent/ dimension

1. Introduction

The fact is that human organism is very complex, dynamic and hierarchically organized system, the abilities and characteristics of which depend, at first on the process of reception, retention and processing of information. This further conditions the necessity to explore the problems of structure, functioning and conducting of certain segments of anthropological status in an integral and interactive way.

Applied to sport i.e. sport activities, this knowledge conditions the assessment of specific demands in order to continue the process of transformation or to influence the improvement of exactly those characteristics of students and players in specific conditions of competitions on which the highest level of sport success depends. Before mentioned demands come from the fact that each sport game, apart from the general and common characteristics, contains its specific characteristics.

Anthropological status of a person is determined by the following characteristics: morphological characteristics, functional capabilities, motor abilities, cognitive abilities, conative characteristics and social characteristics.

Thus, it is necessary to establish methods of determining inheritance factors as the most influential ones for developing human abilities and, based on this, first set the rules for selection in certain sports and then foresee success in certain sports' disciplines. It is necessary to determine their morphological, functional, motor, cognitive, conative and social structure which, as a general anthropological status, benefits sports' results (Petković, 2008).

Considering that in each sport and sport games there are certain exclusive characteristics and differences in their competition structure, there emerges the need to continually and practically explore and confirm these exclusive characteristics, and especially certain anthropological abilities and characteristics which are genetically conditioned, then their hierarchical values in sport games as well as their structure and development under the influence of particular training processes, methods and loads.

Recently, and especially in the last twenty years, very serious efforts to reduce disarray in volleyball training have been made and it has been attempted to transform it into an organized system which could be more successfully included in contemporary sport practice.

2. Methods

2.1. Sample of subjects

Sample of subjects depended on organizational and financial resources required for the research. Sufficient number of qualified and trained personnel performing measurements, defined instruments and standardized conditions of the research planned were provided. Measurements were performed on the sample which is representative for the whole Republic of Serbia.

-subjects were male

-age was defined on the basis of chronological age, so that the research was performed on subjects from 18 to 27 years of age plus-minus 0.5 years

-subjects were registered players of the national competition rank (two highest levels of competition)

-subjects had regular trainings, which was confirmed by evidence kept by coaches

-we chose a sample of 100 subjects based on statistical-mathematical model and program, aims set by hypotheses.

No other exclusion criteria or stratification variables were used in defining of the population from which the sample of subjects was taken apart from the listed ones.

2.2 Sample of the variables

SAMPLE OF THE VARIABLES FOR EVALUATION OF CONATIVE CHARACTERISTICS

For the assessment of conative characteristics, the measuring instrument CON6 was chosen which assesses the following conative regulators:

- activity regulator (EPSILON),

- regulator of organ functions (HI),
- regulator of defense reactions (ALFA),
- regulator of attack reactions (SIGMA),
- system for coordinating regulatory functions (DELTA) and
- system for integration of regulatory functions (ETA).

2. 3. Methods of processing of the results

Value of a research does not depend only on the sample of subjects and the sample of variables, that is on value of basic information, but also on the applied procedures for transformation and condensation of those information. Some scientific problems can be solved by multiple different and sometimes equally trustworthy methods. However, with the same basic data and based on results of different methods, different conclusions can be drawn. Therefore the problem of selection of particular methods for data processing is rather complex.

In order to reach satisfactory scientific solutions, the research was based on, primarily acceptable, adequate, unbiased and comparable procedures, which were appropriate to the nature of the problem posed and which enabled extraction and transformation of appropriate dimensions, hypotheses testing of those dimensions, defining differences, relations, prognosis and diagnosis, as well as definition of principles within the research field.

Taking all this into account, for the purpose of this research we chose procedures which are considered to be appropriate to the nature of the problem which do not impose too severe restrictions on the basic information.

If ξ^2 is variance of any defined total result, if τ^2 is variance of thus defined accurate result, and if ε^2 is variance of measurement deviation of some composite measurement instrument.

As

$$\mathbf{G}^t\mathbf{E} = \mathbf{U}^2 - \mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2$$

Is for tests with regular, and

$$\mathbf{G}^t\mathbf{E} = \mathbf{U}^2 - \mathbf{U}^2\mathbf{R}^{-}\mathbf{U}^2$$

For tests with singular matrices of particle covariance, two theoretical definitions of reliability,

$$\alpha_1 = \tau^2\sigma^{-2}$$

and

$$\alpha_2 = 1 - \varepsilon^2\sigma^{-2}$$

are not equivalent when it comes to the measurement model based on Guttman image theory.

Let us first consider λ_6 measurements (Guttman, 1945) defined by functions α_1 i α_2. For the result defined by function **b**, those measures will be

$$\lambda_{61} = \eta^2\sigma^{-2},$$

and

$$\lambda_{62} = 1 - \theta^2\sigma^{-2}.$$

β_6 measure types (Momirović, 1996) defined by functions α_1 i α_2 for the result defined by function **h** will be

$$\beta_{61} = \gamma^2\lambda^{-2}$$

and

$$\beta_{62} = 1 - \delta^2\lambda^{-2}.$$

It is not hard to prove that for regular particle clusters α_1 measure types of the estimated low limit of reliability of λ_6 i β_6 measure types, and that $\alpha_2$measure types are estimates of high level of reliability of λ_6 i β_6 measure types.

Hypothesis 1

Coefficients γ_π vary in the range (0,1) and can reach value 1 only if **P** = **I**, if all the variables are measured correctly, and value 0 only if both **P** = **0** and **P** = **I**, that is if the entire variance of all variables consists only of variance of measurement deviation, and variables from V have spherical normal distribution.

Proof:

If the whole variance of each variable from some variable cluster consists only of variance of measurement deviation, then $\mathbf{E}^2 = \mathbf{I}$ and **P** = **I**, so all coefficients γ_π equal zero. The first part of hypothesis is obvious from the definition of coefficient γ_π; this means that reliability of each latent dimension, regardless of how that latent dimension was determined, equals 1 if all variables from which the dimension was deduced were measured correctly.

However, reliability coefficient matrix P = (ρ_j) is frequently unknown, so that matrix of measurement deviation variance $\mathbf{E}^2$ is also unknown. But, if variables from V are selected to represent some range of U variables with the same array of importance, high limit of measurement deviation variances is defined by elements of $\mathbf{U}^2$ matrix (Guttman, 1945, 1953), that is by unique variances of those variables. This is why, in that case, low limit of reliability of latent dimensions can be estimated by coefficient

$$\beta_p = 1 - (\mathbf{q}_p{}^t\mathbf{U}^2\mathbf{q}_p)(\mathbf{q}_p{}^t\mathbf{R}\mathbf{q}_p)^{-1} \qquad p = 1,...,k$$

which were reached by the procedure identical to the one used for reaching coefficients γ_π with definition of $\mathbf{E}^2 = \mathbf{Y}^2$, that is the same way Guttman reached his measure λ_6 .

Hypothesis 2

Coefficients β_π vary in the range of (0,1), but they cannot reach value 1.

Proof:

If $\mathbf{P} = \mathbf{I}$, then also $\mathbf{Y}^2 = \mathbf{I}$, so that all coefficients β_π equal zero. However, as $\mathbf{Y}^2 = \mathbf{0}$ is not possible if matrix $\mathbf{P}$ is regular, all coefficients β_π are necessarily less than 1 and tend towards 1when unique variance of variables from which latent dimensions are deduced inclines towards zero.

By means of the same technique it is easy to determine measures of absolute low limit of reliability of latent dimensions defined by this procedure the same way Guttman determined his measure λ_1. For that purpose, we will assume that $\mathbf{E}^2 = \mathbf{I}$. In that case

$$\alpha_p = 1 - (\mathbf{q}_p{}^t\mathbf{R}\mathbf{q}_p)^{-1}$$

will be measures of absolute low limit of reliability of latent dimensions, as, obviously, $\mathbf{\Theta}^\tau\mathbf{\Theta} = \mathbf{I}$.

Hypothesis 3

All the coefficients α_π are always less than 1.

Proof:

It is obvious that all the coefficients must α_π be less than 1, and that they all incline towards 1 when m, number of variables in V cluster, inclines towards infinity, since in that case square form of matrix **P** inclines towards infinity. If **P** = **I**, then, obviously, all the coefficients α_π equal zero. However, low limit of coefficient α_π needs not to be zero, since it is possible, but not for all α_π coefficients, that variance σ_π^2 of some latent dimension is less than 1. Certainly, latent dimension which provides less information than any variable from which it was derived makes no sense, and the best way to show that is by coefficient α_π.

Measure types β_6 defined by α_1 i α_2 functions (Momirović, 1996) will be, for the result defined by function $\boldsymbol{\eta}$,

$$\beta_{61} = \gamma^2\lambda^{-2}$$

ανδ

$$\beta_{62} = 1 - \delta^2\lambda^{-2}.$$

It is not hard to prove that, for regular particle clusters, measure types α_1 are estimated low limits of reliability of measures type λ_6 ι β_6, while α_2 measure types are estimated high limits of measure types λ_6 ι β_6.

Hypothesis 4

If $m \geq 2$, $|\mathbf{R}| \neq 0$ and $\mathsf{T} \subset \alpha$, where α is cluster of all vectors which are in the positive hyperquadrant $\Re^m$ of the space, so that $r_{jk} \geq 0\ \forall\ t_j, t_k$; j,k = 1,...,m, then, for **x**: $\mathbf{x}^t\mathbf{x} = 1$ is such that $\mathbf{x}^t\mathbf{R}\mathbf{x} = \lambda^2$ = maximum,

$$0 \leq \lambda_{61} \leq \beta_{61} < 1.$$

Proof:

Obviously, $0 = \lambda_{61} = \beta_{61}$ only when $\mathbf{C} = \mathbf{0}$, i.e. $\mathbf{R} = \mathbf{I}$. Ako $\mathbf{x} \neq \mathbf{e}$, $\lambda^2 \geq \sigma^2$, which is why it is crucial to determine what is the difference between functions $(\mathbf{x}^t\mathbf{C}\mathbf{x})(\mathbf{x}^t\mathbf{R}\mathbf{x})^{-1}$ and $(\mathbf{e}^t\mathbf{C}\mathbf{e})(\mathbf{e}^t\mathbf{R}\mathbf{e})^{-1}$. As

$$(\mathbf{x}^t\mathbf{C}\mathbf{x})(\mathbf{x}^t\mathbf{R}\mathbf{x})^{-1} - (\mathbf{e}^t\mathbf{C}\mathbf{e})(\mathbf{e}^t\mathbf{R}\mathbf{e})^{-1} = (\mathbf{x}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{x})\lambda^{-2} - 2(\mathbf{x}^t\mathbf{U}^2\mathbf{x})\lambda^{-2} - (\mathbf{e}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{e})\sigma^{-2} + 2(\mathbf{e}^t\mathbf{U}^2\mathbf{e})\sigma^{-2}$$

and as

$$(2(\mathbf{e}^t\mathbf{U}^2\mathbf{e})\sigma^{-2} - 2(\mathbf{x}^t\mathbf{U}^2\mathbf{x})\lambda^{-2}) > ((\mathbf{e}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{e})\sigma^{-2} - (\mathbf{x}^t\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2\mathbf{x})\lambda^{-2}),$$

since matrix elements outside diagonal $\mathbf{U}^2\mathbf{R}^{-1}\mathbf{U}^2$ are negative if $\mathsf{T} \subset \alpha$ and x vector elements in the negative correlation with matrix elements $\mathbf{U}^2$, then $\lambda_{61} \leq \beta_{61}$, which is exactly what needed to be proved.

In a similar manner we can demonstrate that relations defined by hypotheses 1, 2, 3 i 4 stand in case if $|R| = 0$ and $U^2 = (\text{diag } R^-)^{-1}$, taking into account that $RR^- = XX^t$, where X: $X^tX = I$ and matrices typical of vectors of matrix R coupled with typical values of that matrix other than zero. However, in that case, due to inflation of uniqueness in the zone of singularity, there will almost always occur reduction of all measures of reliability which are based on estimation of unique particle variance (Momirović, 1999).

3. Results

It is of utter importance to apply the results of scientific researches to training process in order to reach high sport results in every kinesiologic activity and consequently volleyball too. As the success in sport depends on a range of factors, it is very important to have reliable indicators about which dimensions and to what extent influence reaching maximum results. Conative space presents the part of personality responsible for modalities of one's behavior. As there are normal and pathological modalities of behavior, there are also normal and pathological conative factors.

The characteristic of normal conative factors is that they are mostly independent and normally distributed within the population. The attempts to research normal modalities of behavior and normal conative factors are rare and that is why this subspace of personality is not clearly defined.

Pathological conative factors are better defined in than normal factors in conducted researches and in most cases there are certain theoretical explanations.

It is considered that pathological conative factors are responsible for those behaviors which reduce adaptive level of a human being regarding his or her potential abilities. The influence of conative factors on all the activities which are not very sensitive to the influence of conative factors is not the same, but also there are the ones for which this influence is of crucial importance. That influence can be either positive or negative, depending on the factors and activities. To conclude, there is no activity which is completely resistant to the influence of conative factors, which makes determination of the structure of conative regulatory mechanisms very important in volleyball too.

All this makes assessment of latent dimensions on the basis of simple, confirmative algorithms possible in such researches. These algorithms are proper not only for their great efficacy end economy, but also because they enable very simple interpretation of the results.

Algorithm applied in this research and the program associated to it is used to explain the structure of the spaces treated in the simplest way.

In attempt to determine characteristics of the basic space of conative variables, the transformation and condensation of the data into the matrix of correlations were performed and thus the characteristics of the measuring instruments were explained.

MAIN COMPONENTS OF CONATIVE VARIABLES OF VOLLEYBALL PLAYERS

Table 1

	FAC 1	FAC 2	FAC 3	h2
EPSILON	,03	,59	-,66	,76
HI	-,69	-,03	,26	,52
ALFA	,09	-,83	-,03	,67
SIGMA	,34	,46	,72	,84
DELTA	,65	-,17	-,18	,47
ETA	,87	-,01	,08	,74
Characteristic root	1,89	1,44	,99	
% Variance	29,88	22,31	18,11	
Cumulative %	29,88	52,19	70,30	

MATRIX OF THE CONATIVE VARIABLES’ CLUSTER OF THE VOLLEYBALL PLAYERS

Table 2

	OBL 1	OBL 2	OBL 3
EPSILON	,13	,87	-,19
HI	-,73	-,16	,0
ALFA	,18	-,64	-,43
SIGMA	,10	-,06	,92
DELTA	,69	-,04	-,08
ETA	,81	-,09	,27

MATRIX OF THE STRUCTURE OF CONATIVE VARIABLES OF VOLLEYBALL PLAYERS

Table 3

	OBL 1	OBL 2	OBL 3
EPSILON	,10	,85	-,13
HI	-,73	-,13	,00
ALFA	,20	-,68	-,47
SIGMA	,12	-,00	,91
DELTA	,69	-,07	-,07
ETA	,83	-,10	,28

OBLIMIN FACTORS INTERCORRELATIONS

Table 4

	OBL 1	OBL 2	OBL 3
OBL 1	1,00		
OBL 2	-,05	1,00	
OBL 3	,02	,09	1,00

Based on the Guttman criterion $\lambda_{6,}$ three principal components which explained 70.30% of the total variance of variables were obtained (Table 1). Thereby, already the first characteristic root extracted 29.88% of the common variance of variables. Most variables have large positive projections on the first principal component: ETA.87, HI.69, DELTA.65. This principal component, undoubtedly, acts as a general conative factor, *(Popovic et al. 1995 et 1996)*.

The second principal component explains 22.31% of the variance and the variable for regulation of defense reactions ALFA.83 has the largest projection on it.

The third principal component explains 17:16% of the variance and the variable for regulation of attack reactions SIGMA .72. and variable EPSILON .66. have the largest projection on it.

Communalities of all the variables are satisfactory. Although other main components cannot be given special relevance as it is the case with the first main variance, those generators of variabilities whaich are, according to the position of their importance, responsible for the variability of the analyzed space can be discovered by examination of these components.

To obtain a parsimonic structure, the entire initial coordinate system is rotated in one of the oblique rotations. On this occasion, the direct oblimin criterion of Jenrich and Sampson was used and the same number of factors was kept while obtaining three matrices: pattern matrix (Table 2), structure matrix (Table 3) and factor intercorrelation matrix (Table 4). In order to obtain an interpretable structure, both the factor matrix and the structure matrix will be interpreted at the same time.

The first oblimin factor of the largest parallel and orthogonal projections is with the test vectors whose intentional subjects of measurements were the regulator of organ functions HI, coordination of regulatory functions DELTA and system for integration of regulatory functions ETA.

Another oblimin factor is represented by the activity regulator EPSILON and factor of regulation of defense reactions ALFA.

The third oblimin factor is represented by the factor of regulation of attack reactions (SIGMA).

Matrix of the intercorrelation factors (table 4) shows that the first latent dimension does not have any statistically relevant relation with the other one, which means that the isolated latent dimensions are clean in factorial sense. Cybernetic model of the conative regulators, which is in fact integrated into the model of cognitive functions, functions through biologically and socially most important and most complicated system for regulation and control of the regulatory functions and is related with all other systems. The efficacy of conative regulatory mechanisms partly depends on physiological components which determine the range and stability of the regulation, and partly on the programs formed under the influence of exogenous factors as well as on the interaction of social factors and physiological basis of regulatory mechanisms. Considering that a player does not have the inner drive to perform aggressive movements during the volleyball match, except in extreme situations when the concentration and self-control because of the sense of responsibility in a stressful situation are low, this pathological personality trait should be studied with all available measuring instruments in future researches.

4. Conclusion

The study was conducted in order to determine a structure of conative characteristics in athletes involved in volleyball. To determine the structure of conative dimensions, 100 volleyball players were examined.

For the assessment of conative characteristics, the measuring instrument CON6 was chosen which assesses the following conative regulators:

- activity regulator (EPSILON),
- regulator of organ functions (HI),
- regulator of defense reactions (ALFA),
- regulator of attack reactions (SIGMA),
- system for coordinating regulatory functions (DELTA) and
- system for integration of regulatory functions (ETA).

All the data in this study were processed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Pristina with the help of the software system for data processing developed by Popovic, D. (1980), (1993), and Momirović, K. and Popovic, D. (2003).

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Another oblimin factor is represented by the activity regulator EPSILON and factor of regulation of defense reactions ALFA.

The third oblimin factor is represented by the factor of regulation of attack reactions (SIGMA).

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Lowest limit measures of reliability of tests with a particle covariance matrix in determination of the stucture of conative dimensions of selected volleyball players

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Summary

The study was conducted in order to determine a structure of conative characteristics in athletes involved in volleyball. To determine the structure of conative dimensions, 100 volleyball players were examined.

For the assessment of conative characteristics, there was chosen the measuring instrument CON6 which assesses the following conative regulators: activity regulator (EPSILON), regulator of organ functions (HI), regulator of defense reactions (ALFA), regulator of attack reactions (SIGMA), system for coordinating regulatory functions (DELTA) and system for integration of regulatory functions (ETA).

All the data in this study were processed at the Multidisciplinary Research

Center, Faculty of Sport and Physical Education, University of Pristina with the help of the software system for data processing developed by Popovic, D. (1980), (1993), and Momirović, K. and Popovic, D. (2003).

Based on the Guttman criterion $\lambda_{6,}$ three principal components which explained 70.30% of the total variance of variables were obtained (Table 1). Thereby, already the first characteristic root extracted 29.88% of the common variance of variables. Most variables have large positive projections on the first principal component: ETA.87, HI.69, DELTA.65. This principal component, undoubtedly, acts as a general conative factor, (Popovic et al. 1995 et 1996).

The second principal component explains 22.31% of the variance and the variable for regulation of defense reactions ALFA.83 has the largest projection on it.

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Another oblimin factor is represented by the activity regulator EPSILON and factor of regulation of defense reactions ALFA.

The third oblimin factor is represented by the factor of regulation of attack reactions (SIGMA).

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Canonic discriminant analysis projected in space with standard matrix as optimum method for determining differences between athletes

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Abstract

The obtained result can easily be transformed into the form obtained under the canonic model of discriminant analysis. Matrix of discriminant coefficients can be defined as the matrix of partial regression coefficients, obtained by solving the following problem

$$\mathbf{ZW} = \mathbf{K} + \mathbf{E} \mid \text{path } (\mathbf{E}^t\mathbf{E}) = \text{minimum}.$$

As, in fact,

$$\mathbf{K} = \mathbf{ZR}^{-1/2}\mathbf{X},$$

It is obvious that E = 0, and that

$$\mathbf{W} = \mathbf{R}^{-1/2}\mathbf{X}.$$

Because of this vectors w_k from W are proportional to the coordinates of vectors of discriminant functions in slope coordinate system formed by vectors from **Z** with cosines of angles between coordinate axes equal to elements of correlation matrix **R.** Since the discriminant analysis can also be interpreted as an special case of component analysis with key components transformed by a some permissible singular transformation so as to maximize spaces between the E_p subgroups' centroides, i.e. canonic correlations ρ_k (Cooley and Lohnes, 1971; Hadžigalić, 1984; Popović, 1992), it is customary to base the identification of discriminant functions' content on structural vectors $\mathbf{f}_k$ from the matrix

$$\mathbf{F} = \mathbf{Z}^t\mathbf{K} = \mathbf{R}\mathbf{W} = \mathbf{R}^{1/2}\mathbf{X} = (\mathbf{f}_k) = (\mathbf{R}\mathbf{w}_k),$$

analogusly to identification of the content of canonic variables obtained by Hotelling's method of biorthogonal canonic correlation analysis, since it can be demonstrated by a simple calculation that **F** is factorial matrix of the matrix **R** (Zorić and Momirović, 1996; Momirović, 1997).

Key words: canonic variables/matrix/singular transformation/function/vactors

1. Introduction

Motor abilities are usually considered to be directly responsible for performing tasks in sport and physical education, regardless of whether those tasks are related to educational, competitive or recreative activities. Measuring of motor abilities is a starting point in all processes of the aforementioned fields of sports' activities simply because managing this process cannot be imagined without the information on transformational and final condition of the system which is being managed.

Determining the level of specific dimensions of motor space is of a recent date and it belongs to the field of motor skills diagnostics. Since the abilities which define motor space are not given directly, but as latent dimensions, the quality and quantity of which is determined based on the output of the system, they cannot be measured by a direct methodology. Thus, the motor abilities are measured indirectly, by conventional movement manifestations known as ***motor tests.*** Apart from that, latent dimensions of motor space are not expressed as singular properties, but are mostly combined in different variations, which makes measuring of these dimensions even harder.

Motor tests, as the set of tasks for which model of presenting and evaluation of the result,s as well as their measuring characteristics have been developed in the course of the previous research, are used as the instruments for measuring motor space. Motor tests as standardized mehods are the most valuable source of information on the level and development of movement abilities of the examinees.

2. Methods

2.1 Test group

On the basis of the chosen statistical-mathematical model, i.e. program, goals and hypothesis, it was decided that the sample consisted of about 200 athletes (about 100 judoists and about 100 karatists of both sexes) aged between 18 and 27. The majority of this sample had to meet the following criteria:

- that the effective of the sample was so large that it permited so many degrees of autonomy that any coefficient in the matrix assembly or any correlation coefficient equal to or larger than .21 could be considered different from zero with the conclusion deviation les than 01;

- the number of the subjects in the sample had to be five times larger than the number of applied variables so that, according to the recent principles, adequate statistical methods could be applied successfully;

Apart from the aforementioned, the subjects had to meet the following conditions:

- subjects were male;
- age was defined on the basis of chronological age, so that the research was performed on subjects from 18 to 27 years of age plus-minus 0.5 years;
- subjects had regular trainings in their clubs or national team of Serbia, which was confirmed by the evidence of attendance and number of trainings per month;
- subjects did not have any somatic deformity or aberrations and were physically and mentally healthy.

No other exclusion criteria were used in defining of the population from which the sample of subjects was taken apart from the listed ones (Popović, D. 1990).

2.2 Sample of the variables

Sixteen variables which involved the following regulatory mechanisms were applied:

a) Structuring of movement:
- Broaching and jumping over (PROPRE)
- Shooting the target by leg with a tennis ball (GACINOT)
- Wriggling with broaching (OSSAPRO)
- Polygon backwards (POLINAT)

b) Regulation of tone and synergistic regulation

- Side standing on a low balance beam with eyes closed (RAVZATOČ)
- Dominant hand tapping test (TAPTDR)
- 20 m sprint start running (TIVSTAR)
- Deep forward bend on the bench (DUPRENK)

c) Regulation of excitation intensity
- Stand still long jump (SUDS)
-Stand still high jump (SUS)
- Standing triple jump (TSK)
- Throwing medicine ball with both hands from the sitting back position (BMED)

d) Regulation of duration of excitation
- Under grip pull up on pull up bar (ZVPOT)
- Legs lifting in lying position (DNOL)
- Torso lifts in 30 sec lying on the back (PTLNL)
- Torso lifts in 30 sec lying on the stomach (PTLNS)

2. 3. Methods of processing of the results

Significance of a research depends not only on the sample of subjects studied and the sample of variables, that is on the importance of basic information, but on the applied processes for transformation and condensation of that information, too. Some scientific problems can be solved by means of a larger number of different, and sometimes equally valuable methods. However, from the same basic data and from the same results of different methods different conclusions can be drawn. This is why the problem of choosing particular methods for data processing is rather complex.

In order to reach satisfactory scientific solutions, the research was based on, primarily acceptable, adequate, unbiased and comparable procedures, which were appropriate to the nature of the problem posed and which enabled extraction and transformation of appropriate dimensions.

Taking all this into account, for the purpose of this research we chose procedures which are considered to be appropriate to the nature of the problem which do not impose too severe restrictions on the basic information and are based on the following assumptions:

- that latent dimensions, which are the subject of measuring by the applied measuring instruments, have multivariate normal distribution;
- that the relations between manifest and latent variables can be approximated by genaralized linear model of Gauss, Markov and Rao.

Lately, many researchers have been misusing their position and publishing more and more quazi scientific papers primarily based on mathematical artefacts. Apart from that, they have been using the existing statistical products without even understanding the logic of most multivariate models. For this reason, this paper will primarily focus on statistic processing of the data, as well as the choice of useful algorithms and programs.

All the data in this study were processed at the Multidisciplinary Research Center, Faculty of Sport and Physical Education, University of Priština with the help of the software system for data processing developed by Popovic, D. (1980), (1993), and Momirović, K. and Popovic, D. (2003).

CANONIC DISCRIMINANT ANALYSIS PROJECTED IN SPACE WITH STANDARD MATRIX

The obtained result is easily transformable into the form obtained under the canonic model of discriminant analysis.

Matrix of discriminant coefficients can be defined as the matrix of partial regression coefficients, obtained by solving the following problem:

$$\mathbf{ZW} = \mathbf{K} + \mathbf{E} \mid \text{path } (\mathbf{E}^t\mathbf{E}) = \text{minimum.}$$

As, in fact,

$$\mathbf{K} = \mathbf{ZR}^{-1/2}\mathbf{X},$$

it is obvious that E = 0 and that

$$\mathbf{W} = \mathbf{R}^{-1/2}\mathbf{X}.$$

Because of this vectors w_k from W are proportional to the coordinates of vectors of discriminant functions in slope coordinate system formed by vectors from **Z** with cosines of angles between coordinate axes equal to elements of correlation matrix **R.** Since the discriminant analysis can also be interpreted as an special case of component analysis with key components transformed by a some permissible singular transformation so as to maximize spaces between the E_p subgroups' centroides, i.e. canonic correlations ρ_k (Cooley and Lohnes, 1971; Hadžigalić, 1984; Popović, 1992), it is customary to base the identification of discriminant functions' content on structural vectors $\mathbf{f}_k$ from the matrix

$$\mathbf{F} = \mathbf{Z}^t\mathbf{K} = \mathbf{RW} = \mathbf{R}^{1/2}\mathbf{X} = (\mathbf{f}_k) = (\mathbf{Rw}_k),$$

analogusly to identification of the content of canonic variables obtained by Hotelling's method of biorthogonal canonic correlation analysis, since it can be demonstrated by a simple calculation that **F** is factorial matrix of the matrix **R** (Zorić and Momirović, 1996; Momirović, 1997).

The cross structure of discriminant analysis in this metrics will be

$$\mathbf{U} = \mathbf{Z}^t\mathbf{L}\boldsymbol{\rho}^{-1} = \mathbf{Z}^t\mathbf{PZW}\boldsymbol{\rho}^{-1} = \mathbf{W}\boldsymbol{\rho}$$

As, of course, $\mathbf{W}^t\mathbf{Z}^t\mathbf{PZW} = \boldsymbol{\rho}^2$, so it is evident that **U** is factorial matrix of the matrix $\mathbf{Z}^t\mathbf{PZ}$, that is of the matrix of the intergroup covariance defined in the space with standard **I** metrics.

As the elements f_{jk} of the matrix **F** and the elements u_{jk} of the matrix **U** behave as regular product-moment correlation coefficients, and as they are the function of normally distributed variables and thus asymptotically normally distributed themselves, their asymptotic variances are

$$\sigma_{jk}^2 \sim (1 - \varphi_{jk}^2)^2 n^{-1}$$

$$j = 1,..., m;\ k = 1,..., s$$

that is

$$\xi_{jk}^2 \sim (1 - \upsilon_{jk}^2)^2 n^{-1}$$

$$j = 1,..., m;\ k = 1,..., s$$

and can be used for testing hypotheses type H_{jk}: $f_{jk} = \varphi_{jk}$, that is H_{jk}: $u_{jk} = \upsilon_{jk}$ where φ_{jk} and υ_{jk} are some hypothetical correlations between variables from V and discriminant functions in the population P because asymptotic distribution of the coefficients f_{jk} is

$$f(f_{jk}) \sim N(\varphi_{jk}, \sigma_{jk}^2),$$

and asymptotic distribution of the coefficients u_{jk} is

$$f(u_{jk}) \sim N(\upsilon_{jk}, \xi_{jk}^2),$$

where N denotes normal distribution.

RELIABILITY, INFORMATIVENESS AND SIGNIFICANCE OF DISCRIMINANT FINCTIONS

$$\mathbf{V}^2 = (\mathrm{diag}\ \mathbf{R}^{-1})^{-1}$$

Is diagonal matrix the elements of which are estimations of the unique variances of the variables from V. As Momirović and Zorić showed (1996), reliability, or more precisely generalizability of discriminant functions can be estimated on the basis of the value of diagonal elements of matrix

$$\boldsymbol{\alpha} = (\mathrm{diag}\ (\mathbf{W}^t(\mathbf{R} - \mathbf{V}^2)\mathbf{W}))(\mathrm{diag}\ (\mathbf{W}^t\mathbf{R}\mathbf{W}))^{-1},$$

relative informativeness based on the elements of matrix diagonal

$$\iota^2 = (\mathbf{I} - \boldsymbol{\alpha})^{-1}m^{-1}$$

and the significance of these functions based on the elements of diagonal matrix

$$\boldsymbol{\zeta} = \iota^2\boldsymbol{\rho}.$$

Obviously, these data can be of much greater importance than results of the tests of importance of canonic correlations for evaluating the actual meaning of discriminant functions.

3. Results

Motorics, i.e. anthropomotics, is a system of movement manifestations of man for communicating with the environment. This system is primarily defined as an ability to move the whole body or some of its parts in space with a certain amplitude, rhythm, direction, intensity, and goal. The information that the number of manifest moving activities i.e. their combinations, is practically infinite, is logical, or even the only possible direction for identification of the structure of motor abilities as the system which is in the basis of those manifestations, and which is justifiably reduced and limited by the available number of latent dimensions relative to the movement manifestations.

Planned, systematic and programmed training induces changes in anthropological status of athletes. These changes are most often manifested in the area of some abilities and characteristics, and especially in the domain of motor abilities and motor skills. Anthroplological characteristics appear, develop and change quantitatively and qualitatively. Quantitative changes are those which are articulated in space, or those which decrease the efficiency of a certain ability, characteristic or motor information. Qualitative changes include changes of the relations between characteristics. Both types of changes are inevitable. Changes in general can significantly be influenced by different means and in different ways. They are under the evident influence of exogenous factors i.e. the influence of the environment on formation and manifestation of changes in motor spece is of a great significance.

The results of discriminant analysis of motor variables show that the difference between the tested athletes in respect to the chosen sport is statistically significant. Analysis of the values presented in Table 1 shows that matching of the results between two groups of athletes of the registered indicators is considerable. Only one substantial discriminant function and one substantial canonic correlation (.83) were obtained. This indicates the existence of the relation between discriminant functions and it is a major indicator of quantitative structure. The significance of the differences between groups is presented by Wilks' lambda and the significance of canonic correlations was tested by Bartlett's X^2 test.

Table 4. shows the structure of the discriminant functions of motor variables which demonstrates the contribution of each variable in general distance of the group centroids.

Coefficients of the first discriminant function clearly show that this discriminant function is best defined by the tests for the estimation of segmentary speed of hands, repetitive force, coordination and flexibility. The size and the precursor of the group centroids show that judoists have greater strength and coordination, while karatists demonstrate better segmentary speed of hands and flexibility, which is in accordance with the findings demanded by these two sports.

Table 1 DISCRIMINANT ANALYSIS OF MOTOR VARIABLES

F	Kan. R.	λ	χ^2	df	Sig.
1	.83	,37	217,30	15	,00

Table 2 STRUCTURE OF CANONIC FACTOR IN H SPACE

Variable	D1
SUDS	,24
SUS	,21
TSK	-,38
BMED	-,29
ZVPOT	,44
DNOL	,46
PTLNL	-99
PTLNG	,28
TAPTDR	-,72
TIVSTAR	,41
DUPRENK	1,00
PROPRE	-,18
GACINOT	,22
OSSAPRO	-,15
POLINAT	,39

Table 3 GROUP CENTROIDS

Groups	D1
Judo	-1.44
Karate	1.56

Teble 4 STRUCTURE OF CANONIC FACTOR IN Z SPACE

Variable	D1
TAPTDR	-,45
TIVSTAR	,39
PTLNL	-,29
POLINAT	,23
DUPRENK	,24
PROPRE	,19
PTLNG	-,16
TSK	-,19
OSSAPRO	,17
DNOL	-,12
BMED	-,09
GACINOT	,07
SUDS	-,07
SUS	-,06
ZVPOT	-,02

4. Conclusion

The research was conducted with the aim to investigate specificities of motor dimensions in athletes who practice judo and karate and to determine the differences between them.

In order to determine specificities of the structure of tested anthropologic dimensions, 200 judoists and karatists, members of judo and karate clubs in Serbia (about 100 judoists and about 100 karatists), between 18 and 27 years of age, were tested.

Sixteen motor tests, chosen according to the structural model of Grdelja, Metikoš, Hošekova and Momirović (1975) and Popović (1990) and defined as mechanism for structuring of movement, mechanism for functional synergy and tone regulation, mechanism for regulation of excitation intensity and mechanism for regulation of excitation duration, were used for determining motor abilities.

All the data in this research were processed in the Centre for Multidisciplinary Research of the Faculty of Sport and Physical Education, University in Priština, by means of the system of programs for data processing developed by Popović, D. (1980), (1993) and Momirović, K. and Popović, D. (2003).

Complete algorythms and programs from this dissertation have been presented, and the results of those programs analyzed.

The results of discriminant analysis of motor variables show that the differences between the tested athletes regarding the chosen sport is statistically significant. Analysis of the values presented in Table 1. show that the matching of the results between the two groups of athletes of registered indicators is considerable. Only one substantial discriminant function and one substantial canonic correlation (.83) were obtained. This indicates the existence of the relationship between discriminant functions and it is a major indicator of quantitative structure. The significance of the differences between the groups is presented by Wilks' lambda and the significance of canonic correlations was tested by Bartlett's X^2 test. Table 4. shows the structure of the discriminant functions of motor variables which illustrates the contribution of each variable in general distance of the group centroids. Coefficients of the first discriminant function clearly show that this discriminant function is best defined by the tests for the estimation of segmentary speed of hands, repetitive force, coordination and flexibility. The size and the precursor of the group centroids lead to conclusion that judoists have greater strength and coordination while karatists have better segmentary speed of hands and flexibility, which is in accordance with the findings demanded by these two sports.

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Canonic discriminant analysis projected in space with standard matrix as optimum method for determining differences between athletes

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Summary

The research was conducted with the aim to investigate specificities of motor dimensions in athletes who practice judo and karate and to determine the differences between them.In order to determine specificities of the structure of tested anthropologic dimensions, 200 judoists and karatists, members of judo and karate clubs in Serbia (about 100 judoists and about 100 karatists), between 18 and 27 years of age, were tested.Sixteen motor tests, chosen according to the structural model of Grdelja, Metikoš, Hošekova and Momirović (1975) and Popović (1990) and defined as mechanism for structuring of movement, mechanism for functional synergy and tone regulation, mechanism for regulation of excitation intensity and mechanism for

regulation of excitation duration, were used for determining motor abilities.

All the data in this research were processed in the Centre for Multidisciplinary Research of the Faculty of Sport and Physical Education, University in Priština, by means of the system of programs for data processing developed by Popović, D. (1980), (1993) and Momirović, K. and Popović, D. (2003).Complete algorythms and programs from this dissertation have been presented, and the results of those programs analyzed.The results of discriminant analysis of motor variables show that the differences between the tested athletes regarding the chosen sport is statistically significant. Analysis of the values presented in Table 1. show that the matching of the results between the two groups of athletes of registered indicators is considerable. Only one substantial discriminant function and one substantial canonic correlation (.83) were obtained. This indicates the existence of the relationship between discriminant functions and it is a major indicator of quantitative structure. The significance of the differences between the groups is presented by Wilks' lambda and the significance of canonic correlations was tested by Bartlett's X^2 test. Table 4. shows the structure of the discriminant functions of motor variables which illustrates the contribution of each variable in general distance of the group centroids. Coefficients of the first discriminant function clearly show that this discriminant function is best defined by the tests for the estimation of segmentary speed of hands, repetitive force, coordination and flexibility. The size and the precursor of the group centroids lead to conclusion that judoists have greater strength and coordination while karatists have better segmentary speed of hands and flexibility, which is in accordance with the findings demanded by these two sports.

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Motor Performance and Academic Achievement in Special School Students with Intellectual Disabilities

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Abstract:

Aim. The concept of the integrated development or the interrelationship between motor and intellectual abilities has served as the foundation of a number of theories of child development and of learning. It has been assumed by many that the learning and the performance of motor skills are closely related to intelligence. The basic purpose of this study was to determine the significance of the gender (male/female) difference, grade-level differences in the basic motor development, related to the different IQ-maturity subcategories. Additionally, of special interest in this study was to establish the correlations among variables for the estimation of chronological age (Age/M), academic achievement (ScSs), intellectual maturity (IQ) and motor development (PFT) of Special Secondary School Students, using Pearson's, Kendall's, and Spearman's Correlations Coefficient. (r).

Methods. The total sample of 176 subjects of both genders (118 male and 58 female) was included in the study. *Instruments:* A battery of Physical Fitness Tests (PFT) for the evaluation of motor development was applied (Fjørtoft et al. 2003), comprising nine different tasks (including running, jumping, throwing and climbing) for the estimation of explosive strength, running speed, agility and endurance of participants.

Results. The significant relationship was estimated between chronological age and educational performance (at 0.5* level), and between IQ-maturity and educational performance (at 0.1* level) with Kendall's (.416) and Spearman's (.537) Correlation coefficient. Physical Fitness Tests (PFT) items scores were transformed into standardized ***z***-score, and have not established significant correlation with other variables within total sample of participants.

Conclusion. General conclusion, derived from results of this study, provided within Special education of Secondary school students do not support constant link between PET variables and common indices of academic achievement, such as average various educational subjects marks (grade-points). Continued research is needed to gain more causal understanding of the relationship between motor (physical fitness) and intellectual performance in children with special needs (intellectual disabilities). Future research should address and explain which parameters of physical fitness and activities obtain the greatest cognitive benefits, examine the effects of physical activity and fitness by cohorts, and investigate which moderators have the greatest impact on student cognition and education performance in children with intellectual disabilities, as these factors are important contributors to their health and well-being.

Key words: Special Education; Secondary school students, Motor and Intellectual Performance; Physical-Fitness-Test; Intellectual disability, Academic achievement

1. Introduction

Motor functions are directly in relation with cognitive and affective functions of a personality, particularly in the period of early school age, so that without significant impulse of motor development it is not possible to realize the idea of necessity of integral development of children. As the contribution to the hypothesis that the efficacy in tests for the estimation of motor abilities is possible to explain with integral function of CNS, which represents as well the basis of intellectual functioning, speak the result of Reitana, 1971 (*after Gredelj, Metikoš, Hošekova & Momirović, 1975,* pp. 18-19), which point out that group of children with cerebral damage have as well weaker results in both cognitive and motor function, on the which base author made conclude that the cognitive and motor abilities are in relation **Physical activity** is defined as any bodily movement produced by skeletal muscle resulting in a substantial increase in resting energy expenditure *(Bouchard & Shepard, 1994)* They are citing seven categories of physical activity (exercise, sport, training play, dance, work, and domestic chores), suggested that patterns of physical activity could be described by manipulating the variable of frequency (how often), intensity (how hard), and duration (how long) after *Winnick, 2005* (p. 402). *Casperson, Powell, and Christenson (1985, p. 129)* defined **Physical fitness** as a *"set of attributes that people have or achieve that relates to the ability to perform physical activity"*. The components of physical fitness may be subdivided into two groups: health-related fitness and skill/performance-related fitness. The everyday activities require that children master different motor skills *(Henderson & Sugden, 1992)*. Among these are the skills essential to biological functioning like crawling, walking and running, as well as those required for adequate social functioning, like dressing and playing.

Over the years, several studies have compared the physical fitness performance of youth with disabilities to that of youth without disabilities. With few exceptions, research using subjects with intellectual disabilities, cerebral palsy, spinal cord injuries, and visual impairments has found that the fitness performance of youngsters with disabilities is below that of their peers without disabilities. To the extent that the fitness of youngsters with disabilities falls below acceptable levels, it is probable that students with disabilities are at greater risk for the health concerns mentioned previously than are students without disabilities (after *Winnick, 2005, p. 404).* Individuals with intellectual disabilities present a diversity of abilities and potential, and educators must be prepared to accept this diversity. Intellectual disabilities present a substantial disadvantage to an individual attempting to function in society. They are characterized by cognitive limitations as well as functional limitations in such areas as daily living skills, social skills, and communication.

PHYSICAL AND MOTOR CHARACTERISTICS OF CHILDREN WITH INTELLECTUAL DISABILITIES.

Children with intellectual disabilities differ least from children without intellectual disabilities in their motor characteristics. Although most children with intellectual disabilities display developmental motor delays, they are often related more to the limited attention and comprehension than to physiological or motor control deficit. As a group, children with intellectual disabilities walk and talk later, are slightly shorter, and usually are more susceptible to physical problems and illnesses than other children. In comparative studies, children with intellectual disabilities consistently score lower than children without intellectual disabilities on measures of strength, endurance, agility, balance, running speed, flexibility and reaction time.

Although many students with intellectual disabilities can successfully compete with their peers without intellectual disabilities, those students needing extensive or pervasive supports have a discrepancy equivalent to four or more years behind their peers without intellectual disabilities on tests of physical fitness and motor performance *(after Winnick, 2005, p. 141)*. Important contribution to the explanation of a structure of motor abilities was given by the results of those researches in which the relation of cognitive and personality characteristics and motor abilities was investigated. In investigation of relation of motor abilities and intellectual abilities one of the very first studies was that of Kulcinskaja, 1945 (after *Ismail, 1977*) which established that the relation of intelligence and learning of basic motor tasks is higher, when the intellectual level of examinees is higher. Based on the above demonstrated theoretical approach, and literature review of previous research findings the basic ***Aim*** of this study was to determine the significance of differences in ***motor development***, estimated through the results in Physical Fitness Test (PFT) of the school age children in relation to the different ***Intellectual maturity(IQ) sub-categories***. The logical ***hypothesis*** was stated that there will be stated positive and statistically significant differences between examined groups of participants in applied battery of Physical Fitness relative to the additional indicators of special interests in this study, considered criterion (IQ).

2. Methods

A *cohort* sample **(N=129,** Male-77; Female-52**)** of upper Elementary (aged 11-12 to 15-17 years), and Secondary school participants (aged 18-21 years) was derived from the *global* sample of Children, attending both Special Elementary and Secondary School (**N=282;** M-190, F-92), which represents the whole sample of pupils in these age groups in the school selected in an urban area of the city of Nis (the second large in Serbia). A *cohort* sample (of smaller size) completed the Test of Physical Fitness (TPF) after *Fjørtoft et al., 2003*. The samples include children with intellectual disabilities in a wide range of socio-economic backgrounds and reflect the population of children attending special schools in this area. The sub-samples of examinees consist of both, girls and boys (see Table 1, below).

Physical Fitness Test (PFT) is relatively a new test battery that aims to provide a reliable, objective quantification of children's physical fitness levels (*Fjørtoft et al. 2003; Haga 2008*). It consists of activities that are included in most children's everyday play activities, e.g. *jumping, throwing, running and climbing.* The battery consists of nine test items: (3) three based on jumping; (2) two on throwing; (1) one on climbing, and (3) three on running. For that reason this battery is applicable for the participants with low motor competence, as were considered those with intellectual disabilities. The test battery is simple to set up and is not time demanding, which was also the reason for its selection. Most test items are also included in other measures such as the EUROFIT *(Adam et al. 1998),* the Allgemeiner Sportsmotorischer Test 6–11 *(Bös & Wohlman 1987),* the Erfarenheter från Folke Bernadottehemet (FBH-provet) *(Bille et al. 1992)* and The Prudential Fitnessgram *(Cooper Institute for Aerobics Research, 2001).* The test item *"climbing wall bars"* was especially designed for the TPF. Test–retest correlation of total score of the TPF is high, 0.90. The construct validity of the test was 0.93 for girls and 0.89 for boys (Spearman's correlation). The validation was performed by an experienced physical education teacher who was asked to rank 10 girls and 10 boys in his class from lowest to highest physical fitness, according to his own implicit knowledge *(Fjørtoft et al. 2003).*

Table 1. Presentation of the research samples size, according to the school level, gender, and class-level

Sample	N	**Global** – larger size (N=282)				N	Sample
Elementary		Male	Female	Male	Female		Secondary
V-VIII	106	72	34	118	58	176	I - IV
Total		106		176			Total
		282					
Sample	N	**Cohort** – smaller size (N=129)				N	Sample
Elementary		Male	Female	Male	Female		Secondary
V-VIII	77	51	26	38	14	52	I - IV
Total		77		52			Total
		129					
Sample	N	**Sub-samples** (N=129)				N	Sample
Elementary		Male	Female	Male	Female		Secondary
V - VI	37	26	11	25	8	33	I - II
VII -VIII	40	25	15	13	6	19	III - IV
Total	77	51	26	38	14	52	Total
Elementary		77		52			Secondary
Total		**129**					Total

Additional indicators – criterion variables: (IQ) Intellectual maturity was provided by the School officials in charge, school psychologist, and social worker (see below Table 2).

Table 2. Characteristics of the IQ (intellectual maturity) categories of participants		
Code	**Category**	**IQ**
1-A	Moderate impairments of intellectual development	48 and less
2-B	Intellectual development on the border between moderate and low impairments	49-50
3-C	Intellectual development in lower range of low impairments	51-54
4-D	Intellectual development in the middle range of impairments (mild)	55-65
5-E	Intellectual development in the upper range of impairments	66-68
6-F	Intellectual development between low and borderline level of impairments	69-70
7-G	Borderline level of intellectual development	71-79
8-H	Below-average level of intellectual development	80-89
9-I	Average level of intellectual development	90-109

Research management. The study was carried out in accordance with the Declaration of Helsinki. The assessments of physical fitness took place in the school sports/gym hall with test protocol in accordance with the TPF manual during the timetabled Physical Education session for each particular class. All the children in the sample voluntarily completed the measurements, during the period of two months (May, 7th – Jun, 10th 2011) at the end of the Elementary, and (May, 7th – Jun, 17th 2011) Secondary School Year.

Data processing. Study Results were processed using Basic (descriptive) statistics, Univariate and Multivariate Analysis of Variance Models, as well as Discriminative Analysis Methods using SPSS version 10.0 or higher, edited by *Ntoumanis, N. , 2001*.

3. Results and interpretation

Analysis of the motor development in Elementary and Secondary school participants, relative to the intellectual maturity (IQ). In accordance with previously stated study design, in this part of the study the thematic segment of the participants *"motor development"* in Elementary and Secondary school participants relative to the *"intellectual maturity"* divided in 3 sub-categories: IQ (48-54) (n=56), IQ (55-70) (n=50), IQ (71-109) (n=23).

Table 1. Analysis of group's differences in Performance of Physical Fitness Tests

Data Analysis	n	F	p
MANOVA	9	2.305	.002
DISCRA	9	2.317	.002

Legend: MANOVA – *Multivariate Analysis of Variance;* DISCRA – *Discriminative analysis*; **n –** *number of variables*; **F-***ratio****;*** **p -** *probability*

While is ***p***=.002 of (MANOVA) and ***p***=.002 of (DISCRA) analysis, stated hypothesis had to be accepted, while differences are evident and there is a clearly defined border between IQ maturity sub-categories of the elementary and secondary school participants.

Table 2. DISCRA analysis of the estimated (PET) variables

(PFT)	F	P	C.disc.
StBJ	5.143	.007	.001
2S7m	5.457	.005	.005
1S7m	5.498	.005	.025
TenB	2.889	.059	.027
MedB	3.064	.050	.001
Clmb	6.704	.002	.056
10X5	3.135	.047	.018
R20m	5.321	.006	.081
MCT6	6.309	.002	.000

Legend*:* ***C.disc.*** *- Discriminative coefficient;* **F-***ratio****; p -*** *probability*

(PFT)*:* ***StBJ-****standing broad jump;* ***2S7m-****jumping on two feet a distance of 7m;* ***1S7m-****jumping a distance of 7m on one foot;* ***TenB****-throwing a tennis ball with one hand;* ***MedB-****pushing a medicine ball with two hands as far as possible;* ***Clmb-****climbing wall bars, crossing over two columns to the right, and down the fourth column as fast as possible;* ***10X5-*** *shuttle run;* ***R20m-****running 20m as fast as possible;* ***MCT6-****reduced Cooper test*

While is p<.1 stated hypothesis had to be accepted, which means that there are evident significant differences within some sub-categories of IQ maturity of participants in majority of tests.

CHARACTERISTICS AND HOMOGENEITY OF THE PARTICIPANT'S *INTELLECTUAL MATURITY* (IQ), RELATIVE TO THE MOTOR DEVELOPMENT IN SPECIAL SCHOOL CHILDREN

On the bases of presented consideration and sample analysis of 129 participants and in accordance to the applied methodology, the logical follow-up of the research is estimation of the characteristics and homogeneity of every (IQ) intellectual maturity sub-category of the participants and mutual distance between them.

Table 3. Significance of the difference between IQ maturity and (PFT) variables

(PFT)	IQ sub-categories		Mean		t	p
StBJ	IQ (48-54)	IQ (71-109)	108.357	136.87	3.219	.002
StBJ	IQ (55-70)	IQ (71-109)	116.920	136.87	2.229	.029
2S7m*	IQ (48-54)	IQ (71-109)	5.197	3.6	3.100	.003
2S7m*	IQ (55-70)	IQ (71-109)	4.736	3.6	2.918	.005
1S7m*	IQ (48-54)	IQ (55-70)	4.718	4.122	1.745	.084
1S7m*	IQ (48-54)	IQ (71-109)	4.718	3.355	3.010	.004
1S7m*	IQ (55-70)	IQ (71-109)	4.122	3.355	2.137	.036
TenB	IQ (48-54)	IQ (71-109)	15.060	19.271	1.979	.051
TenB	IQ (55-70)	IQ (71-109)	14.526	19.271	2.484	.015
MedB	IQ (48-54)	IQ (71-109)	5.565	6.746	2.536	.013
Clmb*	IQ (48-54)	IQ (55-70)	19.594	16.344	1.742	.084
Clmb*	IQ (48-54)	IQ (71-109)	19.594	11.444	3.159	.002
Clmb*	IQ (55-70)	IQ (71-109)	16.344	11.444	3.055	.003
10X5*	IQ (48-54)	IQ (55-70)	32.552	27.772	2.042	.044
R20m*	IQ (48-54)	IQ (55-70)	6.015	7.483	1.895	.062
R20m*	IQ (48-54)	IQ (71-109)	6.015	4.56	2.093	.040
R20m*	IQ (55-70)	IQ (71-109)	7.483	4.56	2.777	.007
MCT6	IQ (48-54)	IQ (55-70)	631.357	706.52	2.159	.033
MCT6	IQ (48-54)	IQ (71-109)	631.357	783.913	3.493	.001

Legend: *Mean - mean value;* **t** *– t-test;* **p** *– probability,* ***IQ*** *– intellectual maturity, *reversible values*

Table 4. Characteristics and homogeneity of the IQ maturity sub-categories in Special school participants, relative to (PET) variables

(PFT)	IQ (48-54)	IQ (55-70)	IQ (71-109)	Ctrb. %
R20m	moderate* [1]	higher* [2]	smaller	37.850
Clmb	higher* [2]	moderate* [1]	smaller	26.168
TenB	moderate	smaller	higher* [2]	12.617
1S7m	higher* [2]	moderate* [1]	smaller	11.682
10X5	higher* [1]	moderate	smaller	8.411
2S7m	higher* [1]	moderate* [1]	smaller	2.336
StBJ	smaller	moderate	higher* [2]	.467
MedB	smaller	moderate	higher* [1]	.467
MCT6	smaller	moderate* [1]	higher* [1]	.000
n/m	36/56	24/50	16/23	
hmg %	64.29%	48.00%	69.57%	

Legend: hmg % *- homogeneity;* ***ctrb. %****- contribution of variable to IQ maturity sub-category characteristics*

Table 5. Mahalanobi's distance among IQ maturity sub-categories of (PET) variables

	IQ (48-54)	IQ (55-70)	IQ (71-109)
IQ (48-54)	.00	1.04	1.20
IQ (55-70)	1.04	.00	.91
IQ (71-109)	1.20	.91	.00

By calculating of the Mahalanobis's distance among IQ maturity sub-categories of participants we have another single indicator of the similarity or differences.

Based on presented ***dendogram*** and ***Graph 1*** (see below) it is evident that the closest are IQ (55-70) and IQ (71-109) sub-categories of the intellectual maturity with the distance of (.91), and the highest difference is between IQ (48-54) and IQ (55-70) sub-categories of the intellectual maturity with the distance of (1.15).

4. Conclusions

Based on the results obtained in the analysis and their interpretation, the following conclusions could be stated:

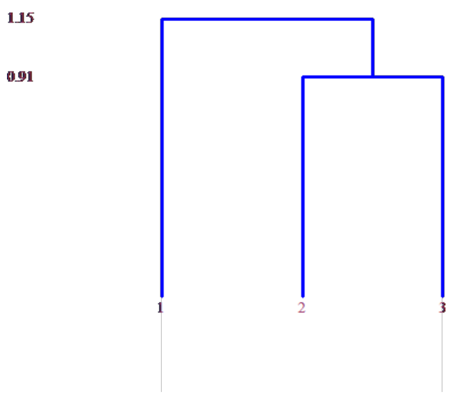
Evaluating ***motor development*** in Special elementary and secondary school participants, using MANOVA (.002) and DISCRA (.002) analysis, statistically significant differences are estimated among 3 sub-categories of ***IQ maturity,*** related to the (PFT) variables.

Evaluating ***motor development*** in Special elementary and secondary school participants, using MANOVA (.001) and DISCRA (.001) analysis, statistically significant ***gender difference*** exists between 2 sub-samples (Male/Female), related to the (PFT) variables.

Evaluating ***motor development*** in Special elementary and secondary school participants, using MANOVA (.000) and DISCRA (.000) analysis, statistically significant ***grade-level*** differences exist among 4 groups (grades/classes), related to the (PFT) variables.

As the alternative hypothesis $A_{1,}$ $A_{2,}$ and A_3 were confirmed in majority of cases, the respective estimated differences and clearly defined borders were determined characteristics and homogeneity of every sub-sample.

General conclusion, derived from results of this study, provided within Special Education Students in upper level of Elementary, and Secondary School children do not support a link between Physical Fitness Test and common indices of academic achievement, such as average of various educational subjects' marks (grade-points).

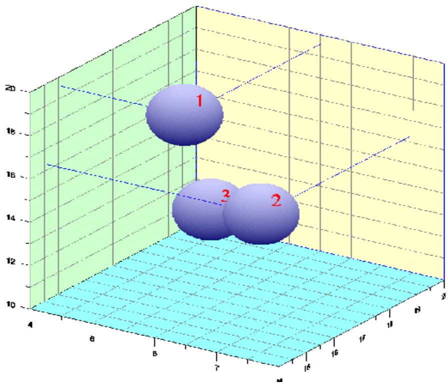


Legend: IQ maturity: (48-54) **(1);** IQ (55-70) **(2);** IQ (71-109) **(3)**

The significant relationship was estimated between chronological age and educational performance (at 0.5* level), and between IQ-maturity and educational performance (at 0.1* level) with Kendall's (.416) and Spearman's (.537) Correlation coefficient.

Physical Fitness Tests (PFT) items scores were transformed into standardized *z*-score, and have not established significant correlation with other variables within total sample of participants.

Graph 1. Three dimensional presentation of the distance/closeness of the different IQ maturity sub-categories of participants evaluated with 9-item Physical Fitness Test (PFT)



Legend: IQ maturity: (48-54) **(1);** IQ (55-70) **(2);** IQ (71-109) **(3)**

Referencess*

Popović, Miloš (2011). *The Evaluation of Motor Development in Elementary and Secondary School Children with Intellectual Disabilities*. Unpublished master thesis, Palacky University in Olomouc: Faculty of Physical Culture (Czech Republic).

Complete List** of* ***References is on disposal complimentary, by copy request to the leading author

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Note:

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