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Vol. 4 (2011), Issue 1 (1-115)

Contents:

Dear reader 5

Mislav Lozovina, Vinko Lozovina and Dobromir Bonacin
(Invited scientific article)
Paradigm of methodological theory and mathematical modulation of sports training . 7

Raphaël Dolléans, Denis Hauw, Melissa Day and Philippe Saramejane
(Review article)
Psychological processes involved during acrobatic performance: a review . . 19

Iraj Sadri, Morteza Jourkesh, Sergej M. Ostojić, Julio Calleja-Gonzales, Ali Ojagi and Abolfazl Neshati
(Original scientific paper)
A comparison of EMG fluctuation of deltoid and pectoralis major muscles in bench press 30

Francecso Perrotta, Felice Corona and Carla Cozzarelli
(Review article)
The efficacy of the project Motorfit: educational actions through physical activity in schools 34

Boyanka Peneva and Danijela Bonacin
(Review article)
Conceptions about physical education at schools 40

Christopher R. Edginton, Chin Ming-Kai and Dobromir Bonacin
(Global statement)
Health and Physical Education: A New Global Statement of Consensus . . 45

Boris Glavač and Marjan Marinković
(Original scientific paper)
Glucose level in blood according to physical stress at sportsmen . . . 50

Julijan Malacko
(Review article)
Preventive management in sport – a challenge of new ideas 55

Nasim Habibzadeh
(Original scientific paper)
Effect of physical activity on body water in sedentary young underweight and obese women 60

Journal text is avaliable on http://www.sposci.com/

ISSN 1840-3662

SPORT SCIENCE

International scientific journal of kinesiology

Vol. 4 (2011), Issue 1 (1-115)

Contents (continuing):

Tomislav Gašić, Saša Bubanj, Mladen Živković, Ratko Stanković, Radoslav Bubanj and Borislav Obradović
(Original scientific paper)
Difference in the explosive strength of upper extremities between athletes in relation to their sport activity, type of engagement in sport and gender . . 63

Romana Caput-Jogunica, Sergio De Privitellio and Sanja Ćurković
(Original scientific paper)
Metrical characteristics of the battery of body power tests suitable for pre-school children 68

Julijan Malacko and Veroljub Stanković
(Original scientific paper)
Canonical relations between variables of coordination abilities, variables of morphological characteristics and motor abilities of boys aged 11-12 . . 73

Joško Sindik, Damir Nazor and Joško Vukosav
(Original scientific paper)
Correlation between the conative characteristics at top senior basketball players . 78

Goran Sporiš, Zvonimir Tomac, Darija Omrčen, Mario Baić and Dražen Harasin
(Original scientific paper)
Motor learning without external feedback when testing motor coordination . . 84

Mislav Lozovina, Vinko Lozovina and Leo Pavičić
(Original scientific paper)
Analysis of certain indicators of the load in the play of external attacker in today's water polo 89

Goran Oreb, Jadranka Vlašić and Meta Zagorc
(Original scientific paper)
The efficiency of a dance training on some motor abilities of folk dancers . . 96

Mohammad T. Aghdasi and Morteza Jourkesh
(Original scientific paper)
Comparing the effect of massed & distributed practice in different stages of discrete motor task learning 101

Zoran Pajić, Žarko Kostovski, Jelena Ilić, Saša Jakovljević and Adem Preljević
(Original scientific paper)
The influence of inertial load application on kinematic and dynamic performances of running at maximum speed phase 107

Guidelines for authors 114

Journal text is avaliable on http://www.sposci.com/

ISSN 1840-3662

SPORT SCIENCE

Međunarodni znanstveni časopis iz kineziologije

Vol. 4 (2011), Broj 1 (1-115)

Sadržaj:

Dragi čitatelju 5

Mislav Lozovina, Vinko Lozovina i Dobromir Bonacin
(Pozvani znanstveni članak)
Paradigma metodološke teorije i matematičke modulacije sportskog treninga . . 7

Raphaël Dolléans, Denis Hauw, Melissa Day i Philippe Saramejane
(Pregledni članak)
Psihološki procesi uključeni za vrijeme akrobatskih izvedbi: pregled . . . 19

Iraj Sadri, Morteza Jourkesh, Sergej M. Ostojić, Julio Calleja-Gonzales,
Ali Ojagi i Abolfazl Neshati
(Izvorni znanstveni rad)
Usporedba EMG fluktuacije mišića deltoideusa i pectoralisa major u bench pressu 30

Francecso Perrotta, Felice Corona i Carla Cozzarelli
(Pregledni članak)
Efikasnost projekta Motorfit: edukacijske akcije kroz tjelesnu aktivnost u školi 34

Boyanka Peneva i Danijela Bonacin
(Pregledni članak)
Koncepcije o tjelesnom odgoju u školama 40

Christopher R. Edginton, Chin Ming-Kai i Dobromir Bonacin
(Globalna izjava)
Zdravlje i tjelesni odgoj: Nova Globalna izjava o konsenzusu 45

Boris Glavač i Marjan Marinković
(Izvorni znanstveni rad)
Razina glukoze u krvi u skladu s fizičkim stresom kod sportaša 50

Julijan Malacko
(Pregledni članak)
Preventivni menadžment u sportu – izazov novih ideja 55

Nasim Habibzadeh
(Izvorni znanstveni rad)
Učinak aktivnosti vježbanja na tjelesnu vodu kod sedentarnih mladih mršavih i gojaznih žena 60

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SPORT SCIENCE

Međunarodni znanstveni časopis iz kineziologije

Vol. 3 (2010), Broj 2 (1-115)

Sadržaj (nastavak):

Tomislav Gašić, Saša Bubanj, Mladen Živković, Ratko Stanković, Radoslav Bubanj i Borislav Obradović
(Izvorni znanstveni rad)
Razlike u eksplozivnoj snazi gornjih ekstremiteta između sportaša u odnosu na njihovu sportsku aktivnost, vrstu angažmana u sportu i spol . . . 63

Romana Caput-Jogunica, Sergio De Privitellio i Sanja Ćurković
(Izvorni znanstveni rad)
Metrijske karakteristike baterije testova tjelesne snage primjerene djeci predškolskog uzrasta 68

Julijan Malacko i Veroljub Stanković
(Izvorni znanstveni rad)
Kanoničke relacije između varijabli koordinacijskih sposobnosti, morfoloških karakteristika i motoričkih sposobnosti kod dječaka uzrasta 11-12 godina . . 73

Joško Sindik, Damir Nazor i Joško Vukosav
(Izvorni znanstveni rad)
Povezanost između konativnih karakeristika kod vrhunskih seniorskih košarkaša . 78

Goran Sporiš, Zvonimir Tomac, Darija Omrčen, Mario Baić i Dražen Harasin
(Izvorni znanstveni rad)
Motoričko učenje bez vanjskog feed-backa u testiranju motoričke koordinacije . 84

Mislav Lozovina, Vinko Lozovina i Leo Pavičić
(Izvorni znanstveni rad)
Analiza određenih indikatora opterećenja u igri vanjskog napadača u današnjem vaterpolu 89

Goran Oreb, Jadranka Vlašić i Meta Zagorc
(Izvorni znanstveni rad)
Učinkovitost plesnog treninga na neke motoričke sposobnosti plesača narodnog plesa 96

Mohammad T. Aghdasi i Morteza Jourkesh
(Izvorni znanstveni rad)
Usporedba efekata nagomilanog i distribuiranog vježbanja u različitim stanjima diskretnih motoričkih zadataka 101

Zoran Pajić, Žarko Kostovski, Jelena Ilić, Saša Jakovljević i Adem Preljević
(Izvorni znanstveni rad)
Utjecaj primjene inercijskog opterećenja na kinematičku i dinamičku izvedbu trčanja u fazi maksimalne brzine 107

Guidelines for authors 115

Tekst časopisa je dostupan na http://www.sposci.com/

Human is only sedge, lowest on the Earth, but it is sedge that thinks. (B.Pascal)

Dear reader,
"Under" all of this heavenly breadths and galaxies, on the position of 'Third stone from the Sun' it becomes a creature which acts in manner that leave us without breath. That creature – a human, although dissimilar and bizarre, neglectful and forbearing, rough and gentle, crude and developed, impetuous and methodical, poor and rich, huge and diminutive, always newly exalts and amaze us. All of that together represents continuous line and composite of all of its values. And that is its biggest treasure and at the same time its biggest scope. Inside such deliberation, sometimes he acts in science, and modest part of that acting is this journal. If we behold contributions that accomplish criteria for this issue, and if we behold regions that authors came from, as well as themes, with pleasure we can specify those places consecutively as Split, Travnik, Montpellier, Chichester, Paris, Nanterre, Shabestar branch, Novi Sad, Marand branch, Perugia, Naples, Sofia, Cedar Falls, Valencia, Belgrade, Rasht, Niš, Zagreb, Rijeka, Leposavić, Osijek, Ljubljana, Tabriz, Novi Pazar and Skopje. This really imposing list "speaks" about science without frontiers and that such communications really makes a World "smallest" than we sometimes imagine it. Deeply assured that this is accurate way, and with avocation to you to join us, we hope that this issue themes are equally interesting as hitherto and that you will find something for you from this storefront that could abet you on reflection. Yes, human is really "sedge that thinks", and Blaise Pascal appreciates that still there in the middle of XVII century. Right with that message, we leave you with your minds, emotions and comprehensions, because those are biggest scopes of human race at all.

Executive Editor
Danijela Bonacin, MSc.

Čovjek je samo trska, najslabija u prirodi, ali to je trska koja misli. (B.Pascal)

Dragi čitatelju,
"Ispod" svih ovih nebeskih prostranstava i galaksija, na poziciji 'Trećeg kamenčića od Sunca' nastao je stvor koji djeluje na način koji zaista ostavlja bez daha. Taj stvor – čovjek, iako raznolik i neobičan, nepažljiv i obziran, grub i nježan, primitivan i razvijen, nagao i promišljen, bogat i siromašan, velik i sićušan, stalno iznova odušavljava i zadivljuje. Sve to zajedno jest neprekidna nit i kompozit svih njegovih vrjednosti. I to je njegovo najveće blago i ujedno najveći domet. Unutar takvih promišljanja, ponekad djeluje i u znanosti, a skromni dio tog djelovanja je i ovaj časopis. Promatrajući priloge koji su ispunili kriterije za ovaj broj, i promatrajući sredine iz kojih dolaze autori, kao i same teme, valja navesti sa zadovoljstvom da su te sredine redom Split, Travnik, Montpellier, Chichester, Paris, Nanterre, Shabestar branch, Novi Sad, Marand branch, Perugia, Naples, Sofia, Cedar Falls, Valencia, Belgrade, Rasht, Niš, Zagreb, Rijeka, Leposavić, Osijek, Ljubljana, Tabriz, Novi Pazar i Skopje. Zaista impozantni spisak govori o tome da znanost nema granice i da ovakve komunikacije zaista čine svijet znatno "manjim" nego li ga mi često doživljavamo. U dubokom uvjerenju da je ovo ispravan put i uz poziv da nam se i vi priključite svojim prilozima, nadamo se da su vam teme ovog broja jednako zanimljive kao do sada i da ćete za sebe pronaći barem nešto iz ovog izloga a što će i vas možda potaknuti na promišljanja. Da, čovjek je zaista "trska koja misli", a Blaise Pascal je to shvatio još tamo sredinom XVII. stoljeća. Upravo s tom porukom, ostavljamo vas s vašim mislima, osjećajima i spoznajama, jer su to najveći i najvažniji dometi ljudskog roda uopće.

Izvršna urednica
Danijela Bonacin, MSc

PARADIGM OF METHODOLOGICAL THEORY AND MATHEMATICAL MODULATION OF SPORTS TRAINING

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Invited scientific paper

Abstract
Training (or transformation process) is a series of operations that is applied in a specific time interval, where each one has its own important characteristic such as: operation content, the way operation is performed, the size of subject activities over which the operation is performed. Paradigmatic and methodological conditions in transformation processes inevitable leads to modulation of such process based on precise methodological presumptions and mathematical definitions. It is of minor importance that some of conditions and occasions could not be monitored and controlled absolutely, because well planed and programmed process includes some type of possible discordance with 'ideal' state defined in starting position. Anyway, after acceptance of methodological presumptions, the only tool we can seriously accept for controlling and evaluation of training is mathematical. This article tries to point on some such major comprehensive allocations that can be of great importance for training understanding, modulation identification and recognition and with global ideas included.

Key words*: training, global, methodology, paradigm, mathematics, modulation*

Introduction

Words: training, education, kinesiology procedures are synonyms in domain of kinesiology transformation. Changes that occur under the action of kinetic operators (exercises) are always changes in entire personality so that in real cases it is not possible to study isolated structures. Each training has to begin with information about two essential components: purpose of these changes and characteristics of those we want to change.

In order to serve the information for training programming, it has to be explicitly defined and objectively characterized according to subject we are changing. Practice today differs from these principles. Besides this, we have to pay attention to realistic space that has to be defined and its coordinates are: time, tangible assets, organization and everything we can express as monetary value. There are controversies between different goals: a) controversy training – educational process. In both cases the purpose is transformation (achieving functional efficacy). The only question is a matter of difference between domains where functional efficacy is achieved in. Man is naturally an integral being, which has the function of integral development (Malina & Bouchard, 1991; Malacko, 2000; Dodig, 2008; Bonacin et al., 2008; Lozovina, 2009; Bonacin & Bonacin, 2010). There are no differences between those two processes in practice but technical nature. b) Controversy reaction – sports training, functional efficacy has to be maintained and improved and there won't be any elemental differences. c) Controversy of differences between quantity and quality changes. Quality changes are changes in dimension relations. All changes are both quality and quantity because of the changes in the size of certain dimensions and relations between them.

Thus, the differences described by controversies exist but they are not inherent methodological but principally technological (Pavičić, 1991; Trninić, Jelaska & Papić, 2009a; 2009b; Trninić & Dizdar, 2001; Lozovina, 2009). Considering domains where differences are projected, both structural (quality) and quantity are only useful way of observing the effects, essentially differences are always procedural, since according to controlled or accumulated all entities are located along continuum (Bonacin, 2005). It is clear that sport is aiming towards upper supraliminal limit of specific motor skills in a regime of high energy engagement, that education (teaching) is development process in all segments in the liminal area, while for e.g. recreation is always activation of potential in harmony with the preserved function and therefore in the area that is still subliminally as complex. Hence, in all situations basically we talk about training.

What exactly is training?

Training is a series of operations that is applied in a specific time interval, where each one has its own important characteristic such as: operation content, the way operation is performed, the size of subject activities over which the operation is performed. The more accurately the aim of the operation gets achieved the more accurate efficacy gets. Kinesiology operator is the operation we use to accomplish some change. This is a series of distinct (mutually separated) operations i.e. procedures. Observed strictly, each of them produces some change, effect. This effect could, but not necessarily has to be in accordance with expected goal. Kinesiology operations are typical cybernetic processes (Dodig, 2002; Lozovina et al., 2008).

Problem of final state definition

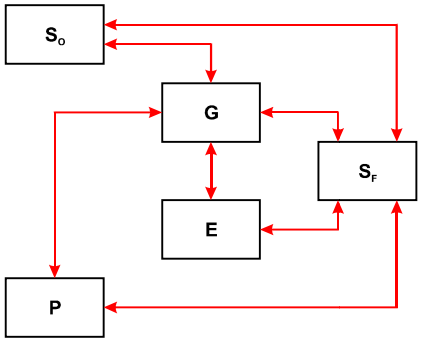


Figure 1. Model of general training parameterization (Source: Lozovina, V.)

(S0 = initial state, Sf = final state, St = transitive state, e = evaluation device, p = device which informs generator about the state in u s0 sf i e, g = generator)

According to image 1, entire process of approaching final state can be defined in two ways: 1. to approach the final state with permissible error regardless number of training and other circumstances, and 2. number of trainings is given (Lozovina, 1986; Matvejev, 1999; Kurz, 2001; Lozovina, 2001; Lozovina, M. et al., 2007). Generator (g) has the task to produce certain structure. The production goes as follows: based on information about the function of the group or individual in final state, what is the functional efficiency. Final state is projected as functional efficiency into device which further generates operators in order to come closer to the desired final state. This desired final state also has to be defined. Efficiency device (e) is a system of filters which explains which features are desirable and which are not. This device has to have information that will help result evaluation. The principle of his functioning is simple: he is checking is the final state structure congruent with the structure that ensures maximal desired sports result. In this case the device is acting as multiple production device, which is, according to characteristics Sf, determining whether the exact desired result can be achieved. It actually predicts how a man will act in such Sf state. When Sf is not defined by some external criteria the evaluation system has to exist (e). This system does not evaluate under certain activity but under optimal structure personality model which is always a value system product accepted in some environment. Evaluation of certain personality dimensions and relation between dimensions is at the same time the subject of science but also ideology. Value system is mostly defined ideologically. 2. Generator Sf has to operate a few more data. The essential one is an allowable cost. Device p, which informs generator about how much the society, is willing to pay for the work done, is responsible. Now let's see what g device is. This device has to gain information: information of material type, i.e. what is available. This information differs a lot from the one generates by the evaluation operator and cost operator.

This information refer to a man, and this is no longer independent operation of specific people, either individual or team. This information could be of the state where we begin transformation which we usually call (S_0) or initial state. However, this could be any other state but initial, including transitional state. However, comparison of this (whichever it is) and final state has to exist in order to generate (Sf). Device e (evaluation), p (which informs g device about S_0 and sf and e device state) does not behave independently from (S_0). Regardless of their primary independence, which stems from their position in entire structure, they are independent only logically but not as devices in the system. Human beings are not suitable devices for generating of Sf-a. They do not posess enough efficient processors in their nervous system which would enable production of some (Sf) based on certain parameters. Humans are capable of producing i.e. programming process, study technical means and the way of how to perform the generating operation (Sf), but the job should be done by machine or device capable enough.
Model can be viewed in image 2.

Global definitions

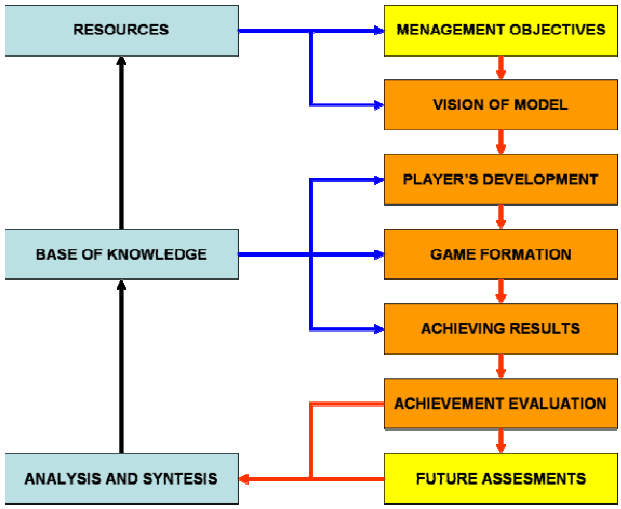


Figure 2. Development phases in sport (Source: Bonacin, D., & Bonacin, Da, 2008)

Obviously, special problems occur in the definition of environmental monitoring requirements (Pavičić et al., 1987; Bonacin, Da., & Bonacin, 2007; Bonacin & Bonacin Da., 2008; Dodig, 2008). In this sense, there are two possible considerations. One aims toward specific supervision from the beginning of any objective definition. This was defined with image 1. Previously defined model (image 1) exactly fits into a global model that begins with vision model (Vision of the model) and ends with an evaluation of achievement (Achievement evaluation). However, management objectives of model are elements of MANAGEMENT (*Resources*), middle part is element of the theory of training in the narrow sense (the Base of Knowledge), and Achievement Evaluation and Future assessments are elements of SCIENCE (Analysis and Synthesis) (Lozovina et al., 2004; Đurović et al., 2008; 2009).

The second consideration aims toward three circles of EXIT regulation: 1 The complex of athlete or a team (Execution), 2 The complex of technical knowledge (Support), and 3 Complex of results in real terms (Universum).

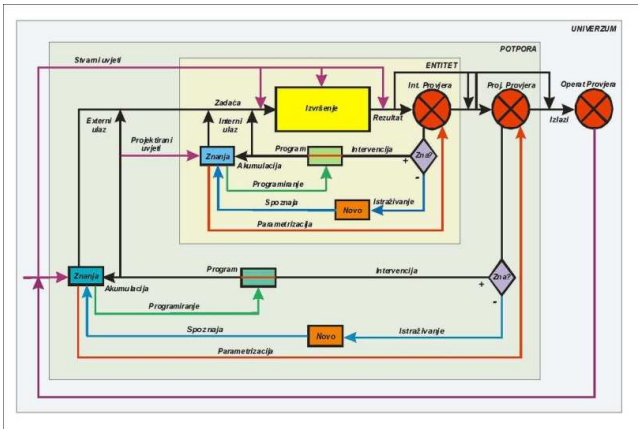


Figure 3. Sports knowledge and advancement (Source: Bonacin, D., & Bonacin, Da, 2007)

Training space

Initial state S_0 is most simply defined as a vector that includes a set of dimensions, i.e., one set of human qualities or abilities. This is the image of this vector:

$$\begin{vmatrix} \vec{Z}_{1,0} \\ \vec{Z}_{2,0} \\ \vdots \\ \vec{Z}_{i,0} \\ \vec{Z}_{2,0} \end{vmatrix}$$

z_1 = characteristic with index 1;

($z_{1,0}$ = characteristic in state 0 or initial state)

This proves these are the coordinates of that person, or group, in a space defined by the dimensions. Let's assume we only have two dimensions and name them factor 1 and 2, and let's say these two factors are mutually orthogonal. Let's assume a man has positive characteristics in both dimensions. Values are a little higher in f2 then f1.

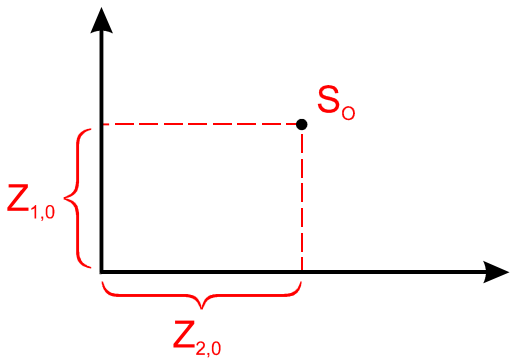


Figure 4. Orthogonal model (Source: Lozovina, V.)

S_0 can be interpreted as a point of a man, where, in the beginning measured dimensions, present coordinates of this point, coordinates of a man in measuring system. The reality is different. Differences between the orthogonal projection and coordinate are arising due to the angle of the closing of these two dimensions. Orthogonal coordinates and dimensions are identical only under the condition that coordinate system is orthogonal, and he really isn't. Let's now define (Sf) with some point.

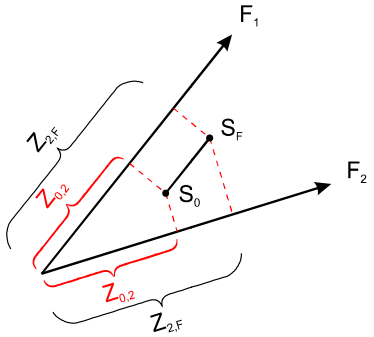


Figure 5. Realistic model (Source: Lozovina, V.)

A man "has moved" from (S_0) to (Sf) under influence of some operator (exercise in a training). Its dimensions are obviously better in both factors 1 and 2, and certainly its orthogonal projections are bigger. But while coordinates in dimension f1 are bigger, they are smaller in dimension f2. What actually happened? He approached dimension f1 even though he improved in dimension f2. Assuming that dimensions are for the set of people who participated in transformation program (training) remained unchanged, i.e. unchanged relations, our man has changed. Since he exists in reality, he deformed this space changing himself, since this space can not be observed the same as before transformation, so it has changed structurally (qualitative) as well. Regardless his change in both dimension directions, the dimension f1 dominantly defines it. He changed quantitatively in both dimensions, but also changed space structure – actually he changed qualitatively.

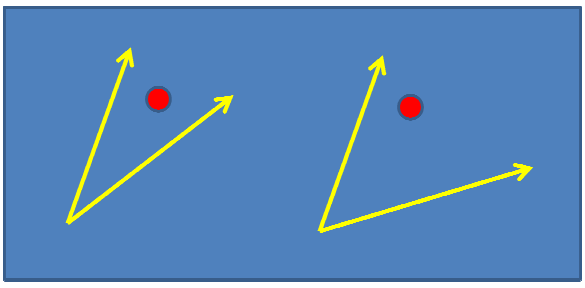


Figure 6. Space deformation (Source: Bonacin, D., 2005)

Our changes are basically quantitative and qualitative. However, the ability of a man's movement in this area is not so simple. Let's imagine that one of the dimensions is height and the other one is weight (their correlation 0, 66). Let's assume these people are exercising for a year.

It is certain that the height will not change (especially after age of 23), however weight can change a lot (diet or excessive food intake). Let's assume weight increased and then he moves only in one direction (image 7).

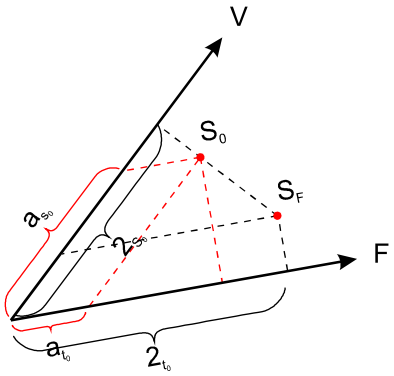


Figure 7. Real model
(Source: Lozovina, V.)

Orthogonal projection on height remained the same. A man has come to a new (Sf) where his projection on a height remained the same, but extremely changed on weight. But his coordinates changed, hence his structure has changed. It's not the same man. Why did this happen? Since we have no idea of how big freedom of movement is along certain dimension, there is no way theoretically or practically to generate any kind of (Sf). The standard way of approximating the freedom of movement on any of the dimensions is to calculate the ratios of innateness in these dimensions. Coefficient of innateness is not parameter dependable only on dimension itself. He is biologically, economically, pedagogically and socially dependable. Holcinger suggested it (in 30-years of this century) and defined it as a ratio between genotype and total variance of one dimension.

$$h^2 = \Theta F^2{}_G \;/\; \Theta F^2{}_E$$

This formula was derived from one simple linear model on the assumption that total variance of certain factor can be defined as the sum of the layout, genotypic, and some exogenous, phenotype, i.e. the one that appears due to the influence of external factors

$$\Theta F^2 = \Theta F^2{}_G + \Theta F^2{}_E + F^2{}_{GE}$$

According to this theory, if everyone had the opportunity to be subject to the same transformation process, living under the same conditions, the differences between them would be defined by genetic code and innateness coefficient would tend to be 1.00 (Dick, 1997; Dežman, 1998; Clark, 2001). Imagine a situation where there is any distribution area in which people are exposed to different transformation operators, therefore they live in different conditions. The differences will appear not only due to their genetic differences but due to entire system of conditions they developed in. Let's take an example of two countries. In one country high school is graduating 80% of people and in the other one 50%.

If these schools give approximately the same stimulus is obvious that the coefficient of innateness in the first country will be higher. Coefficients of innateness are different in each country, but our important characteristic is we have no data of innateness coefficients for our population. Luckily there are possibilities to use certain borders and coefficients of other countries (example from the USA) which are obviously too big for us but certain comparisons are possible. If some dimension is defined by genotype, which is the case when it has equal genotype variance in a few countries, we could confirm this dimension is mostly dispositional. If some dimension has small variability coefficient in one country, this does not necessarily mean that in the other country innateness coefficient will be small as well. Second necessary data is data of freedom of movement where the transformation is being performed. This is information about the processes of maturation under standard conditions. These data are obtained as a credible longitudinal monitoring, but they are very reliable if you get a well-designed and applied transverse sections (monitoring). According to this data we obtain curves of certain dimension development. Realistic variability of some psychosomatic traits is possible at a model that resembles Holcinger's but introduces a new concept, a new variable and actually looks like:

$$\Theta F^2 = \Theta F^2{}_G + \Theta F^2{}_E + F^2{}_{GE} + X^2{}_{DG}$$

This last term in the equation denotes the interaction between the layout and exogenous components of variance. This is not a matter of statistical finesse, but it's basically sociological nature. Layout component acts as a filter to exogenous factors. The same objective environment is not the same for people with different layout characteristics. Therefore the actual variability of a psychosomatic dimension depends on the interaction of exogenous variability of conditions and the layout. The conclusion would be that by giving equal objective opportunities to people in different disposition components, we fairly put them at disadvantage. The theory of equal chances and opportunities is a false theory that does not conserve starting differences that appeared earlier but emphasizes them.

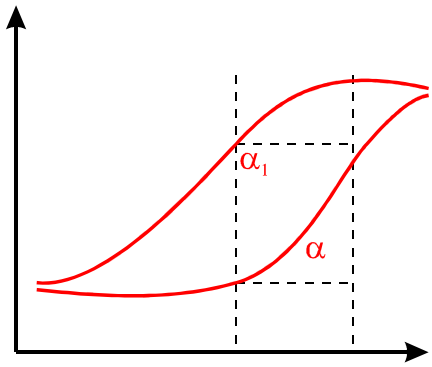


Figure 8. Development curves
(Source: Lozovina, V.)

Illusive objective equality is actually no equality. The actual ability to impact some psychosomatic dimension lies in the fact that each individual make such information or receive such training that is appropriate for him. Obviously, it can not provide the same training opportunities, but only the maximum for each person. Then we can discuss about how much of the maximum we want to realize. Another problem is the problem of the development curve. If we divide people into: 1 below average, 2 average, and 3 above average, we get the possible situations as in Figure 8.

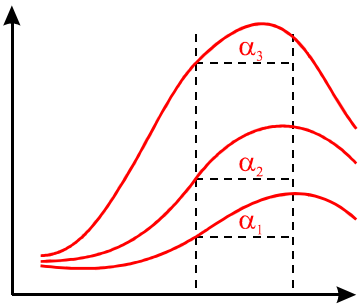


Figure 8. Development curves (continuing)
(Source: Lozovina, V.)

For an explanation of this problem a few words about the factor and taxonomic analysis. Efficiency of transformation process is inversely proportional to some function of the distance between the state a man was brought to and predicted final state of a partly set goal. Commonly, the inefficiency is measured with the distance between desired and actually reached state and thus defined vectors as orthogonal projection of a man in such a system of dimensions (distance Malanobis's) we use as a measure of distance and efficiency

s0------s1-------s2--------si---------sx.

The conclusion would be:

$$\left|S_F\right|\left|\hat{S}_F\right| \quad D^2=(\hat{S}_F-S_F)'R^{-1}(\hat{S}_F-S_F)$$ where is

R^{-1} = inverse matrix of dimension inter-correlation

If we consider two vectors, one of initial state (S_0) and (Sf), that wouldn't be real, especially if all dimension within vectors are given the same relative importance. This we solve applying the procedure of weighting the projection on dimensions. It is usually some diagonal matrix:

$$w=\begin{pmatrix} w_1 & & \\ & \ddots & \\ & & w_n \end{pmatrix}$$

The coefficients within the diagonal represent the size of the proportional importance toe each psychosomatic dimension. Objectively determining the relative importance of each dimension is actually the operation which determines the regression weight of this dimension regarding some criterion variable. From this it is obvious that the system of weights in the sport, which is evaluated each dimension, can not be directly derived from the regression of operations.

It is usually done within canonical operations, i.e. psychosomatic dimensions projections on polydimensional system which describes possible situations that such man could find himself in, and then from the results we determine hierarchic structure according to the importance in certain sport. Training is a process directed toward minimization of distance between predicted final state and the one obtained with applied operations. The following rule applies: Objective behavior in any situation is possible only when there is a function whose extrema can be found, either minimum or maximum. The following problem is connection between reached state in early sequence and the state we are just about to create operator. General rule applies that state in any measured point depends on the states in the earlier points. Thus, the process of training is a stochastic process, and this situation can be called and described as Markovljev's chains or similar operations. However, if the rule applies (and it does) that the states in any measured point depend on the states in earlier points then the stochastic issue is not a real issue, but the question is accumulation and hence these are not only Markovljev's chains but certainly process parameters of accumulation.

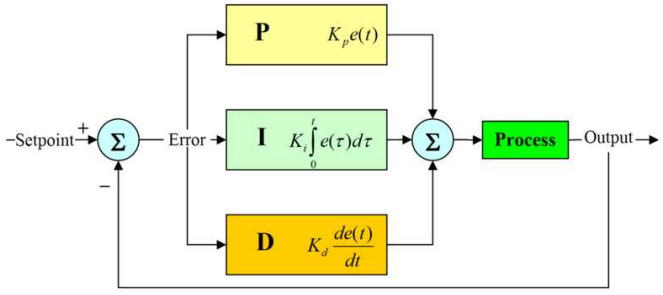


Figure 9. Universal Process Controllers
(Source: Bonacin, 2009)

This can be presented in two ways: The first method: Simultaneous monitoring of the process with at least proportional, derivative and integrative response (Fig. 9). In this case there are two systems of training process integration and they are marked with a summation at the entrance (after setpoint) and the output from the process. Certainly, training is always polydimensional system with starting position which sets criteria of achievement (setpoint).

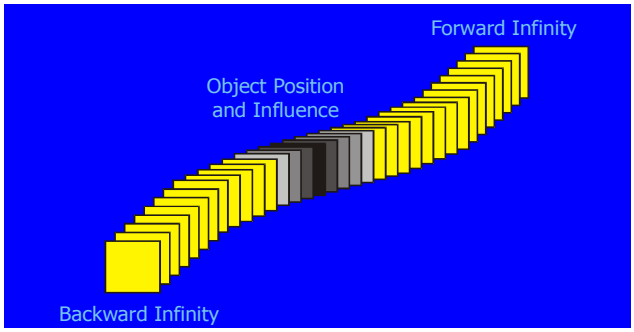


Figure 10. Comprehensive continuum
(Source: Bonacin, D., 2005)

The second method: Universal comprehensive continuum within which "sideways" oscillate local (transitive) values and "back and forth" values of the achievement (fig. 10). In this epistemological format, an entity (whatever that was) cognitive (whatever that means) is progressing along the continuum and the width of the individual accumulation to that direction is generally transversely defined. It is obvious that there are real limits to the natural laws that make it impossible to progress along a continuum but to keep the same maximum width (Bonacin et al., 2009; Bonacin & Bonacin, 2007; 2008). Training programming is a problem that is solved in various ways including markov's chains, i.e. the number of prior state that influence the state we create operator for, but with accumulation in form of cognitive continuum as well. It is fortunate that suitable transformation can always result with acceptable system (e.g. markovity 1 – which means the system where the state directly depends on the previous) or accumulation set by integral which describes total surface but in essence the amount of acquired and absorbed regarding desired final state. The totality of this presentation requires knowledge of some parts of mathematics without which it is impossible to solve these problems. (Bompa, 1994; Clark, 2001; Dodig, 2008; Gambeta, 1989; Lozovina, 2001; 2008; 2009; Malacko, 2000; Malina and Bouchard, 1991; Muller, 1999; Pavičić, 1991; Trninić et al., 2010).

Volume issue of kinesiology transformations

Another problem are the devices we use to collect information about changes that are in our profession extremely primitive. Reasons: 1. They take very long time, 2. Small reliability, 3. Validity even worse. This is an area solved by kinesiometry (theory of measurement). Under the volume of work in training, in modern physiology and psychology implies a cumulative composite of intensity and extensity and the energy equivalent is mainly volume. Under the names of the load or intensity, or scope includes only the energy terms that refer to the amount of work, amount of effort, duration of labor or other energy components (Johnson, 1997; Komi, 1998; Dodig, 2002; Hraste et al., 2008; Lozovina et al., 2009). The volume mainly consists of three components: 1 energetic, 2 programming, and 3 synergy. In mathematics function derivation along with integrals are the basis of infinitesimal calculus which has wide application in all scientific and many other areas where calculation of function development in certain interval is necessary and kinesiology transformational processes are exactly that. Geometric interpretation of this issue describes it with the slope of the tangent to the derivative function at a certain point, which gives us speed of reply of some subprocess training, i.e. local process stability while his coefficient m is as follows:

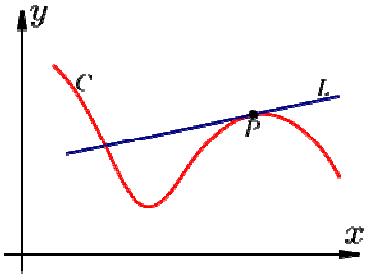
$$m = \frac{y2 - y1}{x2 - x1} \quad .$$

and since

$$m = \frac{f(x+h) - f(x)}{(x_0 - h) - x_0} = \frac{f(x-h) - f(x)}{h}$$

because $(x_0 + h) - x_0 = h$ i $\Delta x = h$, function derivation is:

$$Df = \lim_{h \to 0} \frac{f(x_0 + h) - f(x)}{h}$$



Slika 11. Derivation of oscillator process function (Source: www.wikipedia.org)

(Directional *L* tangs function *f* in point *P* which derivation conforms elevation of directional *L* in point *P*)

Such ideas are possible to explore in terms of Process identification (Bonacin & Carev, 2002; 2010; Bonacin et al., 2003; Bonacin et al., 2005; 2005; Bonacin & Blažević, 2006; Bonacin, 2010). Direction coefficient is closely related to derivation because when the interval $x_2 - x_1 = h$ tends to zero the line becomes tangent function and limit to his direction coefficient becomes derivation of function f in point $(x_0, f(x))$. Function derivation is nothing but stability of training process in analyzed section in this case synergic integrative subprocess regarding final state defined with superposed values of actual state according to limes which describes actual or the total final state. If, in this regard, we mark synergistic component as interactive, that involves some continuous intervention options with derivation aiming toward fine function and under assumption of familiarity then the problem is further solved by the influence on energetic and IT component. In similar way any component can be "excluded" just as it is possible in the same manner to reveal the correctness of any part of the overall training subprocess, which we will mention later in context of load and effects. The total volume of work during a workout is a function of energetic and computer information. Different training courses could have different ratios of energetic and IT components. The equation for the volume could be: vj= a1 e + a2 where a1a = energetic component and a2 IT component. The size of energetic component, if linear model is accepted (not the best model, but the simplest one) is weighted sum of three components e= a11 s + a12 t + a13 b while a11s = force that must be developed during the activity, a12t = activity duration and a13b = speed of activity performance. It is interesting to emphasize that the same physical size that develops during the course of a kinesiology activity for one person may represent submaximum for the second optimal and for the third no stimulus.

This proves that: Objective quantities, such as force, duration, speed, power, etc. are objective values in the physical sense, but not equivalent to real anthropological sizes. Similarly we can define IT component: ij = a21 h (e) + a22 h (d) + a23 h (te), where: a21 h (e) = average measure of transmitted information a22 h (d) = entropy of decoded information, a23 t (e) = emission duration, while e=-i, e= disorder, i= an order. If during training situation is changing a lot, then the entropy of the emission is large. The same number of situation changes, hence the same objective information entropy will present for someone big IT effort and none effort for the other one. Regarding entropy of decoded information, some man can decode more and some less information. The duration of emission is not easy to explain. It's not the same if some material is carried for 4 hours or 15 minutes, even if it's the same amount of decoded information. If it is necessary to decode certain amount of emitted information in 5 seconds, its one thing and it's totally different if available time is 5 hours. According to stated, the volume of work would be as follows:

$$v = a11\ s + a12\ t + a13\ b + a21\ h\ (e) + a22\ h\ (d) + a23\ h\ (e)$$

When we choose some work content in training we haven't done much. We certainly have to define it at least in context of mentioned six volume components. Apropos, duration of both processes must be the same. It is certain that the various components produce different effects, not by how they vary, but how the entire system varies. We can conclude: If one of volume models is linear, the model of volume effects is certainly not. Theoretically, it would be neat if you could incorporate the interactions among all the primary components. Let's now check one rule regarding work volume. Volume grows to a certain point, and there is no increase on factor. This volume is immune as it is not there, since its effect is 0. This point (t) is changeful for humans. All people have volume sizes that do not produce effects and this type of volume size we call subliminal. This is one of fundamental data for training programming, which proves there are loads objective according to type, actual work, which does not produce any effects. So, exercise where we spent the time but did not provoke any change, which is the same like we didn't do anything, except if the goal was only maintaining functions. Loads, therefore, have to reach some limit to take effect. From some point volume starts increasing and gives acceptable effect to a certain point which we call supraliminal volume, when the gain per feature is small or there is none. Adding the load at that point no longer produces a positive result. Since the typical load curve has a logarithmic flow, the first point found is the first derivation of this function. The second point is a second derivation of this function. However, it is possible to find the third derivation of this function, hence, a point after which further increase in volume does not produce effect in dimensions, only maintains the current state. If it reaches this point it is possible to reorganize the volume by changing the ratio of its components. It can still continue to increase, but now as a new structure and in this case certain improvement cam be attained. The second method is to change working content. If you play basketball you will not stop playing basketball and start playing soccer. You will keep on playing basketball but you will reorganize element structure, change technique, tactics etc. Ejecting elements is a classical approach to reorganization in some sport. When a sportsman reaches certain level, some elements are ejected from working content (Bompa, 1994; Dodig, 2002; Dopsaj, 1998; Komi, 1998; Kurz, 2001; Lozovina et al., 2001; 2004; 2009; Lozovina et al., 2007).

Modality definition tasks

Modality implies the way of conducting some operator, whether it is a change in dimension or basic problem in IT matter, i.e. collecting certain amount of information. Using transformation operators we can do two things: 1. We can change personality dimensions and 2. We can increase information amount. In any case you should take into account the situational reorganization and optimization that can be executed regardless of the nature of the training preparation. This part of unknown in the system can not be regarded as an error even it actually is under the aspect of programming, but under the aspect of effects doesn't have to be an error. Modality must include information about the situational part of the positive effects that are not programmed but achieved. Mathematical model of this function should agree with the settings presented in figures 5 and 9. . This is especially true in the context of motor information. First we will define what motor information is. It is a set of data stored in the CNS, which allows the realization of a motion, and since it enables motion we could call it a program by which the motion is carried. Motor programs stored in CNS can be on different levels: 1. Level – on this level only initial impulse is enough, a signal, after which the program continues automatically. Motor information of such type do not require additional processing in order to conduct the program (closed previously parameterized algorithm), 2. Level – some motor information can be stored but for their realization additional information is necessary. They can arrive to NS from the outside or some other parts of NS. In such programs, it requires additional information but not the reconstruction itself. Program is still functioning, but it needs some additional information on order to work (closed algorithm with external parameters), 3. Level – is the level of motor information that is semi-structured: Such program also requires not only additional information, but in order to conduct itself the program has to reconstruct each time i.e. re-create. This is the program which is conducted and when its finished the movement can be carried out.(opened algorithm with subprogramming), and 4. Level - is the one where a program for execution of motion does not exist.

There is only information of how the program can be done. Thus the program that after given signal has to be completely created (open initial idemotor algorithm or an open rudimentary algorithm). In order to obtain certain motor information on the level that enables its appliance certain number of repetition is required (from 3000 – 10000 times). If the number of repetitions is small, information was obtained on level 4. Program was noted, tested but not acquired. This fact proves us a rule that a man can not gain an infinite amount of motor information. Further, there always have to be a selection of information, some smart choice which is not an easy job. According to Bonacin & Co, (2008) programming is performed by reduction (redundant program material), adding (non-existent and necessary material), and optimization (of available material for physical and other parameters). Selection of activities and disciplines should be such to acquire useful information and thereby to change as much dimensions which define psychosomatic status towards aimed direction as possible (ideal final state) (Dodig, 2002; 2008; Dick, 1997; Korenberg, 1979)

Measure of the degree of acquired motor information

1. First parameter measured is the time which passes from start to beginning of motor action (time from signal to start), 2. Next parameter is the time that passes from start to finish (end) of motor action, 3. In order to obtain precise information of the efficiency of motion level we reach for the parameters in biomechanics, i.e. any movement, or assembly, can be analyzed and defined by system of curves or trajectories that describe different points on the body and are specific for that motion. (Selspot system or Ariel) 4. Each movement is performed in a certain area, so besides trajectories, forces acting during motion whether in contact or no contact phase relative to the substrate can be analyzed as well, 5. Also sequences of inclusion and exclusion of muscle force or muscle groups can be analyzed or determined and 6. Certainly, a job will be easier if we treat only meaningful motion since meaningless motions are not considered useful, meaningless information is not considered valid, but it should be recognized that learning these meaningless motion is an excellent tool for the development of coordination. The most frequent dilemma at learning and acquiring motor information is the choice of methods. Generally, we can divide methods in two groups: 1. where the primary achievement of IT effect is acquiring new information and 2. methods where the primary achievement is causing changes in some psychosomatic dimensions. This division is obviously according to primary goal. Learning process is, however, based on actual characteristics of people not on absolute motion characteristics. This adjustment is possible in two ways: 1. first that we can really estimate which motion modality is suitable for people of different anthropological and functional characteristics and 2. we have to be capable of modeling our own motion in a process of demonstration or process of motion correction. In order to carry this out, coaches have to be capable of performing the same motion, but differently from what is optimal for them. It's only possible if the degree of acquired motion in coaches is on the level 2 which means he can modulate it. It is not possible to conduct a study of a man, if a teacher is unable to perform the movement for students and not for themselves. This is not the case if one is teaching history. This results with the rule that the one who is unable to perform the motion in such a modeled manner is absolutely inconvenient to carry out the process of training. Another problem regarding methods of learning motor information is a problem of channel for receiving information, and there are many channels for this purpose. Primarily this is the visual channel. During the course of the learning process it includes the kinesthetic channel. This kinesthetic information is the ones that a man sends to himself. Information can be received through acoustic channel coded in verbal code. There are extremely big differences between abstract code of some motor information and motor information itself. Abstract code can be a signal but not information. For example, if someone says "push" this is not information but the signal from the motor point of view. Realistically and most rational way of obtaining information necessary to learn some motor structure has to be continuous conduction through kinesthetic channels. The logical rule would follow that motor learning always has to be conducted with optimization but in the end always involves an iterative (repetitive) procedure. We also have two strategies here: 1. the number of iterations is maximally increased assuming automatic error correction and the idea is based on assumption that a man is a self leveling mechanism (in the cybernetic sense) improved during the iterations, dominantly through mechanism of self-monitoring, and 2. second strategy is applied when there is no purposeful movement, i.e. meaningful movement, and that is the introduction of correction during the learning process, thus obtaining information from the outside. It seems that these two strategies must be combined. Motions that are highly automated can never be taught with verbal code. (Bompa, 1994; Dežman, 1998; Korenberg, 1979; Lozovina, 2001; 2009; Malacko, 2000; Siff and Verhoshansky, 1999).

The level of complexity of some motor actions or set of actions

Each motion presents an organized structure. In sports, the rule is that this movement is an element of a broader structure If the motion is composed of elements that can be logically and otherwise analyzed and separated, then there are two possible strategies: 1. The first strategy is to learn the elements which are integrated afterwards. 2. Second strategy is to learn primary unit. It is an area of training methods and usually the following methods are applied: a) analytical methods, b) synthetic methods, and c) situational. Certainly, there are combinations of these three.

Learning technique in which the whole structure is learned is suddenly faster and gives superior results in any of the criteria, than the learning technique according to elements if the motion is very complex (Kraemer, 1994; Lozovina & Pavičić, 2004; Trninić, M. et al., 2009; Lozovina, M. et al., 2010; Trninić et al., 2010). However, some motions which require an extremely high degree of energetic engagement and its structure are somewhat simpler, and where there is no direct interference (e.g. javelin in athletics), it is possible that the analytical method in many stages of development is more appropriate. In any case, in general, learning within the whole structure is more efficient than separate learning of substructures. Learning a motion in the framework of a motion must be conducted so that the meaning and organization structure in the learning process is not violated. So it really teaches the entire sequence of a movement that is deliberately linked to a certain goal typical for such movement complex i.e. sport.

Maximization of this learning method is called situational training. The methods differ according to weather parameters, i.e. the manner of implementation in relation to the duration, whether the work is focused on the acquisition of motor information, or to a change in the dimensions. There are two basic different ways: 1. Exercising can run continuously along the time-segment, and 2. exercising can be discontinuous along the time-segment. Be sure to vary the training and learning, because learning is characterized by the dominant fundamental programming patterns and training is marked with integration of desired level of motor skills transfer to biomotor dimensions and this process is a direct function of local or total volume of work in accordance with the genetic capacity of the individual who is subject to such stimuli. Motor exercise is continuing action based on scientific and professional settings to achieve results of pre-defined level. Motor functions are not some hypothetical structures with unknown localization, but set of exactly defined, centrally and peripherally distributed integrated segments. In order to implement the optimal structuring it is necessary to introduce a pause training system which can be very different and where the basic training (operator) is not implemented. During the pause we can do something else or nothing. What pause produces when we do nothing? Resting is not the only thing happening during pause.

Each "biological machine" and man as well, needs a specific time of apparent inactivity in order to stabilize the changes that are irritated in the previous period. The purpose of pause is to enable process of stabilization. When pause contains some other contents and primary goal of training is learning, then there are two approaches: a) Some authors believe that it is good to provide activities that can not structurally have a negative transfer to the primary content, and b) Other authors recommend additional training or corrective training during the breaks. When we talk about functional abilities pauses have different meaning. Normal biological systems are difficult to tolerate extremely high volumes, which are essential for the stimulus to cause the effect, especially when the way of performing is continuous. The idea of introducing pause lies in the fact that in small time segments enables a large volume of work. While programming training and pause we should consider biological rhythms, which greatly condition engagement, activity, rest, recuperation and supercompensation i.e., lasting or short-term effects.

Pre-covering

To ensure there is no random variation in the achievement of the effects of training it is necessary to add a greater amount of work if the effect was at least as much as is needed in levels of competition in which we compete, even bigger if possible. Pre-covering is actually the relationship between the volume of work required to withstand a game or get one's work done and the volume which ensures that this work is performed in any case. Pre-covering coefficients are different for different sports same as they are different in situational training and extra training for all types of athletes (Bompa, 1994; Lozovina, 2008; 2009; Lozovina et al., 2007; Malacko, 2000).

Progressive discontinuous load and "the effect of contrast"

Progressive discontinuous load is a common way of programming load for athletes. In practice, i.e. training it is necessary to increase load in order to bring it down later to the border of a sportsmen load if it was done continuously. Such way ensures that at the lowest load when increasing we burden sportsman same as if we force him to work all the way to cancellation. From the above it is evident that such a programmed load is greater than necessary based on the rule of pre-covering. This type of work produces an effect that in psychology is known as the "contrast effect".

When athlete is trained his body gets used to the volume of work. At the moments he comes in situation to work less (e.g. the official matches in ranking events he is training for) although it is relatively very large volume of work, he senses this work as a break because it is in contrast with what he is accustomed to, which is load in training. Experience proves the rhythm of growth and dropping at beginner's ratio 1:3, and well trained 1:4. Some coaches, practitioners, achieve good effects with the ratio 1:5 (although some authors believe possible ratio 1:2) which not only ensures stability and continuity but preservation of internal consistency and training of athletes as well and presents high guarantee for close approaching to sports (or any other) achievement (Bompa, 1994; Lozovina, 2008; 2009; Lozovina et al., 2007; Malacko, 2000).

Conclusion

In ways described above with the methodological and mathematical, and in any case, epistemological and anthropological positioning of transformation systematic value it is possible to place training as a process on science based settings, which allocates all together on a set of mappings that give rise empirical (strictly practical) foundation and seriously approach symbolic (mathematic) modeling of initial settings, goals, treatment parameters and certainly final achievement evaluation. In this way it is possible to make a plan and training program in a long-term without the clutter of wandering and excessive speculations. In figure 12 an idealized example of shaping a 4-year cycle for sports training is presented. As clearly evident, and taking into account all the above mentioned, the control of the transformation process is very high.

It is actual in the purpose of the proceedings, as well as the possibility of meaningful intervention in the segments which require such operation, regarding the degree of convergence goals. Generally, according to organization, the following global phases of treatments implementation are necessary: 1. define population, 2. define dimensions, 3. define dimensions which are changing, 4. define tests, 5. define operations for dimension estimation, 6. define experiment, 7 calculate initial state, 8. calculate taxons, 9. define objective (final state), 10. define cost price, 11. calculate final state, 12. define available activities, 13. define a set of allowed parameters about the volume change, 14 calculate transitive operations (training control) 15. calculate alternative transitive operators, 16. define methods of applying operator 17. define evaluative procedures.

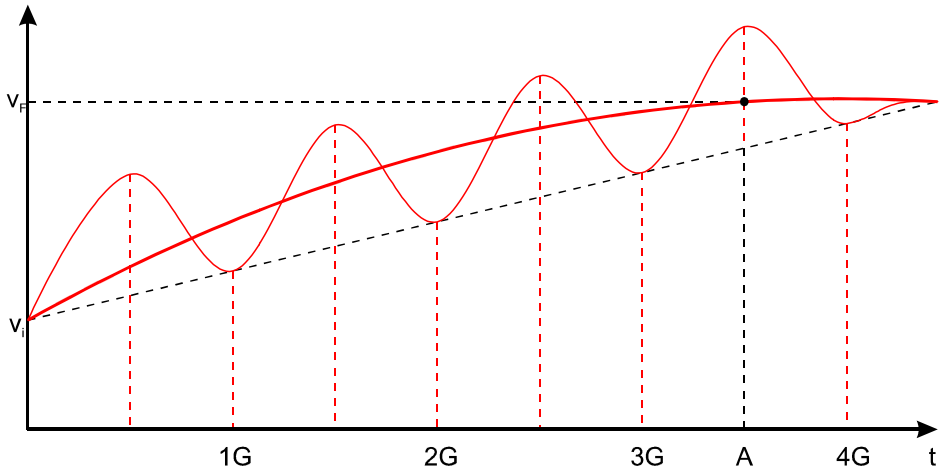


Figure 12. Programming 4-year cycle for sports training (Source: Lozovina, V.)

(1, 2, 3, 4 G = year, V_i = Initial volume, V_f = Final volume, ------ = Theoretical volume, …… = Real volume, Sinusoid = oscillations, A =(Competing point)

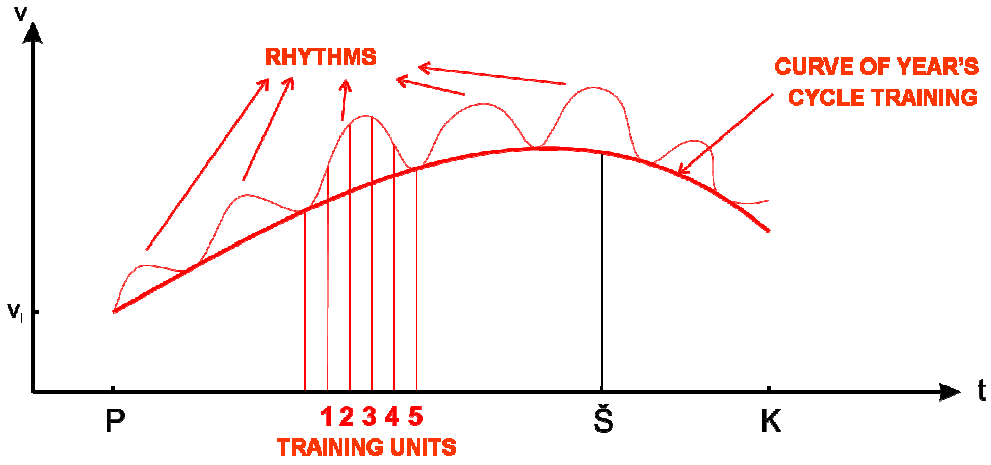


Figure 13. Programming training in the rhythms of the desired cycle (Source: Lozovina, V.)

(1, 2, 3, 4, 5 = training units, P = start point, Š = training start point of deterioration, K = final point)

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PARADIGMA METODOLOŠKE TEORIJE I MATEMATIČKE MODULACIJE SPORTSKOG TRENINGA

Sažetak

Trening (ili transformacijski proces) je serija operacija koja se primjenjuje u specifičnom vremenskom intervalu, pri čemu svaka od njih ima neke svoje bitne značajke kao što su: sadržaj operacije, način na koji se operacija provodi, veličinu akivnosti onih nad kojima se operacija provodi. Paradigmatski i metodološki uvjeti u transformacijskim procesima neminovno vode prema modulaciji takvih procesa temeljeno na preciznim metodološkim pretpostavkama i matematičkim definicijama. Od malog je značenja to što neki od uvjeta i slučajeva ne mogu biti apsolutno nadzirani i kontrolirani, jer dobro planirani i programirani process uključuje moguća neslaganja s 'idealnim' stanjem definiranim u početnoj poziciji. U svakom slučaju, nakon prihvaćanja metodoloških pretpostavki, jedini alat koji možemo ozbiljno prihvatiti za nadzor i evaluaciju treninga je matematički alat. Ovaj članak nastoji naglasiti neke takve glavne spoznajne alokacije koje mogu biti od velikog značaja za razumijevanje treninga, modulaciju, identifikaciju i prepoznavanje s uključenim globalnim zamislima.

Ključne riječi: *trening, globalno, metodologija, paradigma, matematika, modulacija*

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PSYCHOLOGICAL PROCESSES INVOLVED DURING ACROBATIC PERFORMANCE: A REVIEW

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Review paper

Abstract
Acrobatic performance has provided a particularly rich context for sport science research. Currently a high number of publications on acrobatic performance are represented in domains such as biomechanics, physiology and traumatology. However, at present, no research synthesis has yet been reached in the psychology domain. The aim of this article is to review literature on models and empirical research linked to the psychological processes involved in acrobatic performance. This review demonstrates the improvement of scientific knowledge in sport psychology on acrobatic practice. Following literature searches 66 articles were found to combine acrobatic performance and sport psychology. These articles were inductively analysed to reveal three main research themes: (a) the organization of performance, (b) the preparation of performance and (c) the subjects' transformation by the practice of acrobatics. These articles are reviewed and further suggestions for future research advances are made.

Key words: *action, cognition, context, elite performance, acrobatic, sport psychology*

Introduction

Acrobatic performance has represented a particularly productive context for sport science research. The domain of acrobatic performance includes a number of characteristics which may be responsible for this high frequency of scientific interest. These characteristics include: (a) the complex perceptive and particular activity that is closely linked to the body's rotation in the air. (b) The subjective judgement of the performed skill combined with the level of perfection of the movement. This fundamentally questions the motor skills, their room for improvement, their capacity for repetition and their aesthetic components. (c) The risk assessment of the athlete that is demonstrated by bigger movement amplitudes and higher and more complex rotations which use singular cognitive and affective resources (d) The existence of numerous physical and sporting examples in which acrobatic performances are evident, such as the goal celebration in soccer. (e) The technological innovations which are enriching scientific interest of this activity by associating the body of the athlete with the machine, for example in FMX or in the acrobatic plane. Research using acrobatic performance has been extensive. This wealth of research has led to acrobatic review publications in biomechanics (Bruggemann et al., 1994; Yeadon & Challis, 1994; Prassas et al., 2006), on acrobatic injury (Grapton & Barrault, 1999) and in gymnastic physiology (Jemni et al., 2001). However, no synthesis has yet been produced examining the psychological domain. This article presents a review of literature concerning models and empirical research linked to the psychological processes of acrobatic performance. It aims to demonstrate the evolution of scientific knowledge in the applied sport psychology of acrobatic practices and to evaluate the further opportunities for research.

Methods

Data collection involved a two step process. First, a literature search limited to the term acrobat* and including only peer reviewed articles was completed using SPORTDiscus®. This resulted in one hundred and sixteen articles. For each study that was reported the associated acrobatic sport was recorded (e.g., trampolining, diving). A second search was then performed using the platform Web of Science®. For this search, using only the terms acrobatics or tumbling or diving or gymnast* or trampoline*, 15,713 documents were identified.

These documents were sorted systematically using the following criterion: documents types only (12,926 articles) then Subject areas: (i.e., sport science - 3175 articles) then Publication years (from 1978 to 2008 -2475 articles) and finally, Sources title: (i.e., psychology, behaviour, motor, medicine and sport; thereby excluding the terms biomechanics, podiatry, orthopaedics therapy, history, sociology - 599 articles). Finally, the articles were sorted by title, excluding for example the terms history and sociology. A total of 66 articles were found to correspond to the final selection criteria. For each of the 66 articles found, inductive content analysis was used (e.g., Patton 1990; Thomas 2006) to let categories and sub-categories emerge. Each category theme can be divided in subcategories characterizing a particular component of analysis as demonstrated (Figure 1).

Results

Three categories of research emerged from this analysis: (a) the organization of acrobatic performance, (b) the preparation of performance and (c) the subjects' transformation by the practice of acrobatic sports. Results are presented using these categories.

The organization of acrobatic performance

Four subthemes of study characterized the analysis of acrobatic performance: expertise, perception, memory and knowledge.

Expertise

There were nine research articles that were included in this theme. One research axis in this theme suggests possible existing links between cognitive and behavioural aspects of performance. Spink (1990) examined the differences in cognitive and behavioural processes between male gymnasts from different competitive levels. Thirty-eight gymnasts completed a questionnaire that focused on psychological factors impacting on both training and competition. Spink revealed that two psychological factors varied according to level of expertise. The first was psychological recovery, the second was self-confidence. In particular, higher level gymnasts were found to recover better psychologically from mistakes made during competition. Following this analysis of expertise, Slobounov, Yukelson and Obrien (1997) examined the potential links between the variability of routines, self-efficiency, self-evaluation and the level of expertise of springboard dives of Olympic level athletes. Their analysis showed that the variability of the kinematics parameters was linked to the level of difficulty of the springboard dive. Further, feelings of self-efficiency and self-evaluation also improved with increased expertise. Moreover, Hinton-Bayre and Hanrahan (1999), in an exploratory and comparative study, identified the differences in personality variables between a sample of 18 elite divers (i.e., springboard and platform) and non divers. Results demonstrated that elite level divers had a higher level of confidence in their physical performance and in their appearance than non divers however, the impact of personality on performance could not be predicted. Emotions have also been considered as an important factor influencing performance excellence. Robazza, Pellizzari and Hanin (2004) examined the multimodal and individual consequences of self-regulation strategies on emotions in relation to bodily symptoms. Four athletes (4 hockey goal keepers and 4 gymnasts) took part in an Individual Zones of Optimal Functioning (IZOF) test. Robazza et al. supported the hypothesis that using a mental training strategy would optimise psycho biosocial states before competition and would improve the performance of athletes during competition. Results suggest that this test could be used to examine the relationship between emotions and bodily symptoms. The second research axis in the domain of expertise has been inspired by knowledge based on the analysis of outstanding acrobatic performances in trampoline, tumbling and acrobatic skiing (Hauw, Berthelot & Durand, 2003). The methodological basis for this approach has been to analyse video recordings in parallel with self-confrontation interviews with high level athletes. Research has considered expertise as changes in coupling between context-action have been found to be present, based on the analysis of performance of four trampolinists (13 routines comprising 10 skills during the World Championships of 1999). Results demonstrated that even if the expertise of trampolinists were homogeneous, these were not stable as there was a difference in the organisation of the coupling context-action. The analysis of expertise was situated, considering determined variables such as the chaining of actions, their rhythmic properties, the monitoring of the typical alternation between actions aimed transforming the routine and those aimed at analysing it during the routine. Hauw & Durand (2004) used 27 trampoline exercises performed by 10 athletes categorized in three levels (good, average, poor). Three patterns of activity corresponding to those levels of performance were identified. The level of performance could be distinguished by the increase of significant actions occurring at the same time and also by a reduction of actions put on hold and the emergence of new actions targeting an interaction with the situation. This study confirmed that expertise could be distinguished through the identification of meaningful actions modified by the interactions with the context. Further research from Hauw & Durand (2008) aimed to understand the construction and the use of a meaningful time during the same high level acrobatic performance in different conditions (i.e., temporal). The results of this study suggest that the activity occurring during the acrobatic performance depends on the potential time available and that the activity or the cognition of the athlete can use this time to make the performance happen. The same acrobatic skill performed in different contexts (i.e., Tumbling, trampoline, acrobatic ski) involves differentiated mobilisations of the psychological process. Finally, Hauw, Renault & Durand (2008) examined the activity of elite acrobatic skiers, a sport characterised by a long time period in aerial flight. The aim of this study was to understand the processes that were engaged in order to achieve a good landing. An identical methodology was applied to three acrobatic skiers. The results showed an organisation of the action that could be split into six stages whereby the acrobat builds and modifies their activity based on their understanding and achievement of the jump. Finally, Delignières et al. (1998) analysed the preferable coordination mode used by beginners compared to experts during an oscillation on parallel bars. This demonstrated that in a new action beginners are strongly constrained by the intrinsic dynamism of the system and that mastering this spontaneous trend is difficult.

Perception

This theme was comprised of eight research articles. Rezette and Amblard (1985) tested the hypothesis that the monitoring of acrobatic jumps would be dependent on a complex process of information collection. Trampolinists performed acrobatic jumps in three different visual conditions (in half-light, with a stroboscopic, and with normal light). Their results demonstrated that visual indications are important for performance in all of these conditions.

In particular, visual indications will be fundamental to stabilise the acrobatic landing. However, visual indications should be used less during the orientation of complex skills than during simple skills. The authors suggest the use of equivalent vestibular signs. Lee, Young and Rewt (1992) used the tucked forward salto to test the general assumptions of the control of speed approach (Gibson, 1958) and to apply this to the analysis of landing mechanisms in acrobatics. Two elite divers were studied while performing four series of ten saltos. The results demonstrated that landing control is less precise with eyes closed than with eyes open. These results confirmed the works of Rezette and Amblard but also associated the hypothesis that landing was controlled by regulating body extension. According to Bardy and Warren (1997) vision will play two roles (a) to fix the speed of change of the tau angle to be compliant with the remaining time before reception and (b) to maintain constant change of the tau angle. Bardy and Laurent (1998) tested these strategies of body orientation control during the aerial and landing phase of backward somersaults. Their results suggested that information about aerial flight time was not taken into account by participants. On the contrary, the acrobats seemed to control their moment of inertia during the final phase of the somersault by managing the extension of their body together with the speed of time decrease before contact. These works have also been discussed using the dynamic theory of action-perception patterns. Schöner (1994) illustrated that the coupling of sight and body extension through postural adjustments would act as an attractor. Those attractors could be used to explain visual disturbances. This theory is illustrated by the example of the diving gannet and the landing fly in high diving in order to establish the variation of the tau angle in dynamic terms which is self-regulated. Moreover, two studies from Davlins, Sand and Shultz (2001a & b) have specified the role of peripheral vision of the segmented orientation control during the landing phase of the backward somersault. Ten female gymnasts with a good level of ability took part to this study. Backward somersaults were performed under four different conditions of vision: full vision field, horizontal peripheral vision limited to 100°, horizontal peripheral, horizontal peripheral vision limited to 60° and no vision. They concluded that gymnasts have a more stable landing when vision is full compared to the three other conditions and further, that they have a more stable landing by using peripheral vision compared to no vision. Finally, Luis and Tremblay (2008) examined the optimal use of visual feedback on segmented adjustment in backward somersaults depending on head position. Twelve experienced female gymnasts performed 20 backward somersaults under four experimental conditions: full vision, vision at AHV below 350 deg/ s, vision at AHV above 350°/s and no vision. The authors concluded that during back somersaults, visual feedback is used to stabilize the landing with several head angles but that the optimal visual feedback is given when the retina is stable.

Memory and knowledge

Four articles were included this research theme. Initial research directions were developed from Ille and Cadopi (1999) who compared the reminding performance evolution of a gymnastics routine memory and the accountable processes of novices athletes aged between 8 and 14 years. Their results suggested that the performances memory improve with age and are better by experts than by beginners. The study outlined the role of amnesic strategies, as well as the knowledge base and the capacity of mental visualisation. Huber (1997) used springboard divers to demonstrate differences between elite divers and beginners linked to the representation of the problem and to the existing procedural knowledge. Four beginners and four experts were asked to describe their impressions after each springboard dive. The analysis of their descriptions outlined differences between beginners and experts in resolving problems. Experts had more conceptual understanding, thereby allowing them to link their problem with the process to solve it. Ozel, Larue and Molinaro (2002) tested the relationship between sport activity and the performance of a mental task of rotation with three experimental groups: gymnasts who used mental and physical rotations in their practice, athletes whose activities required very little motor rotation, and non athletes. The results suggest that the first two groups have quicker response times than the group of non athletes. The link between acrobatic activity and mental representation was identified by Schack (2003) who analysed the relationship between motor representations and the parameters of a complex acrobatic movement (the twist in gymnastics). Participants in this study were 30 beginners and experts. The aim was to use video observations to compare the mechanical parameters of the movement and the strategies of anticipation aiming to plan the consequences of the segmented placement at each part of the movement by using simple concepts and organising the motor expertise. The results supported the hypothesis that voluntary movements are planned, executed and decided on long term because the participants were able to anticipate. Thus it may be concluded that a link exists between the level of practice of the gymnast and their reminding performance.

Modes of preparation for acrob. performances

Motivation, Goals setting, competency

Ten articles were included in this research area. Feltz and Mugno (1983) extended the work of Bandura (1977) on the theory of competency. Their study tested the assumption that performance accomplishments, direct perception, physiological excitation and competence were the immediate causes which influenced perceived performance in back diving. The model suggests a strong relationship between the central nervous system and the feeling of competence. Additionally, Winfrey and Weeks (1993) examined the effects of self-modeling on self-efficacy and balance beam performance.

Intermediate level gymnasts were separated into two groups: self-modeling videotapes or control group. Results suggest that self-modeling can improve both the skill and the comprehension of feedback. More recently, Feltz et al. (2008) refined the relationship between competency and the central nervous system to answer earlier criticism from Bandura (1997). This concluded that the feeling of competence following the most recent performance was a better indicator of overall performance. Goal setting has also been shown as an important aspect of performance preparation. Pierce and Burton (1998) examined the impact of goal-setting styles on a goal-setting program for 25 female junior gymnasts. Results suggested that competition-oriented gymnasts improved their performance significantly over the course of time when the goal setting program was applied, however this was less evident for those gymnasts who were less motivated towards success. Kirkby and Kolt (1999) examined the motivation of 280 Australian gymnasts and 103 Chinese gymnasts. Participants were asked to complete a version of the participation motivation questionnaire. The comparative analysis of results suggested a cultural difference in motivation factors between the two populations. From an individual point of view, Lambert, Moore and Dixon (1999) investigated perceptions of motivation in gymnastics training. The authors examined the differential effects of self-set goals in comparison to goals determined by the trainer, according to the type of motivation. This study was based on two gymnasts with intrinsic motivation and two gymnasts with extrinsic motivation. They were exposed to conditions of self-determined motivation and conditions created by the coach. The authors concluded that motivation will be higher if goals are self-determined. In addition, Halliburton and Weiss (2002) examined the relationship between motivation and sources of information on competence using 103 intermediate level female gymnasts. They concluded that the perception of a climate of control is associated with the use of self-referenced sources of information and that the perception of a climate of performance is associated with the use of the comparison between pairs and the scores obtained in competition. Finally, a series of studies from Weiss and Weiss (2003, 2006, 2007) analyzed the factors which motivated female gymnasts at an intermediate and elite level. Global and specific research was carried out on between 124 to 304 gymnasts using questionnaire. These studies conclude that (a) the profiles of the gymnasts are similar but not identical to the predictions and that it would be desirable to differentiate the social, motivational and behavioral variables, (b) that the role of the parents and the coach seems central for attraction-entrapment, (c) engagement indicators enable a difference to be established depending on age and level.

Learning process

Eight articles contribute to this research area. Lufi, Porat and Tenenbaun (1986) sought the psychological indicators of competitive performance of young male gymnasts (N=56). Two groups were made up (28 with high potential and 28 with low potential, which was determined after taking a test which took place at the end of one month's practice). Results showed that those with high potential reacted better to frustration, showed greater persistence, less ego defense, and had a more internal locus control. Swinnen, Vandenberghe and Van Assche (1986) aimed to examine the relationship between the cognitive styles concerning dependence/independence, reflection/impulsiveness and the acquisition of a driving skill in an unstructured training environment. Sixty-five girls and 57 boys aged 13 years were tested on a gymnastic performance. It was hypothesized that the independent subjects would do better in an unstructured training environment than the dependent subjects, however, this was only confirmed for the boys. In addition, other researchers have been interested in structured training and the effects of this training on the temporal nature of verbal instructions and the demonstration at the start of training complex figures in skating. Haguenauer et al (2005) tested 18 beginners on a vault by dividing the group into three (verbal instruction, metaphor and control group) following demonstration of the task by an expert and a 15 minute training session. Results suggested that performance modifications were related to the demonstration and the repetition task. Providing verbal instructions at the beginning of training did not have any effect. Robazza and Bortoli (2004, 2005a & b) and Robazza & al. (2007) set up acrobatic and balance tests aimed at analyzing the factors intervening between individual differences, acrobatics and balance. After verifying the internal validity of the tests, they undertook a study on 72 male high-school students during 12 lessons. This study measured the effect of acrobatic practice in physical education on the idiosyncratic management of the emotions of participants presenting approach-avoidance signs. The tests revealed that an education in acrobatics made it possible for participants with strong avoidance to change their attitude towards adventure sports. With a view to assist training, Baudry, Leroy and Chollet (2006) tested the assumption that video will lead to an improvement of gymnastics pommel horse performance. The study focused on 16 promising gymnasts who completed a series of two circles on the pommel horse with the greatest possible amplitude. The study concluded that the video feedback group improved their alignment to a significant degree. Conclusions were that the use of video feedback can contribute it to the correction of complex movements like these circles. However, its effectiveness was in connection with the complexity of the phase circle. It was concluded that videos provide an aid in the construction of a cognitive representation of the movement. Within this framework Hars and Calmels (2007) have also shown that when training of an acrobatic figure, most gymnasts will focus on spatial information (i.e., one or several part of the body) and not on kinematics.

Anxiety and Self-confidence

Six articles make up this research theme. Lee and Hewitt (1987) studied 36 female gymnasts (beginner-level and intermediary level) with anxiety levels which ranked from high to low. The group was divided into three sub-groups. They were asked to practice the mental representation of their gymnastic exercise, some on a small mattress, others in sensory insulation boxes and others stood still, forming a control group. The variables taken into account were the average scores obtained during three competitions and the gymnasts' self-evaluation of their physical state. The results showed that the group who had practiced the mental representation exercises in the sensory box had better performances and evaluated physical disorders as less important. Tremayne and Barry (1990) examined the psychological and physiological effects in accordance with level of anxiety and repression (Davis & Schwartz, 1987). The study used 16 female gymnasts to observe differences in tonic physiological measurements associated with differences in the states and/or of the levels of anxiety. The authors then examined whether similar differences were associated with differences in the levels of repression. Their results showed that the level of repression does not have an influence on the features of anxiety, thus raising questions about the validity of repression in this context. There were, however, small effects suggesting that repression can affect components of the attention process in various situations. Another study carried out by Crocker and Leclerc (1992) aimed to test the validity of a model of confidence in high-risk diving among 40 beginners (men and women). The data showed that confidence in the performance of the dive was directly related to the perceived feelings of pleasure, skill, and perceived risk. Further, Kerr and Goss (1997) studied self-control using a sample of 30 young female gymnasts. Psychological measurements were carried out using The Nowicki-Strickland Locus off Control Scale for Children, the Coopersmith Inventory Coil-Esteem, and the Spielberger State-Feature Anxiety Inventory for Children. Results indicated that the gymnasts had a higher external locus of control and lower self-esteem score than indicated from existing literature on the norms for this age and gender. However, they also observed that the features of their anxiety were the same. Research has also examined the effects of psychological interventions on gymnastic performance. Fournier & al. (2005) tested the effects of a psychological skills training (PST) program on psychological performance and indicators such as relaxation, mental representation, goal setting and visualization. This study used 21 female gymnasts who were divided in two groups; 10 participants using the PST program and 11 without the program over a 10-month period. The authors concluded that the PST program was more effective on the psychological indicators on three apparatus, bars, beam and floor. The 10 gymnasts who had followed the program increased by 5% more than those who had not followed the program.

Further research has examined competitive performance anxiety in gymnastics. Cottyn et al (2006) measured anxiety during a competitive beam performance by eight national level gymnasts. The authors monitored heart rate and used retrospective self-reports of nervousness during one competition and two training session. Three conclusions were made: (a) there is a negative correlation between self-reported score and heart rate during a routine, (b) there were no significant differences on the self-report scores in the three sessions observed, (c) heart-rate was higher during competition than during practice. The results demonstrated the potential value of retrospective report of nervousness and discussed this in relation to catastrophe theory.

Imagery

Five articles are included in the research data for this theme. Early research by Nishida et al (1986) validated a test of controllability of mental images (CMI) among a group of male and female gymnastics students (n=279). The aim of this test is to check the handling of mental images and the ability to control these images. The authors concluded that this test was valid but future research was needed to allow it to be generalized. Grouios (1992) observed the effects of mental practice on diving performances using 30 participants. Results indicated that mental practice can significantly affect performance ($p< 0.1$) by facilitating sensory feedback. Calmels and Fournier (2001) aimed to measure the potential difference between the actual duration of a routine and the mental duration using 12 high level female gymnasts. The assumption was that there would be a lengthening of the duration according to the perception of the difficulty of the lifting skill. Results suggested that the speed of visualization depended on the conditions of the gymnast and the value that they assigned to visualization. If these conditions are verified, the tendency to increase mental time according to the level of difficulty would be proven. Calmels et al (2003) have also shown that high-level gymnasts developed strategies differentiated from imagery to manage their emotional states, to evoke action and to produce a performance. Further research from Calmels et al (2006) extended this work in the field of neuron-imagery. This study aimed to examine the internal functional equivalence of imagery, the external image and the execution of action. 16 elite gymnasts carried out a complex vault performance (10 with an internal perspective, six with an external perspective). However, results did not provide support for the principle of temporal functional equivalence.

Developmental effects of training and performance in acrobatics sports

Two research clusters make up this theme: first, research which has examined how the practice of acrobatics makes it possible to develop athletes resources (e.g., postural information) second, research that is interested in the syndromes and problems encountered by the athletes in practice.

Syndromes, injury and disturbances

Eleven articles are included in this research area. One sub-theme of this area is Lost Move Syndrome. Day, Thatcher, Greenlees and Woods (2006) examined the psychological causes and consequences of this specific phenomenon in acrobatics. The syndrome was proposed to emerge from difficulties encountered by gymnasts during the take-off of the skill and from the training of skills. Semi-structured interviews were carried out with 15 trampolinists. Inductive content analysis led to the description of 54 causal explanatory topics (e.g., difficulty of acquisition of a skill, anxiety prior to take off, fear of disappointing the coach) grouped into sub themes (e.g., trainer athlete relation, pressure to come up with better results) until the obtaining of eight general dimensions. The results showed that even when skills had previously been successful then the training environment could be one potential cause for the emergence of this syndrome. In this research, certain athletes reported their skill learning as easy and fast. It was therefore proposed that this rapid skill acquisition may have made the skill more succeptible to Lost Move Syndrome. Other participants reported their skill acquisition as difficult and slow. It was proposed that this "disjointed" or dissociated processes of training (i.e., not allowing a sufficient construction to establish patterns) may also have led to skill loss. Research has also examined the psychological antecedents of gymnastics injuries. Early research from Mace, Eastman and Caroll (1986) studied the course of a young teenage gymnast who resumed training after a series of accidents and followed a program of eight sessions of mental skills training aimed at increasing his confidence and replacing negative self-images with more positive ones.

Results compared questionnaire data from the beginning of the program and at the end of the program, suggesting an improvement in self-esteem. These results were also corroborated by the trainer who reported an improved attitude and a fast progression in the acquisition of skills. Kerr and Minden (1988) also examined gymnastics injuries using 41 national level female gymnasts with ankle injuries caused by floor exercises and 20 coaches. Participants were asked to complete a questionnaire (integrating the psychological variables of Coddington Life Vent Record; Coddington, 1972) for two years preceding the accident. The results suggested that stressful events which preceded the period could be associated with the severity of the injury, although this did not correlate anxiety, locus of control, and self-concept. In addition, Mace et al. (1989) tested a relaxation program of imagery on 18 female gymnasts and a group control by measuring cardiac accelerations caused by stress. The authors concluded that there were no significant differences between two groups. A number of studies have focused on competition-related injuries (Kolt and Kirkby, 1994). Kolt et al. (1995) examined the psychological factors which were reported by 115 gymnasts following competitive injury.

Results from the POMS-BI and CSAI-2 showed that the most injured gymnasts had higher anxiety and were, in general, more tired. Female gymnasts were found to have higher anxiety, lower general confidence, and increased tiredness and confusion. Later research by Kolt & al. (2004) recruited 20 national and international gymnasts to examine the effects of a stress control program on injury. A longitudinal analysis over nine months separated the group into two subgroups, one group who took part in the program and another who formed the placebo group. The authors concluded that the program has had little effect on stress and injury but that conclusions on the effectiveness of the program were restricted by the small sample size. Chase, Magyar and Drake (2005) examined female gymnasts' psychological strategies and the perception of their effectiveness to overcome fear of injury. Ten female tumblers aged 12 to 17 (who had sustained a knee injury during their competitive career or during practice took part in individual structured interviews. Results suggested that to overcome fear of injury mental preparation strategies (imagery and relaxation) were used by gymnasts. Cartoni, Minganti and Zelli (2005) examined the relationship between anxiety, personal effectiveness and the fear of injury according to age, gender and qualification level. Six hundred and eighty Italian gymnasts answered three types of questionnaires. The self-efficacy for physical abilities scale (Barberini & Robazza, 1996), the Trait Anxiety questionnaire (Busnelli, Dall Aglio & Faina, 1974) and the Gymnastics Fear Inventory (Cartoni & al, 2005). Results established that on average males were less anxious and more effective. Gender showed no difference regarding fear of injury. Three studies have examined how psychological disturbances are managed by gymnasts. The first aimed to understand the perceived effects of emotions on athletic performance. Robazza, Bortoli and Hanin (2006) used the IZOF to determine the idiosyncratic emotions in relation to the physical symptoms experienced by 16 female and 19 male practicing professional ice-skaters and gymnasts. The results underlined a broad difference between individuals on the content of the emotions perceived during their performance and the impact of these emotions on the level of the physical symptoms experienced. However, there was also a relationship between emotions and corporal effects. The second study (Hauw & Durand, 2007) showed the value of taking the athletes' point of view into account in order to improve the understanding of mistakes made by trampolinists. Ten high level trampolinists took part in the study which was based on the "course of action" (Theureau, 2003) methodology. The authors identified zones of disturbance on which they could intervene to correct the errors which escaped the extrinsic analysis. Finally, the third study examined the underlying properties of stress in sport (Thatcher & Day, 2008). This research aimed to evaluate eight environmental properties proposed to underpin stress appraisals (novelty, predictability, event uncertainty, imminence, duration, temporal

uncertainty, ambiguity and timing in relation to the life cycle) using 16 national level trampolinists. Semi-structured interviews were used to focus on stressful experiences in competition. Conclusions were that all the suggested underlying properties of stress were present and relevant to the sporting domain. Further, two other properties were present (self and other comparison and Inadequate Preparation) which may be specific to the sporting context.

Posture

Three articles characterized the research data on this theme. Marin, Bardy and Bootsma (1999) measured the effects of interaction on expertise in gymnastics, the type of surface, and the necessary frequency of the movements of the head on the emergence of the modes of postural coordination. A group of female elite and a group of non-gymnasts were compared. The results suggested that imbalances are more important for the non-gymnasts. Danion, Boyadjian and Marin (2000) have tried to determine first how gymnasts are affected by the suppression of vision at the time of simple movements and second, which sensory signals exist for gymnasts having their eyes banded. Eight expert gymnasts and eight sporting experts were asked to maintain a straight displacement on three standards of locomotion (with eyes banded): (a) walking, (b) carting a wheel chair, (c) giving verbal orders to another person for them to push the wheel chair. The participants deviated in all the situations. However, with the exception of the verbal condition, the gymnasts were closer to a linear movement than the control group. The authors concluded that even for a simple driving task, the performance of the gymnasts deteriorated with a loss of vision. They also showed that compared with other sportsmen, gymnasts remained stable in the absence of vision when the proprioceptive signals were available.

These conclusions led to two possible explanations: (a) that gymnasts are readily able to seize essential information (b) the proprioceptive system of a gymnast is more sensitive. Gautier, Thouvarecq and Chollet (2007) aimed at improving comprehension of the postural regulation by analyzing an arbitrary posture, the reversed handstand. Male participants aged 18 to 25 years, all of national and international level in gymnastics, were asked to carry out a balance on parallel bars. The authors measured the influence of peripheral vision and anchoring of central vision on the balance of the gymnasts from an ecological point of view. The study concluded that postural regulation may be considered as an emergent phenomenon.

Discussion and conclusion

Overall, the studies included in this analysis show an important evolution in the way psychological mechanisms are applied to acrobatic performance. Despite the diversity of themes, it is possible to identify three great acrobatic designs from an epistemic point of view.

The first design is known as "morpho kinetic" conception (e.g., Cadopi, 2005, Paillard 1971) on the one hand this implies a representation of the form prior to the actual action, and on the other hand an adequacy between the feelings of is the movement and the visual image of what the athlete wants to do. An example of this research theme is Calmels & Fournier (2001), in which the actual acrobatic performance is comparable to the realization of patterns driving in a stable environment. It places control and stability at the heart of the questions having to do with the psychological processes implemented at the time of the performances. The stress is laid on the part played by the system of data processing in the production, the regulation and the training of the movement. (Schmidt & Lee, 1999). The concept of driving program becomes a privileged conceptual framework which leads to define acrobatics as a closed skill (e.g., Higgins & spaeth 1972). The representations would have a physical reality, a symbolic system and semantics. In this approach, acrobatics lie in movements projected in space receiving their instruction from an internal model. Within this framework, cognition guides and orders the action. A second theme is apparent in the number of studies which include perception and action. There are two identifiable orientations. The first orientation proposes that the situation and the action are linked and that cognition will not be central (Kelso, 1995). An example of this orientation are the studies of Martin & al (1999).

The concept of "affordance" supports the assumption of a utility given to the context whose acrobat could size upon to act. The links made between perception and action are direct, without any intervention of consciousness. The situation is conceived as a resource, an opportunity to act, and the acrobat adapts to this offer. The second orientation proposes that there are constraints that will weigh on the organization of the action according to a certain number of degrees of freedom (Bernstein 1967). The research of Delignieres et al (1998) is typical of this orientation. This orientation considers that there is "repetition without repetition" (i.e., each time a vault is made, the degrees of freedom of the acrobat are modified to adapt to the environment even if the general form remains the same). These studies can be grouped under the generic term "emergence". The behavior or cognition of the acrobat is not regarded as a central component in the control and regulation of acrobatic performance. In this approach cognition is regarded as a secondary variable. The situation in relation to the action plays the role of resource or constraint for the acrobat. The third design, known as situated cognition (Robbins & Ayedede, 2009), is articulated in the reflections of Varela (1988, 1991) on the systems known as autopoetic. Those studies focused on the embodied character of cognition as well as the co-determination of the action, cognition and the context. Research such as Hauw et al. stresses the meaningful level of organization of acrobatics' performance in a singular context.

The comparison between various disciplines makes it possible to understand the direction which the acrobats grant to their actions, identifying differences in their own perception or cognition during action while they perform seemingly similar skills (e.g., a back flip in gymnastics and a back flip in skiing). This research takes into account instability and introduces the viability of the activity which, from the acrobat's perspective, allows performance. Research on stress and Lost Move Syndrome provided by Day et al. also enriches reflections on this contextual effect. In conclusion, research on the psychological processes implied in acrobatic performance is distributed on a loop which makes it possible to understand the variations in the level of acrobatic performance. This research loop goes from the evocation of external causes either with or without consciousness awareness (e.g., first and second design) with the focusing of an intrinsic dynamic to the action and with participation of the pre-reflexive level of consciousness or experience (e.g, third design). The most frequently analyzed acrobatic activities are diving, trampolining, tumbling, and artistic gymnastics. Research on "freestyle" disciplines such as acrobatic skiing has made it possible to give to increase the validity of the various models proposed. A second research loop may also be identified demonstrated by the skills researched from simple skills to more complex (from analysis of parts to analysis of the whole). However, in order for research to be applicable to acrobatic trainers and teachers the perspective of the acrobat in a particular context as well as from an external point of view must be considered. Following our analysis future research directions can be indicated. Research has examined the differences between an expert and beginner acrobat such as the psychological characteristics of the performance, but how one passes from beginner to expert has not been explained.

Consequently research should be concerned with acrobatic training and its impact on performance blocks such as LMS. Further, research which aims to understand the meaning given to situations by the acrobat would improve the ability of the coach to direct the behavior of the acrobat and possibly to eliminate mental blocks. Finally the development of research in acrobatic performance needs to enhance the links between sports science as a research domain and applied coaching practice.

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PSIHOLOŠKI PROCESI UKLJUČENI ZA VRIJEME AKROBATSKIH IZVEDBI: PREGLED

Sažetak
Akrobatska izvedba omogućava naročito bogati kontekst za istraživanje u sportskoj znanosti. Aktualno, veći broj publikacija o akrobatskim izvedbama je predstavljeno u područjima poput biomehanike, psihologije i traumatologije. Međutim, u stvarnosti, ne postoje istraživačke sinteze koje su promatrane iz psihološke domene. Cilj ovog članka je pregled literature o modelima i empirijskim istraživanjima povezanim s psihološkim procesima uključenim u akrobatske izvedbe. Ovaj pregled pokazuje poboljšanje znanstvenih spoznaja u sportskoj psihologiji na akrobatsku praksu. Prateći pretragu literature pronađeno je 66 članaka koji kombiniraju akrobatske izvedbe i sportsku psihologiju. Ovi su članci induktivno analizirani kako bi otkrili tri glavne istraživačke teme: a) organizaciju izvedbe, b) pripremu izvedbe i c) transformaciju subjekata akrobatskim vježbanjem. Ti članci su pregledani i izvedene su sugestije budućim istraživanjima.

Ključne riječi: *akcija, saznanje, kontekst, elitna izvedba, akrobatika, sportska psihologija*

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A COMPARISON OF EMG FLUCTUATION OF DELTOID AND PECTORALIS MAJOR MUSCLES IN BENCH PRESS

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Original scientific paper

Abstract
The purpose of this study was to compare the EMG fluctuation of pectoralis major-clavicular portion (PMC) and deltoid-anterior portion (DA) muscles executions of bench press with barbell and dumbbell. Fifteen male healthy employees (mean ± SD; age 30.13 ± 5.33 years; hewight 175.33 ± 6.07 cm; weight 69.80 ± 12.14 kg) without previous injuries of elbow and shoulder joints, DA and PMC muscles, volunteered to participate in the study. Surface electromyography data (AEMG and MPF) were recorded and calculated for PMC and DA muscles of dominant hand, during execution of bench press with both barbell and dumbbell exercise. Subjects performed 10 trials of bench press within 20 seconds. Results showed no significant difference between two execution of bench press with barbell and dumbbell over EMG fluctuation of PMC and DA muscles (P ≤ 0.05). However when EMG fluctuation of PMC and DA muscles were compared with each other, a significant difference was found (P≤0.05), but in both exercise executions the EMG activity of DA was higher than PMC. The results of this study indicated that two execution of bench press with barbell and dumbbell are equally efficient in strengthening the PMC and DA muscles because the posture adapted for elevation with hand dumbbells is essentially the same one observed for elevation with barbell. Otherwise the EMG activity of DA was higher than PMC, because PMC showed abrupt activity to surpass the limb inertia and weight against the gravity action at the initial position but it was found similar behavior for DA in all phase of movement.

Key words: *EMG, AEMG, MPF, Deltoid, Pectoralis Major, Bench Press*

Introduction

Studies of neuromuscular system often employ recordings of the electrical activity of recruited skeletal muscles. These electromyographic recordings could be detected and recorded within a muscle throughout needle or wire electrodes or from the surface of the skin above the active muscle group via surface electrodes. Surface electromyography (SEMG) is frequently used to estimate the amount of muscle activation required for specific tasks and to examine changes in muscle activation as a result of training (Finucane et al., 1998). During the last decade, a great number of researchers used the electromyography to prove aspects of muscular activity, not only in free joint movements but also in specific movements and postures of certain professions and/or sport modalities. However, among the most advanced studies found, there are some contradictions related to the effective participation of some muscular groups in basic exercises for physical fitness development (Ferreira et al., 2003c; Perry-Rana et al., 2003; Wise et al., 2001). Several authors (Kellis & Baltzopoulos, 1996; McCaw & Friday, 1994) pointed out that the description of many muscles in specific exercises for a sport is still determined from visual or theoretical anatomical observations and such observations are frequently incorrect or incomplete. It seems that electromyography must be used as a method to give the necessary scientific support to create physical fitness programs (Ferreira et al., 2003b).

Deltoid and pectoralis major muscles are the main muscles of shoulder joint that have important role in most of sport skills. Typically, the best and frequently used exercise for strengthening these muscles is the bench press. Therefore strengthening and preparing this muscles by the bench press, must be attentioned in designing training programs (Ston et al., 1991). However, most training programs are not dealing with conditions and demand levels of each portion of the muscles (e.g. anterior vs. posterior deltoid) although morphophysiological studies on both muscles have already shown clear differences in functional capacity of those portions. Some authors have already tried to establish such detail.

However, most of their statements are not based on electromyographic evidences and often they contradict as for the proposals (Ferreira et al., 2003a; 2003b; 2003c). The anterior portion of the deltoid (DA) and the clavicular portion of the pectoralis major (PMC) muscles are routinely cited as agonist pairs and responsible for the shoulder anterior flexion, the horizontal flexion, the internal rotation and for stabilizing the glenohumeral joint, representing the main motor force for that movement (Barnet et al., 1995; Elliot et al., 1989; Ferreira et al., 2003b). Even so, there is no uniformity in recommendations found among physical fitness exercises guidelines (Ferreira et al., 2003b; 2003c).

The bench press execution is usually performed with barbell and hand dumbbell, but often there is ambiguity between training modes concerning which method could be more effective. This diversity of opinions made us endeavour to analyze the behaviour of DA and PMC during the execution of bench press with barbell and dumbbell.

Methods

Subjects
Fifteen male healthy employers (mean ± SD; age 30.13 ± 5.33 years; height 175.33 ± 6.07 cm; weight 69.80 ± 12.14 kg), volunteered to participate in this study. Subjects were excluded if they had a current or previous record of injuries of elbow and shoulder joints, DA and PMC muscles, trauma, surgery, or other joint disease or were involved in technical-sport training. All subjects gave informed consent as approved by University institutional review board before participating in the study.

Instrumentation
EMG activity was recorded and stored using a ME3000P8 muscle tester (Mega Electronics Ltd, Kuopio, Finland). EMG data were analyzed using the ME3000PV1.2 computer software (Mega Electronics Ltd, Finland).

Procedures
After entering the laboratory, subjects performed 5 minutes of warm-up and skin was depilated and cleaned with alcoholic solution to reduce skin impedance prior to the attachment of the electrodes (Ferreira et al., 2003c). Afterwards electrodes were attached on the bulk of DA and PMC muscles. Bipolar silver-silver chloride surface electrodes (diameter 2 cm, Skintact, Austria) were positioned over the most prominent part of the muscles according to manufacturers manual. The distance between the centers of recording electrodes was 4 cm.

The electrodes were secured with adhesive tape and the wires were secured around the subjects (Kellis & Baltzopoulos, 1996). The execution posture and all conditions such as intensity, duration, number of repetition and angle of elbow joint was strictly controlled to all subjects by cettified strength and conditioning professional and two executions of bench press were performed with both barbell and hand dumbbell. Elbow angle was measured using an electrogoniometer aligned with the rotation axis of the elbow joint (180° = full extended) (Ferreira et al., 2003c; Wise et al., 2001). Regulating supine bench was used and a long bar of 120 cm made of very light wood was exclusively selected for this study. Subjects performed 10 trials of bench press within 20 seconds. In order to avoid muscular fatigue, the execution of exercises were separated by 2 min of resting intervals between each action (Ferreira et al., 2003a; 2003b; 2003c).

EMG data extraction
The EMG signal was recorded by amplifiers positioned to the ground electrodes with a gain of 360, a common mode rejection ratio greater than 130 db and a frequency pass- band of 20-500 Hz. The input noise level was less than 1 μV in the measuring band. The signal was collected at 1000 Hz, converted to digital from using a 16-bit analogue to digital convector and stored in a portable microcomputer (Kellis & Baltzopoulos, 1996). Raw EMG data of average EMG (AEMG) and mean power frequency (MPF), were collected and stored on a Pentium IV 2800 MHZ desktop PC with the use of custom software Megawin V.2.01 (Beck et al., 2004; Matheson et al., 2001).

Statistical analysis
Data were analyzed between the two exercises on EMG activity of DA and PMC muscles using t- test for paired samples. The level for all statistical tests was set at $P \leq 0.05$.

Results

No significant differences existed between two execution of bench press with barbell and dumbbell over EMG fluctuation of DA and PMC muscles ($P \leq 0.05$) (Table 1). However when EMG fluctuation of DA and PMC muscles were compared, a significant difference was found ($P \leq 0.05$), and in both exercise executions the EMG activity of DA was higher than PMC (Table 2).

Table 1 Paired t-test for bar and dumbbell execution on AEMG and MPF of DA and PMC

Muscle – execution	Mean	SD	t-value
AEMG - DA – barbell	3850.26	503.94	1.810
AEMG - DA – dumbbell	3851.33	503.51	
Paired samples t- test			
MPF - DA - barbell	78.26	13.93	1.309
MPF - DA – dumbbell	78.66	13.09	
Paired samples t- test			
AEMG - PMC – barbell	3802.80	465.92	1.075
AEMG - PMC – dumbbell	3803.06	465.83	
Paired samples t- test			
MPF - PMC – barbell	75.40	12.22	1.835
MPF - PMC – dumbbell	75.93	12.49	

Table 2 Paired t-test for DA and PMC on AEMG and MPF in bar and dumbbell execution

Muscle – execution	Mean	SD	t-value
AEMG - DA – barbell	3850.26	503.94	2.658
AEMG - PMC – barbell	3802.80	465.92	
Paired samples t- test			
MPF - DA - barbell	78.26	13.93	4.246
MPF - PMC – barbell	75.40	12.22	
Paired samples t- test			
AEMG - DA – dumbbell	3851.33	503.51	2.726
AEMG - PMC – dumbbell	3803.06	465.83	
Paired samples t- test			
MPF - DA – dumbbell	78.66	13.09	4.289
MPF - PMC – dumbbell	75.93	12.49	

Discussion

Our results seems to be in accordance with other investigators (Elliot et al., 1989; Ferreira et al., 2003a; 2003b; McCaw & Friday, 2004). Due to the high action potential levels measured for DA in two executions of bench press, particular muslce section seems to act as a primary motor agonist for supine exercises (Barnett et al., 1995; Ferreira et al., 2003c; McCaw & Friday, 2004). Equalizing of DA and PMC participation seems to be inappropriate, since the potential levels developed by PMC were always under those presented by DA. However, action simultaneity happened most times, being it possible to consider it an agonist pair. The participation form and intensity of both muscular masses, however, differed frontally (Ferreira et al., 2003c).

PMC participation was clearly concentrated along bar elevation, when the shoulder joint executed horizontal flexion. PMC showed abrupt potential levels elevation just at the beginning of the movement. Such behavior suggests that musculature activation to surpass the limb inertia and weight against the gravity action at the initial position (Elliot et al., 1989).

The trend to maintain high action potential levels during the whole elevation suggests PMC participation as primary motor agonist for horizontal flexion, and as shoulder joint stabilizer during the movement. We believe that is to avoid the upper limbs displacement able to change the 90° angle between those limbs and the trunk, required by the adapted execution pattern. It was found similar behavior for DA in the first phase of two tested supine exercises, repeating, coincidentally, the rough elevations and the trend to maintain high levels and constant action potential for the whole phase, as described to PMC. We attribute such behavior to the same participation needs as primary motor and joint stabilizer attributed to PMC (Ferreira et al., 2003a; 2003b; 2003c). On the other hand, significant differences in muscular demand level determined by the variation of execution forms with barbell and hand dumbbell, were not observed for DA and PMC muscles, which is in accordance with other studies (4, 5). We believe that such difference could be related to the changes of deltoid participation in shoulder movements due to the upper limb deviation in relation to the sagital plan (Ferreira et al., 2003c; McCaw & Friday, 2004).

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USPOREDBA EMG FLUKTUACIJE MIŠIĆA DELTOIDEUSA I PECTORALISA MAJOR U BENCH PRESSU

Sažetak

Svrha ovog istraživanja je bila usporedba EMG fluktuacije klavikularnog dijela mišića pectoralis major (PMC) i anteriornog dijela deltoideusa (DA) za vrijeme izvršavanja 'bench press-a' u 'barbell' i 'dumbbell' položaju. Ukupno 15 zdravih ispitanika (prosjek ± SD; uzrast 30.13 ± 5.33 godina; visina 175.33 ± 6.07 cm; težina 69.80 ± 12.14 kg) bez prethodnih povreda zglobova lakta i ramena, DA ili PMC mišića, dobrovoljno je sudjelovalo u istraživanju. Površinski elektromiografski podaci (AEMG i MPF) su zabilježeni i izračunati za PMC i DA mišiće dominantne ruke, za vrijeme izvršavanja bench-press akcija u barbell i dumbbell vježbi. Subjekti su izvršili 10 pokušaja vježbi u 20 sekundi. Rezultati nisu pokazali značajne razlike između dviju izvršavanja bench-press akcija u barbell i dumbbell vježbi u smislu EMG fluktuacije PMC i DA mišića ($P \leq 0.05$). Međutim, kad se usporedila EMG fluktuacija PMC i DA mišića međusobno, značajna razlika jest pronađena ($P \leq 0.05$), ali je u izvršavanju obje vježbe EMG aktivnost DA bila viša nego PMC. Rezultati ovog istraživanja pokazuju da dvije vježbe bench-pressa (barbell i dumbbell) su jednako efikasne u jačanju PMC i DA muskulature jer je položaj tijela za elevaciju dumbbell prilagođen te je esencijalno jednak onome koji je očuvan za elevaciju za barbell. Inače, EMG aktivnost DA je bila viša nego PMA, jer PMC pokazuje isprekidanu aktivnost da prevlada inerciju ekstremiteta i mase protiv gravitacijskih djelovanja u inicijalnom položaju ali je pronađeno slično ponašanje za DA u svim fazama kretanja.

Ključne riječi: *EMG, AEMG, MPF, deltoideus, pectoralis major, bench-press*

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THE EFFICACY OF THE PROJECT MOTORFIT: EDUCATIONAL ACTIONS THROUGH PHYSICAL ACTIVITY IN SCHOOLS

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Review paper

Abstract
The implementation of the project aims to improve mental and physical Motorfit students and aims to assess the degree of motor pupils attending compulsory education. This research project coordinated by Professor Luke Eid comes at the IRRE Lombardia (Regional Institute for Educational Research) and was made operational in the first instance in the Lombardy region, involving many hundreds of schools at all educational levels. In the school year in progress this project has been screened in the Campania region where, unfortunately, statistical surveys show that this region has the highest number in percentage of children overweight or obese, the figure is very alarming, so much so that estimated that 1 in 4 children are overweight because the percentage is 21% on average nazionale. Un framework that shows how good it is appropriate to intervene where the rate of obesity and overweight have reached significant levels, a fact essential if we consider the risk to which the obese person is exposed, a step away from cardiovascular disease, diabetes. The bad lifestyles and excess nutrition, it also has a strong economic impact on public health costs - more than 30 billion € are burned for cardiovascular disease and diabetes. And without action incisive, in ten years we will have almost 280.000 new adults obese, an increase of public health spending countless more. Just to fill this gap and driving through the action of Prof. Anna Rose was discovered and published a manual for the evaluation of the mobility of disabled people already in force at the Physical Education Academy "Jozef Pilsudski" in Warsaw "Eurofit Special: test of physical fitness for people with mental retardation". In order to develop and spread in our country this protocol, the National Agency for the Development of Education - Core Spatial Lombardy, in collaboration with other public and private institutions, has promoted the project through the trial actions aimed at education and research institutions within its jurisdiction. From this situation, the team composed of Profs. Perrotta, Corona and Cozzarelli has led this experimental project involving primary school children and equal in the province of Naples and Benevento, Italy.

Key words*: psychomotor education, hypokinesia, coordination, integration, motor skills*

Introduction

The implementation of the project aims to improve mental and physical Motorfit students and aims to assess the degree of motor pupils attending compulsory education. The project MOTORFIT Lombardy, whose Memorandum of Understanding was established from 2005-2006, has already been presented in various international fora. Among the latest are: 13-14 July 2006 in Budapest (Hungary) at the Institute of Coaching and Sport Education of Semmelweis University, on 21-22 October 2006 in London (England) at St. Mary's University College, 29 -31 August 2007 in Bratislava (Slovakia) at the Faculty of Physical Education and Sport, Comenius University, 16-18 November 2007 in Oradea (Romania) at Facultatea de Fizica you Educatio Sport din Oradea, on 10-11 December 2007 Belgrade (Serbia) at the Faculty of Sport and Physical Education of the University of Belgrade. Currently our agency is working with Scholastic many European partners who are conducting the same experience in your country: Austria, Estonia, Finland, Poland, Romania, Slovakia, Spain, Hungary. This research project coordinated by Professor Luca Eid comes at the IRRE Lombardia (Regional Institute for Educational Research) and was made operational in the first instance in the Lombardy region, involving many hundreds of schools at all educational levels, and also 'useful the teacher of physical education as an educational tool-integrated methodology for the formative evaluation of students. In the school year in progress this project has been screened in the Campania region where, unfortunately, statistical surveys show that this region has the highest number in percentage of children overweight or obese, the figure is very alarming, so much so that estimated that 1 in 4 children are overweight because the percentage is 21% of the national average (Parizkovà J.1998). A picture that shows how good it is appropriate to intervene where the rate of obesity and overweight have reached significant levels, a fact unavoidable if we consider the risk to which it exposes the obese person, one step from cardiovascular disease, diabetes. The assessment of pupils' motor and its analysis is an important reference point for future educational activities. Studying the motor efficiency can be assessed indirectly the health and lifestyle of a person. Physical control of emotional subjects in evolutionary fact, aims to outline a series of benchmarks that can support both the evolution of mobility is to identify the needs in the development of the movement. This applies both to non-disabled students than for students with disabilities.

If the former, over the years, in Italy have been numerous studies conducted through batteries of tests to assess their engines useful physical fitness for the disabled was not possible at present to do likewise. The bad lifestyles and excess nutrition, it also has a strong economic impact on public health costs - more than 30 billion € are burned for cardiovascular disease and diabetes. And without action incisive, in ten years we will have almost 280 000 new adults obese, an increase of public health spending countless more. Just to fill this gap and driving through the action of Prof. Anna Rose was discovered and published a manual for the evaluation of the mobility of disabled people already in force at the Physical Education Academy "Jozef Pilsudski" in Warsaw "Eurofit Special: test of physical fitness for people with mental retardation". In order to develop and spread in our country this protocol, the National Agency for the Development of Education - Core Spatial Lombardy, in collaboration with other public and private institutions, has promoted the project through the trial actions aimed at education and research within its remit istitutional. The information will be collected in the trial dell'a.s. 2010/2011 analysis by using computerized statistical software (Stata ®, SPSS ® and SAS ®) and spreadsheets (Excel ®). From this situation, the team composed of Profs. Perrotta, Corona and Cozzarelli has led this experimental project involving primary school children and equal in the province of Naples and Benevento. The process followed after the receipt of data until the production of reports, can be summarized in the following five phases: the first stage of cleaning is defined is the identification of those values that have appeared as faults in order to identify those errors or omissions that may be, the second phase has required hard work of structuring in order to identify the relevant benchmark on an application, the third phase consisted in the comparison of averages with the data that existed previously, these data were reference to research carried out in similar or different, in the fourth stage we have focused on the analysis of the ICM (BMI), and using the linear regression model, was searching for a possible approximation of this index to a combination linear results of tests conducted, while the fifth and final phase involved the further structuring of all the comments by reiterating the analysis with respect to the individual.

Objectives and Functions

A key component of most educational programs in kindergarten and primary is the development of motor skills. During this period the child's motor skills continue to evolve. An important aspect of monitoring engine is the early identification of children with challenges in physical activities and sports. They are so well constructed and standardized testing is required, which include basic motor skills. For the project, were selected Motorfit TGM test (Ulrick, 2002): Test for the kindergarten gross motor and primary school and secondary school Eurofit of first and second grade.

The first objective in the construction of TGM was to create a battery of tests that included the contents that are frequently taught to children ages 3 to 10 years. While testing Eurofit there is a tendency towards aspects that characterize the age between 11 and 18 years. The overall aim was to develop tests that could be used by a large number of professionals with a minimum amount of trying to build expertise capable of providing test results and regulatory criteriali. The key objective focused on the fact of giving priority to the qualitative assessment of the harmonic sequence of the development of gross motor skills rather than just the quantitative result of motor performance. The mastery of major gross motor skills requires that the child develops a mature pattern of movement and what is more important than the quantitative results expressed in terms of space and time. The gross motor development test is a test administration that quantifies the individual motor coordination, which assesses gross motor function of children aged between 3 and 10 years and compared the abilities of locomotion ability to control objects the basis for the further development not only motoric and Prestatie but also social and relational. The test measures in its original protocol 12 gross motor skills which are frequently the subject of teaching with preschoolers and early primary school classes. In the case of Motorfit, and following the notes we have received from teachers and from the statistics, we have reduced the evidence 6. The first three items are related to coordination and segmental ritmizzazione, but the other three items refer to the segmental and eye-hand coordination to the space-time.

Figure 1. Movement sample

Figure 2. Movement sample

Figure 3. Movement sample

Figure 4. Movement sample

Figure 5. Movement sample

Figure 6. Movement sample

According to the Guidelines for kindergarten and primary school, the sample was made up of pupils aged 3-10 years, attending the private schools in the region Campania. The factors taken into consideration for the research were: the geographical location of the school, sex, age, the state Motor Pool (Test), weight, height, shoe size, BMI or BMI (Body Mass Index).

The skills required are mainly based on the examiner's ability to observe and detect the presence of appropriate performance criteria for each skill assessed. For best results, those administering the test should initially be formed a mental picture of the optimal execution of a person with good motor skills, as depicted by the specific performance criteria listed for that date skills. It 'was in fact recommended to observe well the illustrations for each test (item) and practice with the specific components before conducting a formal evaluation. The examiner should familiarize yourself with the verbal instructions specific to each test and scoring procedures. To carry out the tests properly took account of certain standard conditions: the parties should carry out the test wearing sports clothes and shoes to perform the tests for locomotion, it is very important that the floor of the gym is not very slippery, the series of engine tests is organized in a specified way. You can, if necessary, change the order of administration, the subject is not allowed to run a warm-up exercise or test. This is because children could improve their performance. It is usually possible to stimulate and encourage the subject during the test by filling in an appropriate manner the appropriate registration form of the pupil and by preceding the test to assess an accurate demonstration of the item / test by a person skilled and a clear verbal request. It is also appropriate to provide further demonstrations when the student appears not to have understood the task by giving the item / evidence that will be assessed for the marking. The supporting material for this design also includes a paper ballot record of the pupil (or PC with excel file included), a colored tape or chalk, cones or cinesine No 4 sponge balls (the size of those courts), n. 4 sponge balls for volleyball, and a tennis racket (even plastic). Each item has provided the performance criteria (what to observe). Typically, these criteria represented a mature pattern of running ability. Compared to the times of administration assessment of a student took on average about 15 minutes. The time clearly can have significant variations depending on the age of the student, his level of competence and organization of the examiner. By the time they have undergone all the testing engines in one session they were administered according to the following order, leaving an appropriate time to recall the subject. In the first instance the survey anthropometric data for all orders of school in relation to height (STA) and weight (PES). Second Test Childhood and Primary School which is a first Test Saltelli forward on one foot (SAP1) in the second Test Gallop lateral (GL), in third Test Saltelli alternating forward on one foot (SAP2), fourth in Test Launch a ball with one hand (LP), a fifth test receive a thrown ball with his hands (RP) and a final test. Hitting a ball with a tennis racket (CP). Test Secondary School provides for the bending of the torso forward (FLE), the standing long jump (LUN), the elevation of the torso from supine (ADD), the suspension arms flexed (BRA), the shuttle sprint 10x5 m. (VEL), running 12 minutes of resistance (RES).

For each test set is shown below the necessary material, the objective of the test, directions for the teacher and the student, and the type of table but not limited to the evaluation of the test.

Material and methods

Piaget (1896-1980) was among the first scholars of child psychology to highlight how large-motor development is a key factor in the general psychic development of the child. Williams (1983) defines large-motor development as "the use progressively more skillful of the entire body in an activity that involves large muscle groups and requires the coordination of spatial and temporal simultaneous movement of various body segments." The development is mainly large-motor skills that are used to move the body from place to place (locomotion) and to move and take items. Many scholars agree that the gross motor skills are developed sequentially (Gallahue, 1982, and Martinek Zaichkowsky, 1980). It is generally accepted that people progress through the various stages engines with a different rhythm, which depends on both biological and environmental factors (Haubenstricker and Seefeldt, 1982). Haubenstricker and Seefeldt (1982) noted fact that when you have not yet mastered the appropriate levels performance with respect to gross motor skills and basic patterns, people encounter obstacles that can reduce their potential for learning in many other more advanced skills in areas other than motor or sports.

The mastery of movement has a positive effect not only on cognitive skills, for more opportunities to steal information from the environment and to experience, but also a deeper psychological level, beginning with the construction of body image to self-esteem and security of person. Psychomotor intervention is an important approach is to encourage the growth is normal in rehabilitation. It is essential to the possibility of reaching an objective situation of motor skills that this test allows you to perform with remarkable precision (Gallahue D. L, Ozmun JC 1997). It 'should at this point to dwell mainly on the description of the test set for kindergarten and primary school which is a primo Test: Saltelli forward on one foot (SAP1). The test involves the tracking of two lines (start and finish) at a distance of 10 meters apart and perpendicular joining the start and finish with colored tape, chalk or use existing lines. The goal will be the action that takes place in the act of hopping on one foot forward along a line in the following four ways. The indications for the teacher are: a. Look closely at the four executions, b. ask the pupil to the side when you look at the first 3 items; c arise behind the pupil when looking at the fourth. The instructions for the student instead are: a. to go from standing before the starting line up in support (one or two feet), b. the journey of trying to go straight. The items are 4 and consist of the 'first use. a foot freely chosen by the student, 2. use the other foot, 3.freely chosen to use his foot earlier, 4. use the other foot.

With regard to the criteria of performance do not need to flex his leg jumping (please record your favorite foot), whether it can hop with the other foot, if you can jump to any slender arms bounce, and finally if you are able to hop while maintaining the straight direction. The survey form should mark a "1" in the column on the registration form, when the student performs the item correctly. Mark "0" otherwise. Clearly the observation criteria must not be communicated to the pupil before the test. The second Test: Gallop lateral (GL) plans to draw two lines (start and finish) at a distance of 10 meters apart and perpendicular joining the start and finish with colored tape, or use chalk lines already exist. The specific objective is to be able to gallop. With regard to the information for the teacher is expected to: a. Look closely at the four executions, b. ask the pupil to the side, perpendicular to the direction of travel, when you look at the first three items, asking the pupil to the side when you look at the fourth. The student is taught the following instructions: a. Starting from standing before the starting line, facing the teacher, b. travel the distance trying to go straight. The items are always four: 1. freely chosen to follow the direction (left or right), 2. go to the other direction, 3. go back to the direction previously chosen freely, 4. go to the other direction. The performance criteria are related to the degree of capacity in the gallop in a brief moment when both feet not touching the ground (flight phase). It also takes into account the ability to gallop toward the other direction, so in the gallop in the direction of freely chosen by throwing her arms with each bounce and gallop in a straight direction. Third Test: Saltelli alternating forward on one foot (SAP2) It grows in tracing two lines at a distance of 10 meters from each other with colored tape, plaster or other objects in the sand. The objective is to assess the capacity in hopping on alternating foot top, on down to the finish line. The indications for the teacher in this juncture are: a. stance in front of the pupil, and perpendicular to the direction of travel, when you look at the first 3 items, ask yourself behind the pupil when looking at the fourth, b. pupil recalled the sequence of hops (two to three times over six feet, two to three times on the right foot). The instructions to give the student are: a. Starting from standing before the starting line up in support (one or two feet), b. travel the distance trying to go straight and the foot switch as explained hops on which to do. The four items are: 1. must bounce twice on one foot and then twice on the other, 2. three times on one foot and then three times on the other, 3. twice on one foot and then twice on the other, 4. three times on one foot and then three times on the other. The performance criteria are established: Perform the required sequence of two alternating jumps, perform the required sequence of three jumps Or, run the required sequence of alternating jumps and keep a straight direction, performs the required sequence of alternating hopping height and amplitude of the regular hops. The board must score a "1" in the registration form, when the student performs the item correctly and mark "0" otherwise.

The fourth test: Throwing a ball with one hand (LP) provides materials such as a tennis ball and a wall. Consequently is to draw a line 10 meters away from the wall with colored tape, plaster or other objects in the sand. The goal is to throw the ball against the wall. The indications for the teacher have to stand next to a pupil for the records and to give the signal to every launch. The instructions to give the student are: a. Starting from standing before the scored line, one foot forward and one back, b. the signal strength of the teacher to throw with the ball against the wall. The board must score a "1" in the column on the registration form, when the student performs the item correctly and mark "0" otherwise. The four items are: 1 run the ball against parete.2. to re-run the ball against parete3. throw the ball once again against the wall, 4. launch a last time the ball against the wall. The performance criteria are focused on being able to hit the wall, take the correct initial position: opposite foot to throwing hand held out. During the launch of the hand is above shoulder height and gives a trajectory to the ball. The five Test: Receive a pitched ball with his hands (RP). The material used consists of a plastic ball. Two lines are 5 meters from each other with colored tape or other material cut-off. The priority is related to taking the ball on the fly.

The indications for the teacher are as follows: a. The student is at a line and who, throws the ball, gets behind the other line, b.si pupil throws the ball from the bottom, making them describe a slight bow, c.si only takes account of the launches arriving in the area between the shoulders and hips. Instructions to be given to the student to meet the need of a. remain behind the line marked in the upright position, ready to receive the ball, b. to try to catch the ball without letting it fall to the ground. The board will mark a '1 'in the column on the registration form, when the student performs the item correctly and is marked "0" otherwise. There are four items that take 4 times the ball on the fly. The performance criteria consist of assuming a position of waiting: the views that are not passive but is ready to receive (note if it receives the ball). The arms stretch forward to catch the ball (note if it gets the ball). The ball is taken only with the use of hands (note if he receives the ball). And they have been received 4 out of 4 balls without dropping them. The Sixth Test: Hitting the ball with a tennis racket (CP). The material used consists of a sponge ball and a tennis racket. You draw two lines to 5 meters from each other with colored tape or other material cut-off.'S goal is to hit the ball.

The indications for the teacher are: a. throw the ball to the pupil from the bottom up, making him bounce in front, b. take account only of the launches come in the space between the knees and shoulders. The instructions to give the student are: a. remain behind the line marked in the upright position, ready to receive the ball, b. hit the ball with the racket that you run the master after it has bounced back to earth. On the board represents a '1 'in the column on the registration form, when the student performs the item correctly and mark "0" otherwise. The items are held four and running for 4 times the action of hitting the ball with the racket. The performance criteria are conditioned to the fact of taking a position of waiting: it is not passive but is ready to blow. When you hit the ball is held on the foot opposite the hand holding the racket.

Results

The study seeks to advance the practice of daily physical activity as a subject. In fact the data show that the importance of correct psychomotor development in preschool and school age is a sound basis for learning of cognitive and behavioral strategies (Le Boulch J.2009). Only the child who has a sound understanding of the bodily self, emotions, as well as information from outside, have the necessary means to experience an authentic learning. The perceptual abilities, motor coordination and control of their emotions are part of what is classically defined process and psychomotor development are essential prerequisites for psychosocial development. Today the practice of "psychomotor" aims at a harmonious and full of personality.

Conclusions

This project is oriented to the achievement of certain objectives that complement those with perceptual motor skills, as most of actions that we perform daily needs this kind of feedback (M.1995 Deutsch). It is also based on a good capacity for coordination of multiple movements, taken simultaneously from different parts of the body, according to the criteria to evaluate the accuracy of timing, the right timeline.The dynamic pattern of movement, and coordination of the various parts of the body is made particularly urge the body expressions through the acquisition of an appropriate facial expression and posture experiencing the pleasure of playing at various levels of complexity and at the same time putting into relational dynamics of the game.

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EFIKASNOST PROJEKTA MOTORFIT: EDUKACIJSKE AKCIJE KROZ TJELESNU AKTIVNOST U ŠKOLI

Sažetak
Implementacija projekta cilja na poboljšanje mentalnih i psihičkih dimenzija Motorfit polaznika i cilja na procjenu stupnja mototike učenika koji pohađaju obaveznu nastavu. Ovo istraživanje koordinirano od prof.Luke provedeno je u IRRE u Lombardiji (Regionalni institute za edukacijska istraživanja) i operacionalizirano je prije svega u Lombardiji, uključujući više stotina škola na svim razinama edukacije. U tekućoj školskoj godini projekt je praćen u regiji Campania gdje, nažalost, statistička anketa pokazuje da ta regija ima u postotku najveći broj pretilih i gojaznih, što je alarmantno jer se procjenjuje da je 1 od 4 djece prekomjerne težine dok je nacionalni prosjek 21 %. To je okvir koji pokazuje koliko je dobro i adekvatno intervenirati tamo gdje prekomjerna težina prelazi značajne razine, a činjenica je da je esencijalno ako se uzme u obzir rizik kojemu su ove osobe izložene, tj. nalaze se svega na korak od kardivaskularnih bolesti, dijabetesa. Loš stil života i neuredna ishrana također imaju snažan ekonomski utjecaj na troškove javnog zdravlja – više od 30 milijardi € (eura) se potroši na posljedice ovih bolesti. Dakle, bez prodorne akcije, u slijedećih 10 godina bit će oko 280.000 novih gojaznih odraslih, slabljenje javnog zdravlja uz brojne dodatne troškove. Samo da se riješi i premosti ovaj jaz, prof.Rose objavila je i publicirala uputstvo za evaluaciju kretanja onemogućenih osoba koje su još pokretne na Akademiji za Tjelesni Odgoj "Jozef Pilsudski" u Waršaawi: "Eurofit Special: test of physical fitness for people with mental retardation". S ciljem razvoja i zamaha ovog protokola u našoj zemlji, Nacionalna Agencija za Razvoj Edukacije – na prostoru jezgre Lombardije, uz suradnju s ostalim javnim i privatnim institucijama, promovirala je projekt kroz probne akcije ciljane na edukaciju iistraživačke institucije u okviru svoje jurisdikcije. Od tada, ekipa sastavljena od profesora Perrotta, Corona i Cozzarelli vode ovaj eksperimntalni projekt uključujući djecu osnovne škola u pokrajiji Napoli i Benveneto u Italiji.

***Ključne riječi**: psihomotorna edukacija, hipokinezija, koordinacija, integracija, motoričke vještine*

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CONCEPTIONS ABOUT PHYSICAL EDUCATION AT SCHOOLS

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Review paper

Abstract
Through last decades, several different tendencies can be registered in schools physical education in general. Some of them are logical result of World transformation as well as school itself, and some of them are generated from different roles of physical exercise. Finally, it is not possible to neglect different ways of organisational forms of nowdays physical education conduction. This article address tasks and conditions of school PE and exercise in following concepts: Biological oriented, Education through movement, Personality education through movement, Conformist sport organisation and Critical constructive movement socialization. Probably new pathways can be find in change from biological forward to social values of PE, and changes in PE teachers forward to more creative support of pupils.

Key words*: physical education, tendencies, concepts*

Introduction

At the end of the 80-ies of XX century new tendencies in the development of school physical education started to gather strength as a world-wide phenomenon. The accent of its purpose was displaced First tendency: This tendency is especially characteristic feature of the economically developed countries in Europe. In the foreground appeared the *emotional side* of physical education activities. Good experience of extracting pleasure of movements and psycho-physical balance of pupils is put ahead and on the first place. The trend to systematic exercising for seeking harmonious development of children and youngsters came to be a subdominant purpose of school physical education. Here we have to do some explanations.

This tendency must not be misunderstood and the result to be disorganization in physical education lessons. As purposes reflect some social necessities, in this occasion the change of physical education main purpose is necessity and is completely logical. Seeking harmonious development of young generation to a certain extent is an idealistic purpose. More or less it is product of the good theory but not of the real practice. In technology of physical education teachers sometimes cannot reach the high put purpose.

There always is something that they could not manage to fulfil though their enormous efforts and wish. Reason is in the limitations of the laws of nature to human capabilities and by the genetic data, on one side, and the material and social achievements in concrete situations, on the other hand, e.g. the material and technical foundations with the necessary equipment, allocation of physical education lessons, etc. Purpose of physical education connected with the pleasures that their main content in the face of the enough number and purposeful motor acts can bring to pupils, is much more near to reality.

To this new formulation of the school physical education purpose can be also add the *personal contentedness* of the reached achievements. There are also authors (Feingold et al., 1992, Knight et al., 1992) who stay behind the standpoint that for a pupil is beneficial even if he or she is not an active participant on the playground but only a passive spectator of the happening there. Even inactivity of this kind is healthful for the rising generation. This opinion goes to extremes and physical education teachers have to be careful with its interpretation. Second tendency: This tendency also has worldwide dimensions. As all of us know, last decades of XX century in addition to super development of electronic technologies and communications are determined as time of the informational expansion. Arising idea somewhere very quickly finds its way all around the world. The same situation we have here. Determination of purpose of school physical education now is declined to the health contributions of motor exercising.

First publications in this direction are since the 80-ies of former century (egg. Almond, 1983; Whitehead & Fox, 1983). The laid emphasis on health effects means building of *health culture* in young generation and terms like style of life, diets, nutrition, wellbeing, etc. to be parallel part of physical education at schools. E.g. in 1987 American Academy of Pediatrics gets the decision to support Physical education programmes that lessen time for motor skill education and team sports and to stand behind school programmes that secure stable and lasting habits for health directed exercising for good general disposition (Feingold, Rees & Barrette, 1992). In this attitude a debate along the school physical education content followed. In same direction is the view of specialists in Brazil (Silveira, Bohme & Myotin, 1992). In Australia along with the programme "Aussie Sports" that in year 1988 spread over 26% of the primary schools.

The number of the primary schools that supported the programme "Aussie Sports" and organized regular sports occupations for their pupils is 2040. in the state emerged other but health related physical education programmes with wide support as well (Hawkins, 1992). During the last 20 years the number of publications of authors who tried to work out theoretical concepts about physical education in mainstream (with general education) schools increased (Lyakh, 2009). They determine former and nowadays views about school physical education. These publications are each one by itself and never discussions or exchange of ideas, reference points, content and other aspects are done. Very rarely comparison between physical education in two or more than two countries in Europe is done (Richter, 2006; 2007; Lyakh, 2009). Scientists like Crum (1992; 1994), Balz (1992), Naul (2003), Richter (2006; 2007), etc., determine the existence of 3 to 5 concepts in school physical education. In this aspect as most complete is accepted to be the view of Crum. Making his analysis he determines the existence of the following 5 conceptions about the philosophy, methodology, and organization of physical education at schools.

I.Biologic oriented conception

In German literature it is known as "das biologischorientierte Konzept", in English literature it is "training conception". The main idea in this concept is that purpose of using physical exercises is the biologic adaptation of the organs and system of organism to the environment. The beginning of this concept is sought in Swedish Gymnastic System whose founder is Per Henrik Ling and is developed further by his son Hajdmar Ling (XVIII – XIX century). This system was adopted in the countries of Western Europe and South America. The initial bases of this conception underwent some modifications because of scientific findings or social changes. In spite of all, the main characteristics of the conception remained untouched. In the centre is the idea about the role of human body with special attention to the motor functions for its development. Biologic oriented conception relies on knowledge of medical and biologic cycle. Physical education programmes that accept this conception have as main purpose and task the development and raise of physical conditioning/fitness of pupils.

Attention is to the development of the components of fitness – level of agility, strength, speed, flexibility, endurance/stamina, mobility, balance, coordination. So, the bodies of pupils are put under a certain amount of stress to increase their physical capabilities. According to Hardman (2001), Pospiech (2003), etc., the task the physical fitness capacity of pupils to be increased is one of the main tasks of school physical education. Supporters of this view rely on the training effect for biological adaptation of body functions to environment. In the frame of the biologic oriented conception and as an example Crum (1992) gives the use of running in school PE lessons.

Main content here is the development of the different kinds of endurance, strength and agility. It is no matter what kind of means the PE teacher uses. It can be a long distance running, plays and games, relay-races, etc. But always the following rules have to be observed:

- Minimum duration of running has to be 10 – 15 minutes
- Pulse-rate of primary and secondary school pupils has to be somewhere around 150 beats per minute
- Exercises included in plays and games have to be with a simple structure, accessible for the greater part of the pupils and to be offered in combination with running

General conclusion is that content of this kind of the PE lessons makes the teacher to look much more like a trainer than like a teacher.

II. Education through movement conception

"Education through movement" is the English term of this conception. The German term for it is "das bildungs-theoretische-konzept Erziechung durch Bewegung". This conception is based on the ideas of the philanthropists and first of all of Guts Muths. Austrian school physical education is based on this conception for years. Movements here are considered as a means for a personal development of character, discipline, strength of spirit, social and esthetic education. There is stressed on the function to be able through movements to express your, to come in contact with the others, to compare yourself with them, etc. Motto of the conception sounds as "*Moving educate yourself* " but not "*Learn to move*". Physical education in this conception is considered to be an important and necessary component of general education of people. As a rule purpose and tasks of physical education in this occasion are connected with training of the strength of will, faith in man, greater ability for concentration, and social and intellectual development as well. In the programmes of physical education there is a lack of variety. Usually content of physical education is based on a list with exercises and games suitable for the concrete age and abilities of children and youngsters. But always is necessary the educational tasks to be conducted in a good atmosphere (Crum, 1992). Purpose of "Running" in this conception for example aims the decision of tasks like development of ability for interaction, wish to take a risk, belief in yourself, responsibility, etc. In the occasion the content is running for orientation in space, games with running, and relay races. The task of the teachers is to secure good organization and enjoyable atmosphere during the lessons. So, in the PE lessons the role of the amusement function is leading.

III. Personality education through movements conception

The term in German for this conception is "das personlichkeitsorientierte konzept der Bewegungserziehung". The key position here is the education in motor skills.

The main idea is that the acquisition of motor skills through purposeful motor activity will lead to development of children and youngsters. The conception also seeks personal development of pupils and building of motor competences for personal orientation in nature and social environment. This conception has variants. For example its English variant relies on the ideas of Laban (1989) formed at 1848 about the *space harmony* of human body where important are (and because of this are principles): 1) Awareness of body, 2) Awareness of space, 3) Quality of effort, 4) Relationships. According to Laban human movements are nothing else but physical moving of body or its parts in space. Second is the Dutch variant of this conception. In its base are the views of Gordijn and Tamboer who look at the human movements as a dialogue between individuum and the environment. In the theme "Running" according to Laban and his followers during the process of education pupils have to master terms as "space", "time", "load", etc. and their quality characteristics, e.g. freedom of performance, grace, etc. According to Gordijn mastering of running has as a purpose the achievement and keeping of a definite speed, passing through the distance for a definite time.

IV. Conformist sport socialization conception

In German the term is "das konformisierende konzept der Sportsozialisation". In the occasion the content of conformism must be understood as adaptation to the social norms and values (Lyakh, 2009, p. 4). The purpose of the idea is "teaching through sports disciplines" (Kurz, 1977; Soll, 2000). In the conception come to the fore social prospects while exercising with its technique and tactics is only the means for participation in sports disciplines. Two are the reasons for the formation of this concept. Firstly, the development of such school programmes whose accent is on the readiness of young generation for existence in society. Secondly, the significance of the organizational forms of sport whose number increases constantly. In some countries, e. g. Germany, matters went so ahead that very often the content of the school programmes concerning physical education are designed with the active participation of representatives of the sports organizations. This concept demands adaptation of school physical education and school sport to the functioning world of sport. "Running" here is mastered as a technique, with acceleration, different starts, with participations in competitions.

V. Critical constructive movement socialization concept

The German term that covers this concept is "das kritisch constructive konzept der Bewegungssozialisation". Main purpose is the mastering of technique, social, motor and intellectual competences by the pupils. These competences will be needed by them for their future participation in different forms of motor/sports activities.

This conception relies on the critical theoretical views of symbolical interactionism, humanistic psychology, cognitive psychology, and the general theories of education (Lyakh, 2009, p. 5). Building in pupils of motor, social and intellectual competences will be necessary for their lifelong participation in different forms of motor activity (Crum, 1994, p. 527). The followers of this conception pay more attention to the meaningful real practice and utility of physical exercising. As former ones this conception also supports the idea of the social meaningfulness of physical education. But here the role of the social meaningfulness is with wider content. In process of education pupils not only do exercising according to the offered to them motor task but they alone try to create new motor tasks. Balance between development of abilities for adaptation to society and development of individuum is sought. In practice this means that pupils have to master not only the technique and tactics of exercises, the theoretic and methodological knowledge, etc., but also to know and use values from the sphere of the emotions and intelligence, such as happiness, health, relaxation, etc. Decision of problem situations and influence on intellectual and reflexive qualities of pupils during lessons, plays, dances, and other forms of physical activity are stimulated. Programme content of physical education in relation to critical constructive movement socialization concept is systematized in themes whose mastering is well methodologically described. "Running" as theme is mastered firstly as a correct technique but later on are recommended different variants of running, so that the senses of pupils to be developed. At the end conditions for rationalization and discussion are established. On table 1 in short can be seen some of the main characteristics of the 5 conceptions about school physical education, defined by Crum (1992; 1994).

Table 1. Main characteristics of school physical education conceptions

Biologic oriented conception
Adaptation of organism to environment. Relying on medical and biological sciences. Main purpose is raise of physical conditioning – agility, strength, speed, flexibility, endurance, coordination, balance, etc.

Education through movements conception
Movements are means for development. You express yourself through movements and come in contact with others. A step forward to social and intellectual development is done. Lack of variety in school PE programmes. Good supporting atmosphere in lessons is necessary.

Personality education through movements
Key position has the purposeful acquisition of motor skills. Building of motor competences will help for the personal orientation in nature or social environment. This conception has two variants.

Conformist sport socialization conception
Content of conformist is understood as adaptation to social norms and values. Teaching is through sports disciplines. Functions of world sport are observed.

Critical constructive movement socialization
Overall mastering of motor (technique and tactics), social and intellectual competences is observed. Seeks lifelong participation in different forms of motor activities. Creativity of pupils in designing new motor tasks is stimulated.

Conclusion

As general conclusion concerning the different conceptions about physical education in schools we can consider the following points: 1. Theoretical conceptions in school physical education follow the necessities of the young generation. In this aspect in retrospective plan we find out development and change from biological to social important values that obligatory PE in schools can have, and 2. To all tendencies and changes school PE teachers have to be enough flexible, so that PE exercising to be creative and helpful for their pupils.

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KONCEPCIJE O TJELESNOM ODGOJU U ŠKOLAMA

Sažetak
Zadnjih desetljeća moguće je primjetiti nekoliko različitih tendencija općenito u školskom tjelesnom odgoju. Neki od njih su logični rezultat promjena u Svijetu baš kao i u školi kao takvoj, a neki od njih su generirani iz različite uloge tjelesnog vježbanja. Konačno, nije moguće zanemariti ni različite načine organizacijskih oblika današnjice u provedbi tjelesnog odgoja. Ovaj članka adresira zadatke i uvjete školskog tjelesnog odgoja u slijedećim koncpetima: Biološki usmjereni, Edukacija kroz kretanje, Osobna edukacija kroz kretanje, Konformističke sportske organizacije i Kritična konstruktivna socijalizacija kretanjem. Vjerojatno se novi putovi mogu pronaći u promjeni od biološkim prema sociološkim vrijednostima tjelesnog odgoja, kao i u promjenama učitelja tjelesnog odgoja prema kreativnijoj podršci učenicima.

***Ključne riječi**: tjelesni odgoj, tendencije, koncepti*

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HEALTH AND PHYSICAL EDUCATION: A NEW GLOBAL STATEMENT OF CONSENSUS*

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Global statement

Abstract

** According to global idea to inform people in countries all over the World, this statement is publish in native languages with chosen authors in this countries: Austria, Belgium, Bosnia & Herzegovina, Brazil, China, Czech, Hungary, India, Japan, Korea, Malaysia, Mongolia, Philippines, Nigeria, Poland, Belarus, Kazakhstan, Romania, Russia, Slovenia, South Africa, Sri Lanka, Switzerland, Taiwan, Thailand, Turkey, Ukraine, United Arab Emirates and United States of America. This Statement is published in Croatian (native language) in Acta Kinesiologica scientific journal.*

The GoFPEP 2010 Consensus Statement provided multifaceted recommendations focused on improving physical education pedagogy and the preparation of physical education teachers. Recommendations advanced the importance of healthy active lifestyles, integrating health and physical education, promoting best practices, advancing the knowledge and skills around physical literacy, student and teacher assessment and community partnerships. The core of the Consensus Statement called for enhancing and maintaining the health and wellbeing of individuals. Action by students, physical educators, health and leisure professionals, policymakers, citizens and business leaders was called for to provide programs that promote a committed effort to addressing the ever increasing worldwide concern of obesity and overweight among children and youth.

***Key words**: Physical Education, teachers preparation, life-style, health, exercise*

Introduction

Significant changes in physical education have taken place over the past 40 years with a transition from a traditional sports skill-orientation to a broader emphasis on health-related fitness and lifelong physical activity (Bocarro et al., 2008; Jago et al., 2009; McKenzie & Kahan, 2008). However, throughout the world, physical education programs are being reduced, minimized and/or outright eliminated from elementary and secondary curriculums (Hardman & Marshall, 2009; Puhse & Gerber, 2005). It is increasingly apparent that the value of physical education programs are being tested worldwide. In an age of increased accountability, the lack of effective measures to demonstrate the importance of physical education in the development of learners is a serious challenge to the future of the profession (Lund & Kirk, 2010). Linking the benefits and outcomes of physical education to 21st Century core learning areas such as critical thinking, problem solving, the ability to operate with agility and adoptability, the ability to analyze information, communicate effectively and the ability to act innovatively will be essential if physical education is to continue to be valued as a part of the basic school curriculum (Bailey, 2006). If, in fact, physical education can be linked to such core learning areas, then the importance of physical education will be more fully embraced. Can we demonstrate that physical education is as important as other basic areas such reading, writing and mathematics as a necessary life-long vocational and ad vocational requirement? It is evident that there is a need to develop more effective assessment leading to greater accountability.

Physical education programs must generate data that can make the profession's efforts much more accountable for program interventions. The lack of accountability in physical education prevents programs from becoming a part of the health care system of any community. There is an obvious need for performance standards and ways to measure the impact of physical education. The need for physical education programs to enable students to demonstrate their basic proficiencies is paramount in an increasingly standardized educational world. Just as there is a need to improve basic skills such as reading, math and science, there is a need to justify the existence of physical education programs.

The physical education teacher is increasingly being called upon to demonstrate student proficiency in developing the skills to achieve a health active lifestyle. We now live at a time when obesity and overweight, especially among children and youth, has become a major health concern on a worldwide basis (International Obesity Task Force, 2009; World Health Organization, 2010). It has been well documented that patterns developed in one's childhood will, in fact, carry forward to one's adult life (Freedman et al., 2007). The emerging epidemic of obesity among children and youth thus becomes a concern for future adult populations. The challenge is a complex one that requires more holistic and multidisciplinary thinking to address the problem. Health, leisure and physical education professionals worldwide have a key role to play in formulating strategies to address this problem.

There is a need to employ new forms of pedagogy, integrate health and physical education programs in a more effective fashion, support the development of healthy active lifestyles, explore ways to employ technology in the teaching of physical education, link school-based activities to informal community programs and review the way in which physical education teachers are prepared (Edginton et al., 2011). In the same context, Bosnia & Herzegovina, as immanent part of Europe, passes through several simultaneous transition processes that all reflects Physical Education position. One of those processes is surely implementation of Bologna presumptions in higher education institutions, therefore those institutions that educate future Physical Education teachers. Second process is already for decades inherent as adoption of sport as industry in all life pores, and with specific and sometimes unacceptable ways of reflection on Physical Education as well as on its role. Furthermore, relations of Physical Education with medical postulates shows some kind of divergent degree that slowly establishes as inevitably cooperation with mutual benefits. All that because it is obvious that those two domains, each with its own subject of examination and treatment, contain high degree of correspondence and interaction. Moreover, organized acting system of physical education teachers slowly but surely has been formed, because it is clear that it is inevitably process that have to bring to common acting in operative sense. Finally, scientific work and researches that can provide relevant conclusions and that can address argumentative messages are a little marginalized on state level, although one can register some local articulations directed exactly toward route of examination of adequate global community solutions for quality of life preservation by means of physical exercise. It is for serious concern, as all over the World, quite emphasized indifference of political top-levels for serious occupation with Physical Education problem, and in the same time maximal possible resources are directed toward sport, and such behavior additionally marginalize physical education, although it is obvious that those two domains do not have same goals. Maybe precisely because of that, education of future professionals in Physical

Education is partly inappropriate with deficit in some areas like pedagogical-methodical disciplines with pronouncedly large amount of motor knowledge about many concrete sport disciplines. One need to notice that total standpoint towards Physical Education varies from one to other local community/milieu (Bonacin et al., 2008). These are, indeed, difficult and complex challenges, problems and issues that require multiple perspectives and, increasingly, views that are global, reflecting successful methods, strategies and procedures from throughout the world. The Global Forum on Physical Education Pedagogy 2010 (GoFPEP 2010) was established and structured to explore ways of rethinking, reforming and reframing health and physical education pedagogy as well as physical education teacher preparation.

The Global Forum on Physical Education Pedagogy 2010 (GoFPEP 2010)

Organized to examine new forms of pedagogy, GoFPEP 2010 sought to review the use of technology, ways of linking practice to theory and the importance of contextually-based education embedded in community life as a way to reshape and redesign the future of health and physical education.

GoFPEP 2010 explored several basic areas including 1) reframing health and physical education pedagogy internationally by promoting dialogue and discussion on critical themes and issues; 2) exploring a new model of pedagogy for preparing health and physical education teachers which promotes accountability, builds community life, employs a greater use of reflection to improve practice and embeds learning in practice; 3) examining the extension of health and physical education based school programs into community life; 4) reviewing the application of technology as related to the teaching of health and physical education; 5) promoting the establishment of partnerships between the school, community, university, nongovernmental organizations and commercial enterprises; 6) rethinking the relationship between health and physical education as a strategy for promoting lifelong active living; and 7) stimulating forward thinking.

GoFPEP 2010 invited international voices in a dynamic program designed for educators, health professionals, administrators, policymakers and citizens the opportunity to discuss the future of physical education pedagogy. The forum provided unique opportunities for professional enhancement, drawing together leading educational and professional experts from throughout the world. GoFPEP 2010 saw 70 invited delegates from 25 countries representing 64 universities, institutions and schools participate in the event. Delegates met over a two-day period of time in an intensive format featuring keynote and invited presentations and workshops and discussion groups. A primary goal of GoFPEP 2010 was the crafting of a Consensus Statement focused on the theme of "Health and Physical Education Pedagogy in the 21St Century" and is found in Table 1.

The consensus statement was built upon previous documents such as United Nations, Scientific and Cultural Organization's (UNESCO) International Charter for PE and Sport adopted at its General Conference in Paris, 1978 (UNESCO, 1978); The Berlin Agenda for Action for Government Ministers, accepted at the 1st World Summit of Physical Education, 1999 (International Council of Sports Science and PE, 1999); and the Magglingen Commitment for Physical Education approved in 2005 in Switzerland (International Council of Sports Science and Physical Education, 2005). The uniqueness of GoFPEP 2010 was that it was deeply embedded in the actual context of a school setting and its community environment.

This enabled focused dialog and discussion in real time as the school day unfolded, providing the opportunity for a more authentic analysis of challenges, problems, issues and solutions. Each delegate to GoFPEP 2010 was asked to offer suggestions and recommendations formatted to poster presentations in advance of the event. Recommendations were sought in the following areas: 1) innovative strategies employed in the teaching of health and physical education at the elementary, secondary and/or post-secondary levels; 2) innovative approaches employed in the preparation of health and physical education teachers; and 3) three to five of their most important recommendations that could be used in formulating the GoFPEP 2010 Consensus Statement. Information from the discussion groups and poster presentations was analyzed using the Qualrus qualitative analysis software package. In turn, this yielded themes which were highlighted in the final drafting of the document.

Concluding Comments

The GoFPEP 2010 Consensus Statement provided multifaceted recommendations focused on improving physical education pedagogy and the preparation of physical education teachers. Recommendations advanced the importance of healthy active lifestyles, integrating health and physical education, promoting best practices, advancing the knowledge and skills around physical literacy, student and teacher assessment and community partnerships. The core of the Consensus Statement called for enhancing and maintaining the health and wellbeing of individuals.

Action by students, physical educators, health and leisure professionals, policymakers, citizens and business leaders was called for to provide programs that promote a committed effort to addressing the ever increasing worldwide concern of obesity and overweight among children and youth.

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Table 1

Global Forum for Physical Education Pedagogy 2010
Health and Physical Education Pedagogy in the 21st Century
A STATEMENT OF CONSENSUS

Physical education programs in the 21st Century can inspire, motivate and prepare learners to live in an ever-changing world, increasingly marked by the epidemic of obesity and overweight individuals. Increasingly, globalization, explosion of knowledge and changing demographics have a significant impact on the knowledge, skills and dispositions required to live, work and play in the 21st Century. Children and youth will be required to gain critical thinking and problem solving skills, operate with agility and adaptability, effectively analyze information, communicate in various oral and written forms, reflect greater curiosity, imagination and innovation in their thinking and develop healthy active lifestyles. Worldwide, physical education programs, as well as physical education teacher preparation programs, need to be rethought and reformed. Hosted by the University of Northern Iowa (USA) and the Grundy Center, Iowa (USA) Community Schools, the Global Forum for Physical Education Pedagogy 2010 (GoFPEP 2010) was organized to examine 1) a new pedagogy for preparing physical education teachers; 2) utilization of technology to help teach physical education; and 3) the building of school, university, community and corporate partnerships. GoFPEP 2010 drew 70 invited delegates from 25 countries representing 64 universities, schools, businesses, community organizations and professional organizations and societies.

The Health and Physical Education Pedagogy in the 21st Century *Statement of Consensus* calls for action by students, physical educators, health and leisure professionals, policy makers and legislators, citizens and leaders from business and industry to encourage programs that promote a committed effort to enhancing and maintaining the health and wellbeing of individuals BY:

Physical Education Pedagogy

- Focusing on content and methodologies to develop healthy active lifestyles for children and youth. This requires the integration of skill development, physical fitness, health, nutrition and planning for leisure,
- Redesigning the physical education curriculum to promote active student-centered learning and empowering individuals to develop life skills that lead to lifelong, self-directed engagement in physical activity,
- Accentuating the importance of co-operation of stakeholders in the community (teachers, administrators, parents, community members, business leaders and others) to advocate, promote, educate and develop individuals to incorporate physical activities into their daily life through formal and informal education,
- Establishing physical education and health programs as models of social justice which foster a safe learning environment, promote the joyful participation of physical activity with appreciation of cultural, racial, ethnic and social and economic differences,
- Linking knowledge, skills and dispositions required by 21st Century learners with program outcomes such physical competency (skills and fitness), health literacy and leisure planning throughout all subject matter and disciplines in the school,
- Using technology to support individualized learning processes and assessment,
- Re-conceptualizing the strategies of assessment with appropriate measurable and performance based goals and objectives tied to standards which promote greater accountability,
- Insuring that qualified professionals teach physical education and health, physical activities and sport and leisure,

Physical Education Teacher Preparation

- Emphasizing the acquisition of teaching techniques and strategies for assisting individuals in developing a healthy active lifestyle; one which recognizes the importance of the integration of health and physical education,
- Advocating for policies and a broad continuum of programs including healthy nutrition, weight management, physical activity and leisure planning,
- Creating a positive learner-centered environment reflecting best practice to encourage students to become active participants in the learning process,
- Promoting the development of partnerships with parents, schools and community organizations to embed and provide contextually based program elements which enhance physical education teacher preparation,
- Developing sensitivity for one's role in addressing racial, ethnic, cultural differences, socio-economic levels, funding levels, access to equipment and facilities, as well as approaches to mitigate these issues,
- Including assessment and educational strategies which provide program accountability, as well as a focus on educational processes and individual developmental outcomes,
- Linking practice to theory, promoting the use of reflection and the use of effective technology to accentuate learning opportunities,
- Linking the evaluation of students in physical education teacher preparation programs to relevant knowledge, skills and dispositions directly tied to best practice.

ZDRAVLJE I TJELESNI ODGOJ: NOVA GLOBALNA IZJAVA O KONSENZUSU**

Sažetak

*** U skladu s globalnom idejom da se izvijeste ljudi u državama cijelog Svijeta, ova izjava je publicirana na domaćim jezicima uz uključivanje odabranih autora u slijedećim državama: Austria, Belgium, Bosnia & Herzegovina, Brazil, China, Czech, Hungary, India, Japan, Korea, Malaysia, Mongolia, Philippines, Nigeria, Poland, Belarus, Kazakhstan, Romania, Russia, Slovenia, South Africa, Sri Lanka, Switzerland, Taiwan, Thailand, Turkey, Ukraine, United Arab Emirates and United States of America. Ista izjava je publicirana na lokalnom (Hrvatskom) jeziku u znanstvenom časopisu Acta Kinesiologica.*

GoFPEP 2010 Izjava o konsenzusu donijela je prijedloge sa višestrukih aspekta fokusirane na poboljšanje pedagogije tjelesnog odgoja kao i na pripremu budućih učitelja tjelesnog odgoja. Preporuke su unaprijedile važnost zdravstveno aktivnog stila života, integraciju zdravstvenog i tjelesnog odgoja, promidžbu najboljih praktičnih rješenja, napredovanje znanja i vještina u svezi educiranosti o tjelesnom odgoju, procjene učenika i učitelja, kao i partnerstvo zajednice. Jezgro Zajedničke izjave poziva na povećanje i očuvanje zdravlja i dobrobiti pojedinaca. Studenti, edukatori u tjelesnom odgoju, zdravstveni djelatnici stručnjaci za slobodno vrijeme i rekreaciju, zakonodavci, građani i poslovni lideri pozvani su na akcije da osiguraju programe koji mogu promovirati odlučan napor adresiranju općenito svjetski rastuće zabrinutosti za pretilost i prekomjernu težinu djece i mladih.

***Ključne riječi**: tjelesni odgoj, edukacija učitelja, stil života, zdravlje, vježbanje*

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GLUCOSE LEVEL IN BLOOD ACCORDING TO PHYSICAL STRESS AT SPORTSMEN

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Original scientific paper

Abstract

Methods: Sample was composed of 21 male entities aged 20-31 that systematically exercise in sport (4-5 times a week), all sportsmen on country and representative level in athletics. Result: Average value of glycemia all examinees at the beginning was 5.00 mm/l, maximal glycemia average of all entities was 5.5 mm/l, maximal average glycemia value was registered in 15th minute and minimal average glycemia value of all entities was in 25th minute. Range of highest and lowest glycemia level in 15th minute was 3.1 mm/l respectively 2.2 mm/l, 7.3 mm/l respectively 6.4 mm/l and 4.2. Standard deviation in 15th minute was 0.72. Coefficient of variation in 15th minute was 13.1 and because it is highest, shows that results variations in that period were highest. Frequency of highest glycemia value is in 15th minute. Statistical significance was set to 0.05 level and it was found in average relations between initial measurement and 5th, 10th, 15th and 20th minute. Among others averages it was not found statistically significance difference. Range of maximal glycemia value under the same conditions in population is from 5.02 mm/l to 5.97 mm/l. Conclusion: carbohydrate (CH) load increases blood glucose level, but in the way that CH with high glycemic index (high-resorption CH) quickly change glucose level. Such decrease of glucose is not stopping on initial level but even goes lower, so one can experience hypoglycemia symptoms. However, after a while, organism balances glucose on optimal level.

Key words: *glucose, stress, sportsmen*

Introduction

Although the food looks tempting, the end product of all that we eat and which is absorbed into the bloodstream are: proteins, carbohydrates, fats, biocatalysts and water. In addition to proteins, which are primarily in building role, carbohydrates and fats are used as energy sources. The process of breaking down of carbohydrates begins in the mouth and ends in the small intestine, where the glucose (Monosaccharide) it is "transported" in the bloodstream. Through the blood, and with the help of insulin, glucose is transferred and stored in the liver and muscles, where glycogen is converted to specific chemical process and if necessary, serves as a source of energy. The brain uses glucose from the blood directly, as well as some other organs, so that in the bloodstream is always optimal level of glucose. Regulation of glucose levels is based on the combined hormones. Depending on the work activity, emotional state and input supplies, alternate action of hormones, glucose level is maintained or reduced the scope of reference values, which are 3.5 to 6 mm/l. Extreme decrease or increase glucose in blood can lead to coma, while minor changes in the fall of glucose levels can cause changes in concentration, coordination, physical ability and so on. Physical effort, such as training, causing increased energy consumption, and if more followed with emotional stress, glucose fluctuations can significantly affect your abilitys.

Subject, problem and aim

The subject of the research are changes in blood glucose levels depending on the physical effort. Research problem is how to avoid or minimize awareness of varying levels of glucose in order to avoid the possibility of hypoglycemia. The aim of this research is to determine the glucose variability during physical efforts, to determine how long it takes to make blood glucose levels reach the highest and lowest value during physical effort. The importance of this research is to see how the physical effort affects blood glucose levels, and according to this data, to recognise important stadiums of glycemia. The mentioned glucose level is essential for those activities or tasks in which it is important overall health state, in terms of concentration, coordination, sense of physical abilities and the like. Therefore, the significance is that there is to know under which conditions can we cause the highest level of glycemia and also hypoglycemia. Pursuant to the requirements, this situation can be effectively used, or prevent. General hypothesis was that the physical effort is changing the level of glucose in the blood and during the physical efforts under the given conditions, the value of glucose will move in the reference values. Specific hypotheses were that beginning of the physical effort (to 5 minutes) will cause the higher level of glycemia and maximal value of glucose during physical effort will appear in the first 15 minutes, as well as that physical effort under the given conditions will not cause hypoglycemia.

Methods

Sample and procedure

Experimental group, consisted of 21 men, age 20-31 years, which are systematically engaged in physical exercise (4-5 times a week), athletes and a representative of the federal level in athletics.

Identification of variables: Dependent variable - the level of glucose in the blood. Independent variable - using the treadmill for 30 minutes steady pace with pulse of 140 to 150, which is approximately 50% VO2 max. Duration of the experiment was three weeks. Phase I of the experiment - the standardization process. The aim of the first phase is to improve experimental variables, conditions as well as the whole process, standardising it so it will not cause doubts about the reliability. At the same time, the element of control mechanism is considered, which is required during the experiment in order to ensure that changes in the dependent variables, are result of action of independent variable. Phase II of the experiment - The subjects ran on the treadmill for 30 minutes steady pace, at a speed of 8 to 9 km/h, which provoked heart rate of 140 to 150 beats per minute. Examiner measures blood glucose levels every five minutes by jump on the threshold of tapes, thus stopping with running as long as it is needed for the blood tester to absorb the blood drop. Conditions: Testing is done in the morning, respondents were told not to have late dinner and breakfast next morrning, they can drink a glass of plain water. Testing conductes an examiner with one responden. Flow of the experiment: After coming to trim cabinet,the respondent first measured the initial blood glucose levels. The next step is to stretch the leg muscles, which will stand the load. We start with running and glucose measurement every five minutes. A total of seven measurements is made. First, the starting and the six measurements during the run. The device for testing blood glucose levels "ACCU CHEK'' and treadmill ''Technogym Excite-900''.

Statistical analysis

Statistical processing was done by the programs: ''Excel 11.5" and "ORIGINE''. Figure 1 is a tabulation of results with a given average value, standard deviation and coefficient of variation. In addition to the above mentioned parameters in the table 1, primarily are shown the average values of glucose per minute. Measuring points are to be seen from the table - the initial measurement, then measure in the fifth, tenth, fifteenth, twentieth, twenty and thirtieth minut. The table is copied from Excel to Origine, in the way so that A column in Origine is correspondant to zero-column I Excel, 5 - B, 10- C, 15 is D, 20 is E, 25 –F and 30 is a G. We were looking for the statistical significance (p 0.05) between the arithmetic mean of the following: AB, AC, AD, AE, AF, AG - Inicial glycemia and each measuring minute, BC, BD - the fifth and tenth minute, fifth and fifteenth minute, CD - the tenth and fifteenth minute, DE, DF - Fifteen and twentieth minute and fifteen and twenty-fifth minute, FG - Twenty-fifth and thirtieth minute.

Results

It has been noted that people during daily activities, mental or physical, is subject to change moods, concentration, willingness, alertness, and so on. One of the causes of such change may be the level of glucose in the blood. Hypoglycemia can lead to expression of negative characteristics, and elevated blood glucose levels can lead to expression of positive characteristics of these categories. Carbohydrate intake increases blood glucose levels, but by CH with a high glycemic index, or the fast-resorbing carbohydrates, rapidly increasing and rapidly decreasing level of glucose. The decrease in glucose does not stop at the initial level, but goes even lower, so that people can experience symptoms of hypoglycemia. However, after a while the body brings blood glucose levels at referent values. Training causes carbohydrate consumption during operation, so that the level of glucose may vary depending on the load and stress. Mechanisms in the body regulate glucose levels in such way, so that a rapid increase, leads to rapid decrease. Training or competition that takes a long time and causes great stress, can lead to a state of hypoglycemia. A frequent occurrence is that athletes, and amaters consume energetic supplies immediately before or during effort, in order to increase the capacity of the''energy''.

	A	B	C	D	E	F	G	
NAME	0	5	10	15	20	25	30	AV
DS	5.3	6.4	5.8	5.7	5.8	5.5	6.0	5.79
AC	5.2	5.9	5.7	5.8	5.7	5.4	5.2	5.56
AK	5.0	6.2	5.9	7.3	6.5	6.5	6.8	6.31
MD	4.9	5.3	5.4	5.1	4.8	4.7	5.0	5.03
NS	4.9	5.9	5.7	5.6	5.8	5.8	5.8	5.64
AM	4.9	5.4	5.4	5.8	5.5	5.1	5.4	5.36
ND	4.5	4.6	4.7	4.2	4.0	3.3	3.4	4.10
AM	4.5	4.5	5.1	4.7	4.4	4.9	4.6	4.67
VP	5.7	5.9	5.6	6.4	6.2	5.1	5.5	5.77
SD	5.4	5.5	6.2	5.8	5.7	5.3	5.7	5.66
AS	4.7	4.7	5.0	5.2	5.4	4.8	4.9	4.96
MV	5.0	5.1	5.0	5.3	5.2	5.7	5.3	5.23
AS	4.1	4.6	4.7	4.6	5.3	5.3	4.7	4.76
MP	5.3	5.2	5.2	5.0	4.9	4.9	5.2	5.10
BM	5.2	5.3	6.0	5.9	5.2	5.4	5.3	5.47
SS	4.7	4.8	5.4	5.3	5.2	5.1	5.5	5.14
MV	5.2	5.5	5.6	5.9	5.3	5.5	5.4	5.49
ML	4.3	4.5	4.6	4.4	4.6	4.8	4.8	4.57
IV	4.8	5.6	5.0	5.7	5.4	5.4	5.5	5.34
ML	5.5	5.7	5.4	6.3	5.9	5.5	5.4	5.67
MM	5.2	5.5	5.2	5.4	6.2	5.8	5.9	5.60
AVG	5.0	5.3	5.4	5.5	5.4	5.2	5.3	5.30
AVG-5	5.3	5.7	5.6	5.9	5.7	5.5	5.6	5.61
AVG-4	4.6	5.0	5.1	5.1	5.0	4.9	5.0	4.96
SD	0.4	0.5	0.4	0.7	0.6	0.6	0.6	
CV	8.1	10.	8.2	13.	11.	11.	12.	

Figure 1 - Table of blood glucose levels
(A - Initial measurement of glucose, from B to G on every 5 minutes)

The column labeled 0 (Figure 1) indicates the initial level of glucose prior to testing, and in turn every five minutes, until the thirties. Respondents listed bythe name. Row called ''prosek'' means the average of all respondents in a given minute. Row, named ''prosek 5'', indicates the average glucose value of only those patients whose initial blood glucose value was 5, and more. Row named ''prosek 4'', indicates the average glucose value in those patients whose initial blood glucose value was below 5.

From Figure 1 we see that the largest variation are fifteenth minute. The division of the initial glucose value above and below 5 is based on the following: Looking at individual results we see that only one respondent (P. Martin) reduced the level of glucose in the fifth minute, compared to the initial level, and with all others there was an increase in the level of glucose. However, the changes are not the same for those respondents whose initial blood glucose is under 5 and those over 5 mm/l. Respondents with the initial glucose above 5 mm/l, after the increase in the fifth minute, have the fall of glycemia in tenth minute. Respondents with the initial glucose below 5 mm/l, after the following increase in the fifth minute there is no fall, but a further increase in glucose until the tenth minute, except for patients under the number 5 and 19 who had a sudden jump of 5.9 glucose, respectively. 5.6 mm/l and then decrease. The reference glucose values are from 3.5 to 6 mm/l, which leads to the assumption that the hormones are involved in regulating blood glucose levels and maintaining it in a range of reference values. At first glance it may be concluded that the insulin, the hormone that lowers the value of glucose is included when you bring up the referent value to the max, as shown in Figure 3 - red line with two peaks. However, in the same figure is shown the green line of respondent whose initial glucose value was below 5.

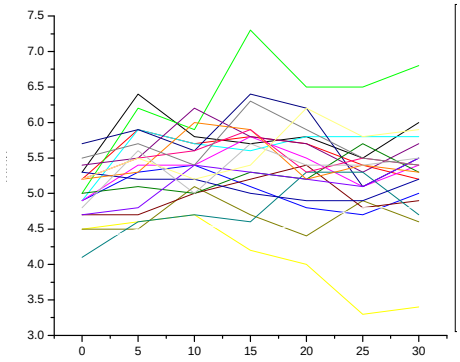

Figure 2. Summary presentation of some results

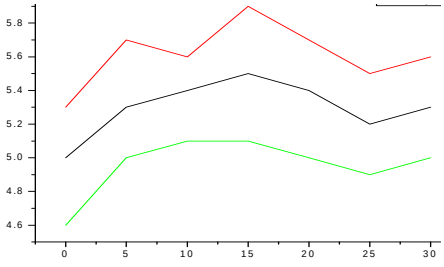

Figure 3. Summary display of average results

If the previous observation was true, the green graph would grow up to peaks of red graph. Given the established state, more precisely to say that the insulin response is level based, not nominal. Lavel based range of tolerance, as shown in Figure 1, based on the average difference in the 15th minute is 0.8 mm/l and it can be attributed to characteristics of an individual. In Figure 4 and 5 can be seen that the grouping of sinusoid wave lines in subjects with initial glucose level below 5 mm/l, in the range of 4.1 to 5.9.

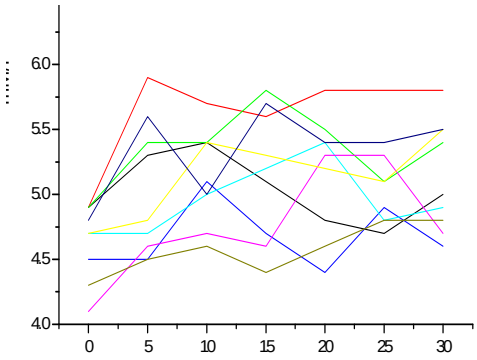

Figure 4. Summary display of individual results with initial glycemia above 5 mm/l

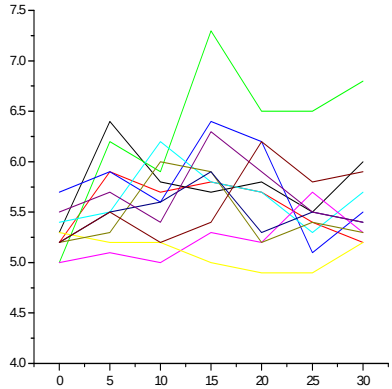

Figure 5. Summary display of individual results with initial glycemia under 5 mm/l

Range is 1.8. In subjects with initial glucose above 5 mm/l, sinusoids are grouped within the range of 4.9 to 6.4, without taking into account the green graph as extreme. The range is 1.5. The individual diagrams show the individual differences, and in Figure 6 is a table showing the distribution of the highest values of glucose per minute. It is obvious that in the 15 th minute there are six results, in ten minutes five results, in twenty three, and so on.

Table 2. Frequency of highest glucose values

Time	0	5	10	15	20	25	30
Highest value	1	3	5	6	3	3	2

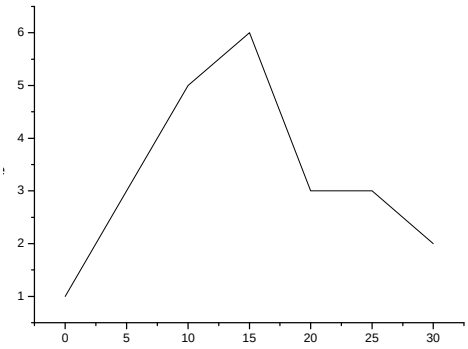

Figure 6. Graphic display of Frequency of highest glucose values

When the results of measuring the frequency by minutes are statisticly processed, we get that the arithmetic mean (AS) is 15.26, standard deviation (SD) 8.1, and standard error (SE) 1.69.

Discussion and conclusion

The average value of glucose in all subjects at the start of measurement is 5.0 mm/l. The highest average value of glucose in all subjects is 5.5 mm/l. The highest average value of glucose in all subjects was recorded in the 15 th minute. Lowest average value of glucose in all subjects was recorded in the 25 th minute. Range of the highest and lowest glucose in the 15 th minute was 3.1 mm/l. The standard deviation in the 15 th minute was 0.72. Because coefficient of variation in the 15 th minute was 13.1 and it was the highest, it shows that the variation of results in that period is the greatest. The frequency of the highest serum glucose level is in the 15 th minute - six results.

Statistical significance was sought at the level of 0.05 and was found in relation to the initial measurement of arithmetic mean in the 5th, 10th, 15th and 20th minute. Among other arithmetic means, there was no statistical significance. The standard error in the 15th minute was 0.15667, and AS is 5.5. We see that the range of maximum serum glucose level under the given conditions is in the range from 5.03 to 5.97 mm/l. Statistical processing of results by measuring the frequency by minutes, says that the arithmetic mean of 15.26, standard deviation of 8.1, and standard error of 1.69. The average serum glucose level varies within the reference values. Average of all respondents ranges from 5.0 to 5.5 mm/l. The average value of the eleven patients whose initial serum glucose level was 5 mm/l or more ranges from 5.3 to 5.9 mm/l (Figure 1) . The average value of ten patients whose initial glucose value was below 5 mm / l ranges from 4.6 to 5.1 mm/l. (Pct. 1). The largest variations of results were in the 15th minute when the highest average value of glucose was established. The range is from 5.03 to 5.97 mm/l. In the given conditions the highest value can be expected fifteenth minute. However, when we look at the individual graphics, it can be noticed that individual differences impose to determine the frequency of the highest serum glucose level by measuring minutes. We see that the results are the most concentrated in the 10 th and 15 th minute. The average time when the highest glucose value will appear was 15.26 minutes, and a standard deviation of 8.1 tells us that 68% of results are in the range from approximately the 7th to the 23rd minute.

Standard error of 1.69 tells us that the arithmetic mean of the highest values of glucose in the is almost certainly in the range of 10.2 to 20.3 minutes. Lowest average value of glucose in the given conditions appeared in the 25th minute. Statistical significance (p. 0.05) of difference in the arithmetic means during the physical efforts under the given conditions, confirmes that there are changes of glucose level, so, we can accept the first hypothesis. From 21 respondents, in six was found that the value of glycemia exceeded the upper limit reference value of 6 mm/l. Since the second hypothesis is only partially correct, we can not accept it. Considering the average of all respondents, we can see that the results range from 5.0 to 5.5 mm/l, so that looking from this perspective we can accept the second hypothesis. Statistical significance (p. 0.05) of difference between the arithmetic means of initial glucose levels and glucose in the 5th minute, with 5.0 to 5.3 mm/l, shows that this increase was not due to random variation of results, but shows that we can also expect it in the population, so, we can accept the third hypothesis. Statistical significance (p. 0.05) of difference between the arithmetic means of initial glucose levels and glucose in the 15th minute, with 5.0 to 5.5 mm/l, shows that this increase was not due to random variation of results, but we can also expect it in the population, so, we can accept the fourth hypothesis.

Lowest average value of glucose was recorded in the 25 th minute and since it is within the reference values, the fifth hypothesis can be accepted. Summing up the whole issue related to blood glucose in healthy people, we see that it depends on many factors, that in the final sum provoke response of the whole organism. This response is the result of coupling of hormones that alternately adjust the parameters of glucose and provide the most suitable body functions. Sometimes, man, out of ignorance, the excessive desire or fashion, disrupts the hormonal result with various medicines and inadequate food or stress. We have just, with this study, indicated at physiological justification and compatibility of conditions that will balance the goals and health. In this sense, as a final conclusion and recommending result from this research, is that before an equivalent load as testload, carbohydrates should not be consumed, because there is no need to distort the biological balance.

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RAZINA GLUKOZE U KRVI U SKLADU S FIZIČKIM STRESOM KOD SPORTAŠA

Sažetak

Metode: Uzorak ispitanika je činila 21 osoba muškog spola, starosti od 20 – 31 godine, koji se sistematski bave fizičkim vježbanjem (4-5 puta u toku tjedna), sportaši saveznog i reprezentativnog ranga u atletici. Rezultat: Prosječna vrijednost glikemije svih ispitanika na početku mjerenja je 5,0 mm /l, najviša prosječna vrijednost glikemije svih ispitanika je 5,5 mm /l, najviša prosječna vrijednost glikemije svih ispitanika je zabilježena u 15-oj minuti, a najniža prosječna vrijednost glikemije svih ispitanika je zabilježena u 25-oj minuti. Raspon najviše i najniže glikemije u 15-oj minuti je 3,1 mm/l odnosno 2,2 mm/l, 7,3 odnosno 6,4 i 4,2. Standadna devijacija u 15-oj minuti je 0,72. Koeficijent varijacije u 15-oj minuti je 13,1 i pošto je najviši, ukazuje da su varijacije rezultata u tom razdoblju najveće. Učestalost najviše vrijednosti glikemije je u 15-oj minuti. Statistička značajnost je tražena na nivou 0,05 i nađena je u odnosu aritmetičkih sredina početnog mjerenja i u 5-oj, 10-oj, 15-oj i 20-oj minuti. Između ostalih aritmetičkih sredina nije nađena statistička značajnost. Raspon najviše vrijednosti glikemije pod datim uvjetima u populaciji je od 5,03 do 5,97 mm/l. Zaključak: Unos UH povećava razinu glukoze u krvi, ali tako što UH sa velikim glikemičkim indeksom, tj. brzo-resorbirajući ugljiko-hidrati, brzo povećavaju i brzo spuštaju razinu glukoze. Taj pad glukoze se ne zaustavlja na početnoj razini nego ide i niže, tako da osoba može doživjeti simptome hipoglikemije. Ipak, nakon nekog vremena sam organizam dovede glukozu u krvi na optimalnu razinu.

Ključne riječi: *glukoza, stres, sportaši*

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PREVENTIVE MANAGEMENT IN SPORT – A CHALLENGE OF NEW IDEAS

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Review article

Abstract
Sport management constantly delves into new challenges, ideas and applications of the approach, construction and strategies of creative philosophy, vision and mission, and with the aim of promoting the functions of modelling – prediction, diagnostics – prognosis, and projecting - planning, since there is the need for integration and interaction of many management categories, functions and direct applications. The aim of this paper is to show that certain action measures are taken in a timely, purposeful and efficient manner through a newly-formed strategic category called preventive management in sport and that the environment, in which future desired events will take place and effective outcome will be achieved, is created along with further operational solutions emanating from this approach. The results of the analysis of existing state and recent research have shown that there is a possibility for the solutions consisting of searching for new ideas, creations and constructions of contemporary, more thorough and more functional models of technological and managerial elements based on integration and interaction. The construction, functioning and application of the three above-mentioned technological and management functions of modelling – prediction, diagnostics – prognosis and projecting – planning, which are called preventive management in sport, opens up new possibilities for getting more optimal comprehensiveness, purposefulness and objectivity in promoting the desired state expeditiously accompanied by having much more dramatic effects of overall labour technology and achieving top sports results

Key words: *sport, preventive management, modelling-prediction, diagnostics-prognosis, projecting-planning*

Introduction

From the perspective of today's level of sports accomplishments, development of sports science and training, business and organizational technology, modern sport management is constantly searching, on the one hand, for new challenges, ideas, approaches and strategies of creative philosophy, vision and mission. On the other hand, the efforts are channelled into the construction and function of the integral model of basic structural and technological management elements of modelling – prediction, diagnostics – prognosis and projecting – planning, and their integration, interaction and application because they are considered to be key management projections for stimulating strategic development of modern sport. As regards this, scientists and experts in sport management devote more attention to forming, structuring and developing a special strategic category that ought to deal with supporting events in future as well as other operational solutions emanating from such approach - what is needed to be done to make existing theoretical assumptions, scientific results and recent experience be more congruent, effective and practical in the immediate social reality. Recent strategies and applications show that sport management refers not only to managing a sportsperson / team by a couch, team of experts and sport scientists with the aim of achieving better results but also to an efficient and effective management of the overall sport system by sports managers, marketing managers, directors and sport volunteers. Without a well-structured and well-organized sport system, management cannot provide its purposeful content.

Conversely, without properly structured and organizationally functional management of sport organizations (sports club, unions, association and institution) top sport does not own integral, interactive and optimal power for their actions, transformations and development (Bonacin, Bilić & Bonacin, Da., 2009). In view of the fact that people with their genetic and labour potential (creative abilities, knowledge, experience, tradition, labour and motivation) have the central position and role in the process of social reproduction and that they are mainstays of overall activities in all segments of social development, human resources management in sport is rightly considered to have a leading position because competent technologists, managers and organizers involved in training, business and organization are chief creators and implementers of reforms, development and progress through implementing high interaction and integration technology without which development policies, science and technology can hard be created and implemented in modern society (Poole, 1990; Malacko, 2007; Tomić, 2007).

The aim of the paper

The aim of this paper is to form, construct, define and apply a special strategic category in sport management which can be called preventive management in sport due to the needs for higher integration and interaction of management categories, functions and immediate application, which in their structure include the most important compatible elements in the field of training, business and organizational technology.

All of that on the one hand, as starting points of creative philosophy, vision and mission, and, on the other hand, of stimulating modelling – prediction, diagnostics – prognosis and projecting – planning within the distinct category. Further, they include other operational solutions emanating from this approach with the necessity of taking certain action measures at all hierarchical levels in sports organizations in a timely, purposeful and efficient manner and creating the environment in which desired events will take place and effective outcome will be achieved by obligatory involvement of analytical, controlling and corrective mechanisms.

The term of preventive management in sport

The term of preventive management in sport can be defined in the best way by purposeful and optimal projected strategic prevention, i.e. futurist design and creation of the philosophy, vision and mission of management, which are in the function of long-term continuous ontogenesis of organization, and its essence is seen in constructing future desired state and development of integral, functional and interactive sport system constructed on the basis of modelling – prediction, diagnostics – prognosis and projecting – planning of their dominant and relevant elements. Preventive management in sport is helpful in searching for the answers about potential projections and flows by which more homogeneous future events will be developed. These events will occur due to the changes in external and internal environment and thus they serve as the basis followed by relevant management functions - training, business and organizational technology. The attempts to treat preventive management in sport as the distinct strategic category, with its specific ideas, visions, rules, laws, technologies and application have strong grounds because its use leads to newer, clearer, safer and more objective pathways to the prosperity of sport. However, it does not mean that preventive management can be observed separately from other management categories or functions in sports organizations but the concept of so-called integral and interactive business ought to be established since it is the first fundamental segment referring to the future general development as well as to operational application of different structural elements of management functions - the organization of all relevant resources, processes and functions, providing financial means, building and managing premises and investments, economic and profit function, communication and coordination, decision-making about the implementation of the most appropriate solutions, controlling the work process, etc.

Philosophy, vision/mission – starting points for defining preventive management in sport

The overall development of a sports organization at all hierarchical levels should be based on and directed to clearly defined strategic aims of preventive management.

Most of which are incorporated into management philosophy and thus into the vision and mission of the sports organization. Then the main objectives and social status of the organization are considered to be the key elements because of their influence on the its business operations, method, organizational structure, organizational processes, profile and range of human resources, business partners in the region, etc. (Malacko & Rađo, 2006).

Management philosophy serves as the basis for establishing preventive management in sport, or more concretely, "mental support" for managing the operations and development of an organization, and it represents the system of values expressed through general principles of operations, and thence through conceptions and projections with strong impact on the way of thinking, behaviour and actions of human resources within the organization.

Figure 1. Position of preventive management

In all human activities the process of conceptualization of the development starts from establishing the existing state (diagnosis) and desired state (model), then there is their comparing and creative philosophy according to which realistic aims (projections) are defined and these aims determine the immediate reaction to changed environment conditions and the adaptation of certain policies, strategies, tactics and actions (as a sequence of activities), with the support of economy, technology and technique (as a flow of information) and the aim to apply the established goals in the most optimal way.

Management vision determines the future position of an organization and it refers to the field broader than the area of current activities and it may be defined as a "mental picture" by which is convincingly and realistically articulate more attractive future of the organization and it is usually associated with entrepreneurial and creative abilities of managers since they are the only who are able to translate visionary ideas into the reality – "what we are like now" and "what we want to be like". In a sports organization vision should be the product of coaches, managers, directors and volunteers as the direct creative generators of ideas about future sports accomplishments. Concretely, it refers to particular sportspeople and/or teams that in their development have the strong position of sports values and, accordingly, an imagined and projected value that can be achieved.

Management mission can be defined as a distinct description of reasons for existing and functioning of an organization and it represents a fundamental determination of intentions for accomplishing the vision as a logical extension of visionary process that should be transformed into the actual planning action in the form of a statement or formal explanation of the nature of the organization's business activities and refers to the essence of the reasons for its existence (the purpose of existence) – "in which business – activity are we involved in" and "why are we here". A well-planned content of the organization's mission enable human resource to comprehend the possibilities, directions, meanings, executions and results. In fact, the mission of an organization is the means for integrity and interaction of all employees for achieving the common aims and tasks of the organization although they independently perform certain working activities within work allocation.

Modelling, diagnosis and projecting – integral and interactive elements of preventive management in sport

The concept and construction of preventive management in sport is a new theoretical, scientific and pragmatic approach which systematises the recent findings about the importance of management resources and it may be constructed and operationalized exclusively by a projecting procedure that includes the basic elements of sports function (modelling of training technology, diagnosis of anthropological characteristics of sportspeople and planning the training process), business function (modelling the business function, diagnosis of the overall business operations and planning the needs for human resources) and organizational function (modelling the organizational structure, diagnosis of the state in the organizational function and planning the aims of the organizational function). These sports, business and organizational elements, which are implemented and unified in a strategic category of the first and most important part of the fundamental structural segment of the technology of preventive management in sport, are "compatible" with the cybernetics expression "like input like output" (Malacko, 2010).

Modelling - prediction is usually defined as a set of assumptions about the future, which is based on various resources, information, scientific research, with the aim of understanding future desired state - its input and output, the influence of environment and setting the goals that should be marked with both qualitative and quantitative characteristics (equations of specifications in sports, hierarchical structures of activities etc.) whose achievement can be measured, controlled and corrected (Voich & Wren, 1984; Panić, 1993; Malacko, 1997). Therefore, it must be first defined what type of the desired state is to be achieved because only there, the models and processes of activities leading to the realization of the desired outcome can be projected and constructed.

In order to have the implementation of the process of any activity, the desired state must be defined in the most precise, objective and clear way – not generally (hypothetical, reflexive, verbal). In other words, it should be presented by measurable sizes so it will be possible to check, control and analyzing the achieved effects (Malacko & Popović, 2001).

Diagnosis - prognosis**,** in conjunction with modelling – prediction, represents more concrete, precise and quantified step in "viewing" the future state and development, and it essentially applies measuring instruments with satisfactory metric characteristics (valid, reliable, objective) for the purposes of diagnosis of the existing states of dominant and relevant phenomena and processes, which are incorporated in certain mathematical and cybernetics management functions, and then for comparing with the desired state. Finally, there will be the prognosis of future flows, events and achieved effects. Diagnosis determines the current state, analyzes and presents its assessment and determines its prognosis - main concepts, global strategy and projections, models of priority, organizational structure, strategic aims and objectives, programme orientation of development, managing, organizing, functioning, decision-making, operationalization, implementation and control of the most relevant, valid and purposeful activities in the development of sport. In top sport the prognosis predicts sports achievements, certain sports branches as well as individual and team results in the future (individual result, team positions, national team participation etc.).

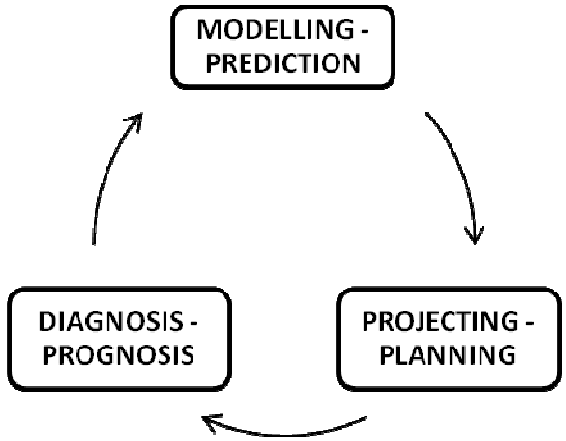

Figure 2. Integration of preventive management

Projecting - planning is a constant process of determining the aims, tasks, terms and policies of the development on the basis of the previous diagnosis and prognosis as a whole, then comparing the existing state with the desired state, finding the most optimal variant of their realization through certain period of time - what, where, when and who should do something in the future, then how to achieve the goals and when it will be and what effects will occur. Projecting is formed according to the information about previous and present events.

But also, future tendencies of the need changes, behaviour of external relevant factors, possibilities of the development of available potentials of an organization and their directions for the purposes of satisfying the future needs. Planning necessarily includes determining the aims and task of activities and how to achieve them, content of activities, material and intangible assumptions (the availability of resources), human resources, subjects of activities, duration of certain activities, order and interdependency, and the final results.

Discussion

We are living in the sports era adjuring individuals, groups, associations, organizations and institutions to interaction and integration. This is a period of generating ideas, visions, missions, great potentials and a period of great opportunities for discoveries, happenings, paths and applications so it is important to bear in mind that every modelling and predicting the future state, then a diagnosis of the existing and prognosis of the desired state as well as projecting and planning the flows of more varied, optimal and efficient activities, actually represents the creation of a set of paces to the unknown and also the birth of the idea and hope for newer, more optimistic and implementing outcomes.

The overall career in sport is an experiment that is continuously carrying out and it is never finished. Human resources in sport (coaches, managers, directors) always search for and apply new content, methods and forms in their creative and operational work with sportspeople, teams and club members. Even when they plan and check what they did in detail, they collide with the elements of the unknown during their operational work, so they are forced to find themselves in new and unpredicted situation in a timely, right and purposeful manner and to solve new problems in a short and optimal way. If we want to construct a valid model, it means that all the previous and present knowledge, scientific, expert and pragmatic literature, personal experience, intuition, tradition, logic, genetically-based creation should be incorporated into it. The model must be primarily intended for solving a present, relevant and, above all, practical problem. In such situation, the extent of the success of its application will depend on the extent of approaching and overlapping the intuitive and creative way of thinking, approaches and procedures with the reality. The practical sphere of life shows that in most sports there are still no appropriate phenomenological (structural, functional and hierarchical) models of the development of certain activities, and valid and purposeful projection of the development with the previously compared norms of actual and desired state, although it has long been recognized in sports science that these are the basic methodological postulates. The analyses show that the existing concepts and constructions of the long-term and short-term strategies of the development of sports organizations must be changed and based on an increased integration and interaction of certain relevant sport, business and organizational management functions because each function on its own is not sufficient to satisfy the needs of modern management technology for integrity and totality. It comes to conclusion that it is almost impossible to predict the processes of the development of sport in the future without a previously constructed phenomenological, structural and/or functional model, constructed on the basis of the application of the latest methodological procedures - application of multivariate mathematical and statistical methods of data processing, then of the diagnosis of dominant and relevant (input and/or output) phenomena (manifest or latent dimensions) with satisfactory metric characteristics for prognosis of sports achievements of individual and/or team results in the future, and projecting the directions of the development at the moment of planning and implementation.

Conclusion

Newly-established preventive management in sport is to make sure in the future that its structural strategic categories (components, functions) of modelling – prediction, diagnosis – prognosis and projecting – planning as well as their interactive functioning on the integral basis will contribute to more successful operating of overall sport management technology along with further operational solutions emanating from such approach. Planning, as the most important component of preventive management in sport, is the foundation of every managing mechanism of any managing action where philosophy and policies of sport, vision, mission, aims, strategies and tactics are entangled and applied by management in order to ensure future positions of sports organizations. Such approach means that every scientific, technological and pragmatic planning is preceded by projecting, i.e. determining short-term and/or long-term directions of the future development, and every prognosis of future events and achieved effects of work is preceded by the diagnosis of dominant and relevant phenomena and processes incorporated in the specifications of the models of certain management functions.

Every prediction of future desired state follows modelling of the assumptions about the future, which are based on various resources, information, scientific rules and competent opinion of experts and managerial entrepreneurial philosophy, vision and mission. The construction, function and application of these three management functions united in a strategic category called preventive management in sport opens up new possibilities for achieving more optimal comprehensiveness, purposefulness and objectivity for stimulating the desired state (managing actions, technological innovations and sports results) as soon as possible in the most efficient manner and with the effective outcome in sports organizations.

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PREVENTIVNI MENADŽMENT U SPORTU - IZAZOV NOVIH IDEJA

Sažetak

U sportskom menadžmentu kontinuirano se traga za novim izazovima, idejama i aplikacijama, s jedne strane, u pristupu, konstrukciji i strategijama kreativne filozofije, vizije i misije, a s druge strane, pripreme modeliranja-predviđanja, dijagnoze-prognoze i projektiranja-planiranja, s obzirom na potrebu za integralnošću i interaktivnošću sve većeg broja menadžmentskih kategorija, funkcija i neposrednih aplikacija. Cilj rada je da se putem novokonstruirane strateške kategorije pod nazivom preventivni menadžment u sportu na svim hijerarhijskim razinama, blagovremeno, svrsishodno i efikasno poduzimaju akcijske mjere i kreira ambijent u kojem će se razvijati budući željeni događaji i ostvarivati što efektnija ishodišta, pa u tom sklopu i svih daljnjih operativnih rješenja koja iz takvog pristupa slijede. Rezultati analize postojećeg stanja i dosadašnjih istraživanja pokazuju da su u tom pravcu moguća rješenja, koja se sastoje u pronalaženju novih ideja, kreacija i konstrukcija suvremenijih, kompletnijih i funkcionalnijih modela tehnološko menadžmentskih elemenata utemeljenih na integralnosti i interaktivnosti. Konstrukcijom, funkcioniranjem i aplikacijom navedenih triju tehnološko menadžmentskih funkcija modeliranja-predviđanja, dijagnoze-prognoze i projektiranja-planiranja pod zajedničkim nazivom preventivni menadžment u sportu, otvaraju se nove mogućnosti za postizanje optimalne sveobuhvatnosti, svrsishodnosti i objektivnosti u pripremi željenog stanja za što kraće vrijeme, uz postizanje većih efekata ukupne tehnologije rada i postizanja vrhunskih sportskih rezultata.

Key words: *sport, preventivni menadžment, modeliranje-predviđanje, dijagnoza-prognoza, projekt-plan*

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EFFECT OF PHYSICAL ACTIVITY ON BODY WATER IN SEDENTARY YOUNG UNDERWEIGHT AND OBESE WOMEN

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Original scientific paper

Abstract

The purpose of the present study was to examine the effect of a walking exercise on body water in order to restore body water and reduction dehydration among sedentary obese and thin women. Forty young untrained girls between the age of 20-25 years (obese n=20, BMI>30 and thin n=20, BMI <20) volunteered to participate in this study. Participants were randomly assigned to two exercises (obese=10, thin=10) and two control (obese=10, thin=10) groups matched by BMI. DXA was used to measure each subject's body water, percentage body fat and lean mass. Serum estrogen level by radioimmunoassay (RIA) was assessed. Each walking session was 30 min long at an intensity corresponding to 50-75% of maximal age adjusted heart rate, 3 days per week for 2 months. Percent body fat and lean mass were affected positively by exercise program and significant change was observed in Serum estrogen and body water in both exercise group (p<0.05-0.001). In conclusion this study demonstrated to 30 minutes walking exercise improved adaptation of body fluids and to exercise training in both obese and thin sedentary women.

Key words: *walking exercise, body water, women, obese and thin*

Introduction

During exercise, increased capillary hydrostatic pressure caused by elevation of arterial pressure produces plasma volume shifts from the vascular space to the interstitial fluids. Following a rapid efflux of vascular fluid within minutes of exercise, there is very little further reduction in plasma volume during exercise. Recall that body water content regulates sweating, and sweating provides our best method of heat loss during exercise. So, adequate body water is essential to avoid heat injury (e.g., heat exhaustion or heat stroke) (Convertino,1991).Body water retention is common in high estrogen states. There are a number of "fluid retention" hormones that exert a profound control over this fluid regulatory system. Hormones are substances in the body that act to promote certain activity by specific organs. The fluid regulatory hormones act primarily on the brain and kidney to control both intake and output of water. The most important hormone of this type is the antidiuretic hormone, which responds rapidly to changes in body water status, and is responsible for controlling the rate of water retention by the kidneys. To complicate matters, antidiuretic hormone regulation maybe modified by a variety of factors, one of which may be the female sex hormone estrogen (Akaishi & Sakuma, 1990). Early research suggests that the greater body water content in high estrogen states is likely due to changes in both water intake and output in premenopausal women. In addition, fluctuations in antidiuretic hormone parallels those of estrogen throughout the menstrual cycle, and are increased following estrogen administration in postmeno-pausal women, suggesting that fluid retention is also likely to be increased. Thus, the combination of enhanced fluid intake and retention causes the increase in total body water content during high estrogen states. Some of this excess water is retained in the blood vessels (i.e., in the plasma), leading to plasma volume expansion, which has potent effects on physical performance during heat stress (Stachenfeld & Taylor, 2009). Most people walk every day but it is often overlooked as an exercise activity. Walking is one of the easiest, and cheapest, ways to improve your fitness and increase specific hormones in young individual. It is a light cardiovascular exercise, which means it improves the condition of your heart and lungs (Suter et al., 1994). Chumlea et al concluded that there is inadequate timely information on measured total and extra-cellular water volumes for the population (Chumlea et al., 2007). Distributional body water relationships within the body have been considered fixed, but there was evidence these relationships were affected by the level of fatness, body composition models and to our knowledge, no study has shown the effect of an exercise program on body water in obese and thin women with a mean age of 20 years simultaneously that were performing the same exercise program. The purpose of this study was to investigate whether two months program of closely supervised walking exercise would be beneficial for increasing body water among healthy sedentary obese and thin women.

Material and methods

Forty young untrained girls between the age of 20-25 years (obese n=20, BMI>30 and thin n=20, BMI <20) volunteered to participate in this study. Participants were randomly assigned to two exercises (obese=10, thin=10) and two control (obese=10, thin=10) groups matched by BMI. Written informed consent for all procedures was obtained from all participants prior to entering the study and this study was approved by local Committee of Ethics. The criteria for the invitation were being willing to participate, clinically healthy

(no cardiovascular, musculoskeletal, respiratory, or other chronic diseases that might limit training or testing), no menstrual irregularities, not using medication and no beta-blockers, sedentary life style (no regular sports activities for at least 2 years), non dieting, and no apparent occupational or leisure time responsibilities that could impede their participation. The following measurements were made at baseline prior to the start of the exercise program and at after completion of the 2-month training program. *Measurements*. Body weight and height were recorded and body mass index (BMI) was calculated as weight (kg) divided by height (m) squared. DXA (Lunar DPX-L, software version 1.31, USA) was used to measure each subject's body water, percentage body fat and lean mass. The DXA scans were performed in the Orthopaedic Diagnostic Centre at the National University Hospital, Guilan. In addition, all subjects were weighed every week. Blood samples were collected after an overnight fast (>12 h) in a sitting position and centrifuged at 1500 rpm for 30 minutes at 4^{o} C within 2 h. Serum sample from each participant were stored frozen at -20^{o} C until analyzed. Serum estrogen level was assessed by radioimmunoassay (Amersham Biosciences, Piscataway, NJ, USA) in follicular stage in each subject's menstrual cycle. The program included warm-up phase for 5 minutes that included stretching exercises, 30 minutes walking at 50-75% of maximum heart rate and cooling-down phase for 5 minutes of stretching, three times a week for 2 months in indoor place. A target heart rate range between 55-70% of age adjusted maximum heart rate intensity was calculated by each walker from her age and walking supine resting heart rate (Swain et al., 1994) . Heart rate was measured with an electronic heart rate monitor (Sport Tester PE, Polar Electro, Oy, Finland). The exercise program was accompanied by drinking water in every 10 minutes. *Data analysis.* The data were analyzed using the SPSS 11.5 for Windows; SPSS, Chicago, IL, USA). Mean and standard deviation (SD) was used as descriptive statistic. Student's t-test was to assess the change in BMI, body weight, serum estrogen and body water before and after the exercise intervention. A significance level of set at $p<0.05$ was used for all comparisons.

Results

Forty subjects (100%) completed the training program. No major change in menstrual status was observed during the study. Table (1) shows the changes in data on both exercise and control groups. There were no significant differences in mean age, height between the groups. There is notable differences between the groups were body weight, BMI in obese and thin groups. Percent body fat and lean mass were affected positively by exercise program and significant change was observed in Serum estrogen and body water in both exercise group ($p<0.05$-0.001).

Discussion

This is the first study to asses the effect of exercise on body water in young women. This difference may be due to the younger age of subjects in our study and the nature of the mechanical load. In our patient a simple 30 minutes of walking exercise at the range of 50-75% maximum heart rate was enough to decreasing the fat mass and increasing lean body weight. "Lean mass" means muscle."Lean mass," the researchers conclude, "is the major determinant of body size, providing further evidence that body size is adapted to the dynamic load imposed by muscle force rather than passive loading" by fat. On the other hand Muscle mass able to hold *more water* weight to fat mass (Thompson et al., 2004). Increase in serum estrogen and total body water in both exercise obese and thin group is good responses to walking program. These mechanisms probably include increasing plasma protein oncotic pressure, differences in peripheral vasoconstriction in active muscles and inactive tissues, and elevated lymph flow. The interaction of these factors provides optimal thermoregulatory and cardiovascular stability. The beneficial effects of hyperdydration and subsequent hypervolemia are manifest in the adaptation of body fluids and electrolytes to exercise training. Thus, with regard to fluid receiving shifts during exercise, training is an effective way to become hyper hydrated and to reduce the dehydration (Convertino, 1987). Stachenfeld et al similarly indicates water retention was the primary contributor to increasing estrogens during endurance exercise. Weinheimer et al (2008) supported that young, physically active women can completely compensate for exercise-induced sweat losses by increasing adequate water intake. Bossingham et al (2005) showed that healthy older adults maintain water input and balance comparable to those of younger adults and have no apparent changes in hydration status. To prevent dehydration, consume plenty of fluids is helpful. In conclusion this study this study demonstrated to 30 minutes walking exercise improved adaptation of body fluids and to exercise training in both obese and thin sedentary women.

Table1. Mean value (±SD) before (Pre) and (Post) training - Significantly different $p<0.001$; 0.05 marked dark)

variable	Obese (Exe)		Obese (Con)		Thin (Exe)		Thin (Con)	
	pre	post	pre	post	pre	post	pre	post
Age (year)	22.2±1.9	-	22.6±1.5	-	21.1± 1.7	-	21.9±1.2	-
Height (cm)	157.7±5.1	-	159.1±1.5	-	159.9 ±7.5	-	162.7±6.6	-
Weight (kg)	74.9±8.1	73.2±7.7	78.1±10.8	78 ±10.1	45.8 ±5.3	46.4 ±5.1	46.4±5.7	46.3±5.2
BMI (kg/m^2)	30.2±1.8	28.8 ±2.1	30.9 ±3.5	30.4±3.0	17.7 ±1.0	17.8 ±1.4	17.5±1.0	17.2 ±0.9
Estrogens(pg/ml)	30.4±15.6	61.0 ± 8.6	23.9±3.15	41.5 ± 7.2	25.6 ±8.4	60.2 ±18.8	33.0±14.3	38.0±10.6
Body Fat Content	38.8±4.0	36.4 ±6.8	39.7±3.5	39.0 ± 5.2	21.8 ±3.1	20.1± 3.6	22.4± 2.9	22.4±3.2
Lean Body Mass	43.3±5.3	44.4 ± 6.2	43.9±6.0	44.3 ± 6.7	33.5 ± 3.7	34.5 ± 4.0	33.9 ± 4.3	33.7±4.1
Total Body Water	30.26±7.8	33.155±99	30.11±22	30.00±10	19.81± 9.3	21.59± 8.25	19.18 ± 9.3	19.11±7.32

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UČINAK AKTIVNOSTI VJEŽBANJA NA TJELESNU VODU KOD SEDENTARNIH MLADIH MRŠAVIH I GOJAZNIH ŽENA

Sažetak

Svrha predstavljene studije je istraživanje učinka vježbanja hodanjem na tjelesnu vodu u smislu restitucije tjelesne vode i redukcije dehidracije među sedentarnim gojaznim i mršavim ženama. Ukupno 40 netreniranih djevojaka uzrasta između 20 i 25 godina (gojazne n=20, BMI>30 i mršave n=20, BMI <20) dobrovoljno je sudjelovalo u istraživanju. Sudionice su unutar grupa (gojazne, mršave) po slučajnom ključu raspoređene u dvije eksperimentalne (deset gojaznih i deset mršavih) i dvije kontrolne grupe (također po deset gojaznih i deset mršavih) primarno definirane prema BMI indeksu. Korištena je DXA metoda za mjerenje tjelesne vode za svaku ispitanicu, postotak masnog tkiva i suha masa. Određena je razina serumskog estrogena uz pomoć radioimmunoassay (RIA) metode. Svaka sesija vježbe hodanja trajala je 30 minuta 3 dana u tjednu za vrijeme 2 mjeseca, uz intenzitet koji odgovara 50-75 % uzrastu prilagođene maksimalne srčane frekvencije. Postotak masnog tkiva i suhe mase pozitivno je zahvaćen programom vježbanja i značajne promjene su primjećene u Serumskom estrogenu i tjelesnoj void u obje eksperimentalne grupe (p<0.05-0.001). Zaključno, ovo istraživanje je pokazalo da vježba hodanja od 30 minuta povećava adaptaciju tjelesnih tekućina na tjelesni trening kod obje grupe, i gojaznih i mrđavih sedentarnih žena.

Ključne riječi: *vježba hodanja, tjelesna voda, žene, gojazne i mršave*

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DIFFERENCE IN THE EXPLOSIVE STRENGTH OF UPPER EXTREMITIES BETWEEN ATHLETES IN RELATION TO THEIR SPORT ACTIVITY, TYPE OF ENGAGEMENT IN SPORT AND GENDER

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Original scientific paper

Abstract
The ability to perform an explosive movement is of a great interest for athlete's performance and success in sport. Developing qualities such as strength, power and rate of force development appear to be of greater importance than training at the actual movement velocity of a task. Aim: The aim of actual research was to determine difference in the explosive strength of upper extremities between athletes in relation to their sport activity, type of engagement in sport (recreational and professional) and gender. Methods: The sample of subjects consisted of 94 athletes (74 male and 20 female), recreationally and professionally engaged in different sport activities. Measurement of explosive strength of upper extremities comprehended one set of five bench press repetitions with a load of 20 kg. Variables of explosive strength, i.e., Power (expressed in W/kg), Force (expressed in N/kg), Velocity (expressed in cm/s) were measured by a wireless accelerometer "Myotest" (Sion, Switzerland). The hypotheses were that significant differences in measures of explosive strength will occur between athletes engaged in handball, volleyball, basketball and combat sports vs. athletes engaged in soccer, swimming, athletics, other sports and recreative athletes in favor of first mentioned group, between professional vs. recreative athletes in favor of professional athletes and between genders in favor of male sex. Results: The main finding of this research is that first and the second hypotheses weren't confirmed. Results of Mann Whitney U Test confirmed the third hypothesis, i.e., showed that there are statistically significant difference in explosive strength of upper extremities in all analyzed variables in relation to the gender. Conclusion: The data neither indicate that explosive strength characteristics are specific to each group of athletes, nor to the type of engagement in sport (recreational and professional). However, current data provide a quantified look at differences between certain athletes (engaged in athletics, soccer and combat sports) which are most likely influenced by the various training protocols utilized and sexual dimorphism.

Key words: bench press, athletes, Myotest, sport activity, type of engagement, gender

Introduction

Explosive strength is an ability which makes it possible for an athlete to propel his body towards some object or partner. The expressed explosive strength depends on the percentage and the structure of the motor units of some muscle groups (Bubanj, R. & Branković, 1997). The ability to perform an explosive movement is of a great interest for athlete's performance and success in sport.

Developing qualities such as strength, power and rate of force development appear to be of greater importance than training at the actual movement velocity of a task (Cronin et al., 2002). Authors Newton et al. (1997) stated that average velocity, average and peak force, and average and peak power output are significantly higher for the stretch shortening cycle bench throws, compared to the concentric only bench throws. Authors Baker & Newton (2006) stated that the rate of progress in strength and power development diminishes with increased strength levels and resistance training experience. They also indicated that strength and power can still be increased despite a high volume of concurrent resistance and endurance training.

In research conducted by author Baker (2002), related to the explosive strength and age, upper-body power outputs, assessed during bench press throws with a resistance of 20 kg were significantly higher in the elite professional National Rugby League players, than those of the college-aged rugby league players, which in turn were significantly higher than those of the three high-school groups of rugby players. In addition, senior high-school players were more powerful in the upper body compared with nonresistance-trained junior high-school players. Consequently to certain discordances, in the previous studies, concerning the strength training exercise methods, i.e., to single vs. multiple sets, optimal repetition range for increasing muscular strength and endurance, speed of movement during exercise and optimal training frequency, authors Stanković et al. (2009) focused in their research on the speed of movement during exercise. As the differences of relative and absolute gains in the lifted amounts, at the initial and final measurements, between two sub-samples existed, but weren't significant, mentioned authors suggested a slower movement speed during exercise i.e., slower bench throw tempo, which implies a smaller consumption of energy in relation to the faster bench throw tempo.

The aim of actual research was to determine difference in the explosive strength of upper extremities between athletes in relation to their sport activity, type of engagement in sport (recreational and professional) and gender.

Methods

The sample of subjects consisted of 94 athletes (74 male and 20 female), with body height 178.32±8.47 in cm, body weight 74.03±12.37 in kg, aged 20.52 years±1.23 months (Mean±Std.Dev), recreationally and professionally engaged in different sport activities (soccer, N=33; basketball, N=13; combat sports, N=13; volleyball, N=7; handball, N=7; swimming, N=5; recreative athletes, N=5; athletics [middle distance running], N=4; other sports, i.e., gymnastics, dance, tennis, table tennis, body building, paragliding, orienteering, N=7). Subjects voluntarily participated in the research, conducted in accordance with the Helsinki Declaration. At the measurement, subjects primarily applied the warming protocol in duration of 5-10 min, which included smooth run (120 bpm/maximum) and bench press repetitions of different intensities: 2x5 repetitions with a light load and low (controlled), moderate (controlled) and high intensity, respectively. Between sets of repetition, subjects had 1 min rest intervals, i.e., three minutes at the end of warming protocol in aim of preparation and concentration for the measurement which comprehended one set of five repetitions with a load of 20 kg.

Variables of explosive strength i.e., Power (expressed in W), Force (expressed in N), Velocity (expressed in cm/s) of upper extremities (pectoralis, anterior deltoids, triceps brachii) were measured by a wireless accelerometer "Myotest" (Sion, Switzerland), positioned safely on the barbell. The only valid and objective way of assessing muscle strength is measurement with a dynamometer (Bubanj, S. et al., 2010, a).

Mentioned device is a reliable, wireless and small weight device (Bubanj, S. et al., 2010, b). Subjects were instructed to wait for two audio signals of the device "Myotest", and perform five repetitions with maximum speed of vertical barbell displacement (the first signal for barbell lowering and the second for the barbell lifting). The hypotheses were that significant differences in measures of explosive strength will occur between athletes engaged in handball, volleyball, basketball and combat sports vs. athletes engaged in soccer, swimming, athletics, other sports and recreative athletes in favor of first mentioned group, between professional vs. recreative athletes in favor of professional athletes and between genders in favor of male sex. For the statistical analysis and interpretation of the results, the statistical package Statistics 13.0 was in use. Results were expressed by descriptive statistics, while in aim to calculate statistically significant differences in the explosive strength of upper extremities between subjects in relation to their sport activity and gender ANOVA method and Mann Whitney U Test were in use (Pallant, 2007).

Results and discussion

Table 1. Descriptive statistics of explosive strength of upper extremities in subjects

Variables		Power (in W)				Force (in N)				Velocity (in cm/s)			
Activities	N	Mean	Std.D.	Min	Max	Mean	Std.D.	Min	Max	Mean	Std.D.	Min	Max
Recreative	5	726.00	284.73	247	979	423.60	105.55	244	519	219.60	57.20	120	258
Combat	13	517.31	246.85	82	956	363.38	79.48	233	504	178.62	68.99	39	260
Soccer	33	586.88	128.19	415	1040	385.21	37.45	320	493	205.79	26.96	166	288
Athletics	4	233.25	22.02	204	255	268.25	11.27	252	278	157.00	92.70	107	296
Other	7	527.57	245.25	170	982	358.29	78.74	239	501	189.43	60.70	81	280
Basketball	13	468.77	263.49	17	957	337.23	75.30	213	434	167.85	85.83	8	335
Volleyball	7	441.29	233.84	72	740	331.43	76.57	219	416	162.86	71.11	35	232
Swimming	5	565.20	258.81	134	776	391.20	67.38	291	454	194.20	74.17	64	241
Handball	7	466.71	264.67	98	784	328.86	76.16	235	432	175.57	88.90	46	295

Table 2. ANOVA for determination of statistically significant difference in explosive strength of upper extremities between subjects.

Variables		Sum of Squares	df	Mean Square	F	Sig.
Power	Between Groups	790872.61	8	98859.08	2.22	**.034**
	Within Groups	3793044.71	85	44624.06		
	Total	4583917.32	93			
Force	Between Groups	98450.70	8	12306.34	2.91	**.006**
	Within Groups	358975.65	85	4223.24		
	Total	457426.35	93			
Velocity	Between Groups	31414.04	8	3926.76	1.01	.433
	Within Groups	329522.57	85	3876.74		
	Total	360936.61	93			

Table 4. Differences between subjects engaged in different sport activities in relation to the variable Power, determined by usage of Tahman's Test

Power Tamhan Test	Recreatives	Combat sports	Soccer	Athletics	Other sports	Basketball	Volleyball	Swimming	Handball
Recreative athl.		1.000	1.000	.475	1.000	.992	.982	1.000	.997
Combat sports	1.000		1.000	.047	1.000	1.000	1.000	1.000	1.000
Soccer	1.000	1.000		.000	1.000	.996	.998	1.000	1.000
Athletics	.475	.047	.000		.499	.236	.879	.811	.886
Other sports	1.000	1.000	1.000	.499		1.000	1.000	1.000	1.000
Basketball	.992	1.000	.996	.236	1.000		1.000	1.000	1.000
Volleyball	.982	1.000	.998	.879	1.000	1.000		1.000	1.000
Swimming	1.000	1.000	1.000	.811	1.000	1.000	1.000		1.000
Handball	.997	1.000	1.000	.886	1.000	1.000	1.000	1.000	

Table 5. Differences between subjects engaged in different sport activities in relation to the variable Force, determined by usage of Tahman's Test

Force Tamhan Test	Recreatives	Combat sports	Soccer	Athletics	Other sports	Basketball	Volleyball	Swimming	Handball
Recreative athl.		1.000	1.000	.661	1.000	.997	.996	1.000	.994
Combat sports	1.000		1.000	.036	1.000	1.000	1.000	1.000	1.000
Soccer	1.000	1.000		.000	1.000	.811	.988	1.000	.978
Athletics	.661	.036	.000		.566	.218	.934	.398	.952
Other sports	1.000	1.000	1.000	.566		1.000	1.000	1.000	1.000
Basketball	.997	1.000	.811	.218	1.000		1.000	.999	1.000
Volleyball	.996	1.000	.988	.934	1.000	1.000		.999	1.000
Swimming	1.000	1.000	1.000	.398	1.000	.999	.999		.999
Handball	.994	1.000	.978	.952	1.000	1.000	1.000	.999	

Results of ANOVA (table 2) show existence of statistically significant differences in explosive strength of upper extremities between subjects engaged in different sport activities in variables Power (p=0.034) and Force (p=0.006). Homogeneity in results of subjects engaged in different sport activities was tested by usage of Levene's Test (Table 3).

Table 3. Levene's Homogeneity of variances test

	Levene Statistics	df1	df2	Sig.
Power	2.22	8	85	.034
Force	2.41	8	85	.021
Velocity	3.02	8	85	.005

Due to the non-homogeneity in results of subjects engaged in different sport activities, in use was Tahman's Test for multiple comparison (Tables 4 and 5). The main finding of this research is that first and the second hypotheses weren't confirmed because, according to the results of Tahman's Test (tables 4 & 5), in relation to the variables Power and Force, there are statistically significant differences only between subjects engaged in soccer and athletics (p=0.000; p=0.000, respectively) and between subjects engaged in combat sports and athletics (p=0.047; p=0.036, respectively).

There are available researches dealing with the similar objectives, but not many are comparable between each other due to different methodology, cohort, type of muscle action, testing conditions, etc. For example, authors Izquierdo et al. (2002), evaluated effects of long-term training specificity on maximal strength and power of the upper extremities in athletes from different sports (weightlifters-WL, handball players-HP, amateur road cyclists-RC, middle-distance runners-MDR and age-matched control subjects-C).

The one repetition maximum bench press ($1RM_{BP}$) in WL was larger ($P<0.05$) than those recorded in HP, RC, MDR and C. In the bench press, average muscle power outputs in WL and HP were higher ($P<0.05–0.001$) than those in MDR, RC and C, and were maximized at a load of 30% of 1RM for WL and HP, and at 45% for RC, MDR and C. Authors suggested that the magnitude of the sport-related differences in strength and/or muscle power output may be explained in part by differences in muscle cross-sectional area, muscle fibre type distribution and in the muscle mechanics of the upper limbs as well as by training background. Due to the absence in normal distribution of values, difference in the explosive strength of upper extremities in subjects in relation to the gender was tested by usage of Mann Whitney U Test (Table 7).

Table 6. Descriptive statistics of explosive strength in subjects in relation to the gender

		N	Mean	Std. Dev.
Power	Male	74	615.93	145.356
	Female	20	202.25	135.165
Force	Male	74	392.00	44.783
	Female	20	254.45	26.289
Velocity	Male	74	211.36	30.634
	Female	20	102.30	74.391

Table 7. Difference in the explosive strength in subjects in relation to the gender

	Power	Force	Velocity
Mann-Whitney U	52.000	.000	146.000
Wilcoxon W	262.000	210.000	356.000
Z	-6.356	-6.837	-5.488
Asymp. Sig. (2-tailed)	.000	.000	.000
a. Grouping Variable: gender			

Results of Mann Whitney U Test (Table 7), confirmed the third hypothesis, i.e., showed that there are statistically significant difference in explosive strength of upper extremities in all analyzed variables in relation to the gender (Power, p=0.000; Force, p=0.000; Velocity, p=0.000). Obtained results of actual research in relation to the gender are in accordance to the results of research conducted by authors Thomas et al. (2007).

Conclusion

The data neither indicate that explosive strength characteristics are specific to each group of athletes, nor to the type of engagement in sport (recreational and professional). However, current data provide a quantified look at differences between certain athletes (engaged in athletics, soccer and combat sports) which are most likely influenced by the various training protocols utilized and sexual dimorphism.

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RAZLIKE U EKSPLOZIVNOJ SNAZI GORNJIH EKSTREMITETA IZMEĐU SPORTAŠA U ODNOSU NA NJIHOVU SPORTSKU AKTIVNOST, VRSTU ANGAŽMANA U SPORTU I SPOL

Sažetak

Sposobnost izvođenja eksplozivnog gibanja je od velikog interesa za sportaševu izvedbu i uspjeh u sportu. Razvoj kvaliteta poput snage, sile, tempa razvoja sile, postaju od veće važnosti od samog treninga u trenutku aktualne brzine gibanja u zadatku. Cilj aktualnog istraživanja je bio utvrđivanje razlike eksplozivne snage gornjih ekstremiteta između sportaša u odnosu na njihovu sportsku aktivnost, vrstu angažmana u sportu (rekreacijski i profesionalno), i u odnosu na spol. Uzorak ispitanika sadržavao je 94 sportaša (t4 muškog i 20 ženskog spola), rekreacijski i profesionalno angažiranih u različitim sportskim disciplinama. Mjerenje eksplozivne snage gornjih ekstremiteta sadržavalo je skup od pet bench-press ponavljanja s opterećenjme od 20 kg. Varijable eksplozivne snage, npr. Snaga (izražena u W/kg), Sila (izražena u N/kg), Brzina (izražena u cm/s) mjerene su bežičnim akcelerometrom "Myotest" (Sion, Švicarska). Postavljena je hipoteza da će se značajne razlike u mjerenju eksplozivne snage pojaviti: a) između sportaša angažiranih u rukometu, odbojci, košarci i borilačkim sportovima nasuprot sportašima angažiranim u nogometu, plivanju, atletici, ostalim sportovima i rekreacijskim aktivnostima u korist prve spomenute grupe, b) isto tako između profesionalaca i rekreativaca u korist profesionalaca i c) između sportaša po spolu u korist muške grupe. Rezultati istraživanja su u glavnom dijelu pokazali da prva (a) i druga (b) hipoteza nisu potvrđene. Rezultati Mann Whitney U Test-a potvrdili su hipotezu vezanu za spol (c), tj. pokazali su da postoje statistički značajne razlike u eksplozivnoj snazi gornjih ekstremiteta svih analiziranih varijabli u odnosu na spol. Može se na temelju podataka zaključiti da niti su značajke eksplozivne snage specifične za grupe sportaša, a niti je to vrsta angažmana (profesionalni ili rekreacijski). Međutim, tekući podaci osiguravaju kvantificirani pogled na razlike među određenim sportašima (uključenih u atletiku, nogomet i borilačke sportive) koji su najvjerojatnije pod utjecajem različitih trenažnih protokola iskorišteni i u spolnom dimorfizmu.

***Ključne riječi**: bench-press, sportaši, Myotest, sportska aktivnost, vrsta angažmana, spol*

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METRICAL CHARACTERISTICS OF THE BATTERY OF BODY POWER TESTS SUITABLE FOR PRE-SCHOOL CHILDREN

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Original scientific paper

Abstract
The main goal of this experimental study is to apply and examine the suitability of the new battery of 24 body power tests and its parameters of descriptive statistics. Measurements were carried out on 180 pre-school children; 74 or 41,11% girls and 106 (58,88%) boys, aged 5 years (M=5,27 years, SD=0,42), participants in extracurricular sports programme which has been organized in the kindergartens in Rijeka. The pre-school children were measured by 24 tests; 6 tests for explosive body power; 5 composite and 1 one-item test, as well as 9 tests (one item) for dynamic and 9 (one item) tests for static body power. It could be concluded that the battery is suitable for preschool children and due to some of the tests which have to be modified it is necessary to test it on the on larger samples of pre-school children divided into several age groups (for example; 5, 6 and 7).

Key words: *pre-school children, new battery, power body*

Introduction

It is well known that lack of playing, experience and the opportunity to take part in a different physical activities can slow down their regular process of development as well as that until the age of seven, children learn the basic types of motor activity, which stimulates the process of development of their basic motor abilities, among the coordination, speed, power, flexibility, balance, and precision, and it is difficult to make up for the lack of these abilities later on (Živčić at al., 2008). During the latest years, in Croatia we have had more studies on the sample of pre-school children (De Privitellio 2009; De Privitellio at al., 2006; Babić at al., 2007; Caput-Jogunica at al., 2008; 2009). Some of the Croatian national documents as well as the mentioned studies have recognized the problem of preferences of sedentary lifestyle and its influence on children and youth health. If somebody asks to describe an actual state of physical activity and actual sports programme which are provided in Croatian kindergartens we may conclude as follows; 1. There are so many different sports programmes that were evaluated by the Ministry responsible for education and sport but the thing that is questionable is their quality as well as who should provide sports programme in preschools institutions?, 2. In the 21 century, we still have a small percentage of kindergartens with adequate sports infrastructures (gym, playground, etc.) 3. It is important to emphasize unsatisfactory proportion of kindergarten teachers with regard to numerous pre-school children in one group, 4. Most of educators in kindergartens aren't motivated to provide regular physical activity programmes such as; morning exercise, physical activity classes in the gym as well as in playgrounds and 5. We can notice the lack of cooperation between the PhD professors and kindergarten teachers which leads to the conclusion that we don't have a unique and standardized battery suitable for pre-schools kids which allows all the researchers to provide longitudinal study of the kinanthropology features, the most interesting for these age. Anyhow, more researchers have done experimental studies with the aim to explore the kinanthrophology features of preschool children so far. In recent years there have been more and more scientific studies regarding the differences in motor abilities between the preschool girls and boys (Morris at all, 1982; Dukovski, 1984; Rajtmajer, 1993; Vidamšek, 1996; Bala, 2003; De Privitellio at al., 2006; Robin at al., 2006; Fratrić & Robin, 2007; Babić at al., 2007; Poček, 2007). Some of the authors have determined significant differences between boys and girls in realization of all motor tests, where boys have achieved better results in all tests (Dukovski, 1984; Perić, 1989, Rajtmajer, 1993). On the other hand there are researchers who pointed to the significant differentiation of motor tests regarding gender where boys are better in explosive body power tests, coordination and agility, while girls have had better results in flexibility tests (De Privitellio at al., 2006, Babić at al., 2007). Rajtmajer (1997) and Fratrić & Rubin (2006) have compared the latent structure of motor abilities and found the identical general motor factor for both genders which they have explained with similar developmental changes during preschool.

Problem and aim

There were a large number of problems when we tried to research motor abilities of young children. Some of them we already mentioned related to lack of cooperation between the PhD and kindergarten teachers specially related to the important skills of measuring as well as for providing experimental studies. Besides, one of the most important problems is an analogue motor test for preschool children as well as its metric characteristics, such as sensitivity, validity and reliability.

According to the previous studies in motor field, it is necessary to make composite tests (to repeat the activity two, three or more times with an appropriate rest time between the performances) which would ensure that the test reliability can be better defined. The main objective of this study is to determine the body power structure on the sample of 5 year old kids. For this purpose we have defined a very simple battery of 24 motor tests; 5 composite and 1 more test for explosive power, 9 tests (one item) for dynamic and 9 tests for static body power (Table 1). It is important to emphasize that there is no evidence about the studies which have been carried out on the sample of preschools children with the aim to determine the structure of body power as well as either experimental studies which have used the battery of higher than 6 new motor tests for the different action types of body power. According to that, the main goal of this experimental study is to apply and to examine the suitability of the new battery of body power tests and its parameters of descriptive statistics. Finally, this paper could be one more contribution in process of developing the battery of motor tests as a unique battery on national level for some longitudinal studies in the future.

Methods

Subjects

Measurements were carried out on 180 pre-school children; 74 or 41,11% girls and 106 (58,88%) boys, aged 5 years (M=5,27 years, SD=0,42), participants in extracurricular sports programme which has been organized in the kindergartens in Rijeka. The tested children were participants in the classes of the kindergartens in Rijeka and regularly attended extracurricular sports programme during school year 2008/2009.

Variables

The applied variables were selected mainly from the gymnastics school programme carried out with the aim to determine the latent structure of the motor manifestations which are under control and dominant influence of the mechanism for regulation of excitation duration. Its manifestation characteristics are explosive, dynamic and static way of performance (work). The pre-school children were measured by 24 tests with the following characteristics; they were suitable for the assessment of the children's abilities, the complexity of conducting test was as low as possible and little equipment was needed for performing tests.

The results in the test for measuring the explosive power is children's achievements in seconds or meters depending on the tests for the dynamic power is the number of repetitions per 30 seconds, and for each body static way of performance we recorded the time in seconds that the child held the correct position. Only 5 tests for explosive power were repeated three times with appropriate rest time between the each performance, other tests in the battery were repeated once.

Table 1. Abbreviations and descriptions of the tests applied in the muscle activity measurement

Topological groups	Tests of explosive power
Hand and arm area	MFEBLD - Throwing the tennis ball from the standing position
	MFEBMD - Seated medicine ball throwing from the chest
	MFEBML - Throwing 1 kg medicinal ball from lying on back
Trunk	
Legs	MFESVM standing jump up (Sergeant test)
	MFE20V sprint
	MFESDM Standing long jump

Topological groups	Tests of dynamic power
Hand and arm area	MRAZGP – chins, supinated grip, pull up until your chin reaches the bar
	MRASUS push ups, with back support
	MRASUK push ups, on the knees
Trunk	MRAMPT- sit ups, 30 seconds
	MRAMPN – lying on the back, rise up the legs
	MRAZAK – extensions
Legs	MRAČUČ – squats
	MRASTEP- rise up on the step bench
	MRABPO – side jumps

Topological groups	Tests of static endurance
Hand and arm area	MSAIVZ – hold on by the chin up on the bar
	MSAUPP – hold on with forward support by hands, and by feet on the wall (position hand stand)
	MSAIUZ – push up hold with back support
Trunk	MSAIVPZ – pull up hang
	MSAIZZ – extension, hold arms below the chin
	MSAIZS – seating position, back support by hand, rise up and hold the legs up the floor
Legs	MSAIZC – half – squat – hold
	MSAIZU – standing on the toes, hold as high as possible
	MSAIZN – in the prone position, lift up and hold extend legs

The following procedure was applied; mean (Mean) and standard deviation (SD), range of the results (minimum- MIN and maximum - MAX) as well as symmetry (skewness - SKEW) and homogeneity (kurtosis – KURT), in Table 2. For the 5 composite tests (consisting of at least three items) except above mentioned procedure, the following parameters were calculated for each item (repetition); multiple correlation of each item with others (SMC), Cronbach index of generalisation of the common object of measurement re-scaled to anti-image metrics (Cronbach Alpha) and correlation coefficient of composite items with the common object of measurement (F1), in Table 3.

Metric characteristics of the motor tests for explosive strength were determined by the RTT7stb. (Dizdar, 1999) which was based on the RTT7 program (Momirović, 1983), statistical programme for determining the metric characteristics of composite measurement instruments).

Results and discussion

The results are presented in tables 2 and 3. The first table shows the basic descriptive parameters of body power tests on the basis of which it is possible to make conclusions referring to the sensitivity and applicability of the tests applied. One of the criteria of the sensitivity and applicability of the tests is the range of results; the measure was derived from the difference between the maximum and minimum results. The wide range of results on the entire sample of the tests suggests a very good sensitivity. According to the analysis of the results in the Table 2, achievements in the following tests: MRAMPT - sit ups, 30 seconds, MSAIVZ – hold on by the chin up on the bar, and MSAIZN - in the prone position, lift up and hold extend legs are zero. Further analysis should explain the main reason or necessity to improve and change the motor tasks. Distribution of the results does not substantially deviate from the normal Gauss distribution, which satisfies the condition of the suitability of the exercise to the tests, since their differences are both in the zone of low and high results. Considering the projections, we can determine that the tests of dynamic and explosive body power have the highest correlation.

Table 2. Descriptive characteristics of the tests applied

Variables	X	SD	Min.	Max	Skew.	Kurt.
MFEBLD cm	744.61	326.17	156.67	2283.33	1.27	2.84
MFEBMD cm	191.48	43.54	83.33	303.33	0.26	-0.24
MFEBML cm	95.38	39.11	28.33	231.67	0.81	0.73
MFESVM cm	15.49	4.41	5.00	28.33	0.48	0.22
MFE20V sec	5.25	0.58	4	7.8	0.90	1.56
MFESDM cm	100.23	17.60	51.67	139.67	-0.13	-0.44
MRAZGP n	9.67	4.89	1	30	0.86	1.00
MRASUS n	12.22	4.95	2	27	0.46	-0.10
MRASUK n	18.29	8.95	1	49	0.90	0.49
MRAMPT n	13.01	3.55	0	22	-0.41	0.45
MRAMPN n	13.97	2.92	5	22	0.00	0.46
MRAZAK n	21.39	5.69	3	36	-0.37	0.17
MRACUC n	23.48	3.75	12	32	-0.36	0.20
MRASTEP n	13.52	2.59	5	20	-0.46	0.85
MRABPO n	16.58	6.27	5	32	0.28	-0.78
MSAIVZ sec.	11.31	9.54	0	48	1.98	4.20
MSAUPP sec.	41.64	22.93	8.41	202	2.35	12.47
MSAIUZ sec.	30.24	20.65	4	223	4.85	41.85
MSAIVPZ sec.	23.13	16.97	1	104	1.91	5.10
MSAIZZ sec.	38.13	20.47	7.64	120.19	1.13	1.37
MSAIZS sec.	36.16	24.53	5	187	2.48	9.84
MSAIZC sec.	52.91	33.52	9	180.21	1.36	2.24
MSAIZU sec.	76.63	44.64	15.09	336	1.72	5.98
MSAIZN sec.	48.64	97.16	0	794	5.87	37.56

Table 3 shows the parameters for the 5 composite tests applied in the study. For each repetition were calculated mean value (X), standard deviation (SD), multiple correlation of each item with others (SMC), Cronbach index of generalisation of the common object of measurement re-scaled to anti-image metrics (Cronbach Alpha) and correlation coefficient of composite items with the common object of measure (F1) as well as the Kaiser–Rice measure (MSA). All tests for explosive body power are composite, except the MFE20V - sprint 20 m. According to the analysis of the mean and standard deviation of all items in each test (Table 3) shows that the second and third performance of the task gave better results. This conclusion reconfirmed the results in the previous study (Bala, 2003) where the author determined that children were learning how to perform the task during the first performance, and actually performed it during the second and third performance.

Table 3. Composite tests

Variables	ITEM	X	SD	SMC	α	F1	MSA
MFEBLD1 dm	1	74.82	34.85	.84	.69	.92	.80
MFEBLD2 dm	2	74.94	33.62	.88	.68	.96	.85
MFEBLD3 dm	3	73.61	33.70	.84	.69	.92	.80
MFEBMD1 dm	1	18.81	48.9	.78	.74	.88	.72
MFEBMD2 dm	2	19.12	46.0	.83	.74	.94	.79
MFEBMD3 dm	3	19.50	44.8	.81	.74	.89	.74
MFEBML1 dm	1	91.77	40.3	.72	.75	.85	.64
MFEBML2 dm	2	94.66	43.0	.76	.74	.91	.70
MFEBML3 dm	3	99.70	43.2	.74	.74	.85	.65
MFESVM1 cm	1	15.32	4.7	.77	.76	.87	.71
MFESVM2 cm	2	15.46	4.4	.85	.75	.95	.82
MFESVM3 cm	3	15.70	4.7	.83	.75	.93	.80
MFE20V sec.	1	5.25	0.6	.53	.76		.72
MFESDM1 cm	1	99.47	18.70	.78	.75	.88	.78
MFESDM2 cm	2	99.97	18.60	.82	.75	.93	.77
MFESDM3 cm	3	101.26	18.73	.82	.75	.91	.77
MRAZGP n	1	9.67	4.89	.45			
MRASUS n	1	12.22	4.95	.43			
MRASUK n	1	18.29	8.95	.31			
MRAMPT n	1	13.01	3.55	.40			
MRAMPN n	1	13.97	2.92	.38			
MRAZAK n	1	21.39	5.69	.51			
MRACUC n	1	23.48	3.75	.42			
MRASTEP n	1	13.52	2.59	.45			
MRABPO n	1	16.58	6.27	.55			
MSAIVZ sec.	1	11.31	9.54	.35			
MSAUPP sec.	1	41.64	22.93	.30			
MSAIUZ sec.	1	30.24	20.65	.17			
MSAIVPZ sec.	1	23.13	16.97	.57			
MSAIZZ sec.	1	38.13	20.47	.56			
MSAIZS sec.	1	36.16	24.53	.32			
MSAIZC sec.	1	52.91	33.52	.40			
MSAIZU sec.	1	76.63	44.64	.29			
MSAIZN sec.	1	48.64	97.16	.37			

Number of repetition (items), mean value (X), standard deviation (SD), multiple correlation of each item with others (SMC), Cronbach index of generalisation of the common object of measurement re-scaled to anti-image metrics (Cronbach Alpha- α) and correlation coefficient of composite items with the common object of measurement (F1) and Kaiser – Rice measure of representative (MSA)

In this study we have applied only 5 composite tests for explosive body power due to children's age and their interest for measuring procedure as well as the number of tests in the battery and lack of required time for recovery between the repetitions. The correlations of tests (Table 3) are within 01. and .57 Higher number of tests applied have positive intercorrelations, especially the intercorrelations along the diagonal. Based on the measure of the tests representative (Kaiser – Rice measure; the main object of items of each test; .65- .85) as well as the above mentioned results related to other metric characteristics it could be concluded that the battery is suitable for preschool children and due to some of the tests which have to be modified it is necessary to test it on the on larger samples of pre-school children divided into several age groups (for example; 5, 6 and 7).

Conclusion

The applied battery of motor tests for body power had a good descriptive statistics. According to the analysis of the composite tests for explosive body power, and with the aim to influence on the real result in the first attempt it could be more effectively if children could try the task before the measuring procedure. Some of the tests which were applied in the study have to be modified.

This study is one step forward in the process of identifying the battery suitable for pre-school children. For further studies it is important to follow some guidelines that we mentioned in this paper with the aim to improve the whole measuring procedure on pre-school sample.

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METRIJSKE KARAKTERISTIKE BATERIJE TESTOVA TJELESNE SNAGE PRIMJERENE DJECI PREDŠKOLSKOG UZRASTA

Sažetak

Osnovni ciljevi ovog eksperimentalnog rada su usmjereni na primjenu nove baterije testova namijenjenih procjeni tjelesne snage djece predškolske dobi, te provjere primjerenosti baterije testova s obzirom na dob, sposobnosti i motorička znanja petogodišnjaka. Istraživanje je provedeno na uzorku od 180 djece (74, (41,11%) djevojčica i na 106 (58,88%) dječaka predškolske dobi, polaznika sportskog izvankurikularnog programa u vrtićima u Gradu Rijeka. Primijenjena je novokonstruirana baterija od 24 testa; 5 kompozitnih i jedan 1-itemski test za eksplozivnu snagu, 9 (1-itemskih) testova za procjenu dinamičke i 9 testova za procjenu statičke snage. Analizom rezultata su utvrđene dobre metrijske karakteristike primijenjene baterije testova, uz napomenu da je pojedine testove potrebno doraditi (osobito se to odnosi na testove statičke snage) te se predlaže primjena dorađene baterije na većem uzorku djece predškolske dobi i provjera primjerenosti u odnosu na dob (5, 6 i 7 godina).

Ključne riječi*: djeca predškolske dobi, nova baterija testova, tjelesna snaga*

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CANONICAL RELATIONS BETWEEN VARIABLES OF COORDINATION ABILITIES, VARIABLES OF MORPHOLOGICAL CHARACTERISTICS AND MOTOR ABILITIES OF BOYS AGED 11-12

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Original scientific paper

Abstract
For a sample of 125 boys, aged 11 ± 6 months, a system of 30 variables was applied, of which 6 criterion variables of coordination abilities, 12 predictor variables of morphological abilities and 12 predictor variables of motor abilities, in order to establish canonical relationships between systems of variables of coordination capabilities, the system of morphological and motor variables, in order to form rational procedures for optimal orientation and selection of sports, as well as planning and programming of educational and training content. The data were analyzed using canonical correlation analysis. By application of Bartlett's chi-square test (χ^2), between criterion system of variables of coordination abilities and predictor system of morphological variables two canonical correlations were obtained (the first Rc =.88 and the second Rc =.76), which were statistically significant at the level of p =.00. Between the criterion system of variables of coordination abilities and predictor system of motor variables two canonical correlations were also obtained (the first Rc=.87, and the second Rc=.51), which were statistically significant at the level of p=.00, or p=.04. The results showed that boys achieve better results in the coordination abilities because they have the right morphological characteristics (integral canonical factor of growth and development) and motor abilities (motor integral canonical factor), which were examined by the applied system of morphological and motor variables.

Key words: *coordination abilities, morphological characteristics, motor abilities, relations, boys*

Introduction

Within the group of problems of the total anthropological status of children, the problems belonging to the field of links between coordination abilities, morphological characteristics and other relevant motor abilities are scientifically and vitally significant not only due to the fact they have not been examined, but their coordination is the most complex and probably the most important motor abilities, especially regarding the majority of sports. Concretely, there are virtually no moving structure comprising one movement and without a strong influence of complex mechanisms for complex movement regulation. It primarily refers to the mechanisms which have been, in recent research (Gredelj, Metikoš, Hošek & Momirović, 1975), identified as mechanism for movement regulation, or in a narrower notion, mechanism for movement structuring. Although the more precise definitions cannot be found in scientific references, the term of coordination is often considered as fast performance of complex and various motor tasks in complicated and unpredictable situations (Malacko & Popović, 2001; Malacko & Rađo, 2004). Concerning this, it cannot be stated that only classical phenomenological approach to structure research and thus the term and definition of coordination is enough to induce the most favourable solutions. Therefore, another approach has emerged and its goal is to diminish, as much as possible, effects of the previous approach, but also to enable more profound and, what is more important, more systematic insight into the essence of the phenomenon of movement coordination.

This approach is widely known as functional approach originating from theoretical hypotheses of Bernstein (1947), Anochin (1970) and Chaidze (1970) and their numerous associates. In scientific references one may find the definition of coordination as an ability to efficiently solve complex motor problems in terms of motor intelligence and systems of intensive interactive links between cognitive and motor abilities (Malacko & Doder, 2008). Whereas in a motor situation one type of body directly hinders the realization of kinetic programme, the same body in another motor situation can be appropriate (Stanković & Malacko, 2008). In recent research most authors have carried out analyses of the problems of structuring morphological characteristics and motor abilities (Stojanović et al., 1975; Kurelić, Momirović, Stojanović, Šturm, Radojević & Viskić-Štalec, 1975), that is to say, identification of latent structures by which those spaces are defined. Almost equal attention is paid to analyzing the links between morphological characteristics and motor abilities (Malacko, 2005), and the smallest number of studies belongs to the field of motor coordination and its links with other segments of anthropological status (Hošek-Momirović, 1981). This study attempts to give contribution to the problem-solving of finding the most optimal morphological characteristics for certain coordinated moving structures, that is to say, of defining relatively constant relations between the system of coordinated moving structures and the system of some relevant motor abilities existing in most sports.

The aim

The aim of the research is to define statistically significant relations between the systems of criterion variables of coordination abilities along with the system of predicted morphological variables, and the system of variables of motor abilities with boys aged 11-12 in order to form procedures which are as rational as possible during the programme of sport orientation and selection on the one hand, and optimal planning, programming and implementing the control of efficiency and effectiveness of educational and training activities on the other hand.

Methods

A sample of respondents totals 125 boys aged 11-12. A sample of variables consists of 30 variables in total, out of which there are 6 criterion variables, 12 predictor variables of morphological characteristics and 12 predictor variables of motor abilities /*Coordination variables - body coordination*: PTJ - passing through and jumping over (sec), AGA - agility in the air, OCB - obstacle course backwards, S3B - slalom with three medicine balls, *leg-hand coordination* (sec): S2B - slalom by kicking two balls, HDR - hand dribbling;

Morphological variables - dimensions of the skeleton: BOH - body height (mm), SHW - houlder width, PGW - pelvis girdle, *body mass and volume (kg):* BOM - body mass, FOC - forearm circumference, UPC - upper arm circumference, THC - thigh circumference, CAC - calf circumference, WAC - waist circumference, *subcutaneous fatty tissue (mm):* UAS - upper arm skinfolds, SUS - subscapular skinfold, ABS - abdominal skinfold.

Motor variables - frequency of movement (repet.): HTA - hand tapping, FTA - foot tapping, FTW - foot tapping against the wall, *power (explosive strength):* SLJ - standing long jump, *power (explosive strength) (cm):* MTL - medicine ball throw from supine lying, 20R - 20m running from the standing start, *strength endurance (repet.):* ASB - all-out declined sit-ups off the bench, AHB - all-out hyperextension on the box, UCB - undergrip chin-ups on the bar, *flexibility (cm):* BFB - bent forward on the bench, SSR - straddle sit-and-reach, SCB - shoulder circumduction backwards with a stick/. For calculating the relations between the system of criterion variables of coordination abilities, predictor system of morphological variables and predictor system of motor variables, canonical correlative analysis has been applied. Testing of statistical significance of hypothesis on global links between two different systems of variables is conducted with the help of: λ - statistically significant characteristic roots, Rc - quotient of canonical correlation of statistically significant pairs of canonical factors, Rc^2 – squared canonical correlation, χ^2 – Bartlett's chi-square test and p – testing of statistical significance at the level .05 to .00 (p=.05-.00).

Results

Table 1: Crosscorelation between criterion variables of coordination abilities and predictor variables of morphological characteristics and predictor variables of motor abilities

Variables	PTJ	AGA	OCB	S3B	S2B	HDR
	Morphological variables					
BOH	.49**	.30**	.38**	.08	.15	.24**
SHW	.48**	.20*	.35**	.28**	.28**	.32**
PGW	.61**	.25**	.53**	.32**	.33**	.36**
BOM	.72**	.26**	.60**	.35**	.39**	.45**
FOC	.55**	.17	.43**	.32**	.35**	.33**
UPC	.65**	.24**	.54**	.36**	.37**	.41**
THC	.65**	.27**	.54**	.30**	.40**	.42**
CAC	.63**	.24**	.50**	.37**	.35**	.44**
WAC	.07	.78**	.16	.00	.04	.18*
UAS	.63**	.21*	.54**	.38**	.44**	.42**
SUS	.67**	.09	.59**	.38**	.39**	.43**
ABS	.69**	.25*	.60**	.39**	.42**	.43**
	λ	Rc	Rc^2	χ^2	p	
1	.05	.88	.79	329.5	.00*	
2	.27	.76	.58	149.9	.00*	
3	.65	.40	.16	47.77	.18	
4	.78	.35	.12	27.03	.46	
5	.90	.26	.07	11.42	.78	
6	.97	.16	.02	3.08	.87	
	Motor variables					
HTA	-.33**	-.08	-.35**	-.44**	-.26**	-.19*
FTA	-.40**	-.13	-.43**	-.45**	-.22*	-.31**
FTW	-.45**	-.20*	-.47**	-.38**	-.31**	-.39**
SLJ	-.58**	-.32**	-.61**	-.43**	-.38**	-.46**
MTL	-.06	-.23**	-.12	-.14	-.08	-.18*
20R	.62**	.28**	.59**	.40**	.53**	.52**
ASB	-.57**	-.38**	-.53**	-.37**	-.40**	-.58**
AHB	-.58**	-.30**	-.57**	-.50**	-.43**	-.55**
UCB	-.58**	-.42**	-.58**	-.46**	-.35**	-.55**
BFB	-.41**	-.11	-.29**	-.24**	-.34**	-.26**
SSR	-.34**	-.03	-.19*	-.18*	-.38**	-.25**
SCB	.44**	.11	.38**	.36**	.37**	.31**
	λ	Rc	Rc^2	χ^2	p	
1	.11	.87	.77	243.4	.00*	
2	.52	.51	.26	73.41	.04*	
3	.72	.42	.17	37.53	.58	
4	.87	.23	.05	15.07	.96	
5	.92	.21	.04	8.76	.92	
6	.97	.16	.02	3.13	.87	

Rc – canonical correlation, Rc^2 - canonical R - square, χ^2 - Bartlett's chi-square test, p - level of significance (* = < .05; ** = < .01)

From what can be seen in the cross-correlation between criterion system of coordination variables and predictor system of morphological variables and predictor system of motor variables (Table 1, Graph 1 and Graph 2), there are statistically significant correlation between variables. Between the system of criterion variables of coordination abilities and larger number of predictor morphological variables there are statistically significant correlations at the level .01 (**), then four variables at the level .05 (*), whereas there are no statistically significant correlations between body height (BOH) and slalom with three medicine balls (S3B), slalom by kicking two balls (S2B), waist circumference (WAC) on the one hand, and passing through and jumping over (PTJ), obstacle course backwards (OCB), slalom with three

medicine balls (S3B) and slalom by kicking two balls (S2B) as well as subscapular skinfold (SUS) and agility in the air (AGA) on the other hand. As far as motor abilities between the system of criterion variables of coordination abilities and larger number of motor variables of predictor system there are statistically significant correlations at the level .01 (**), and at the level .05 (*) in case of four variables, whereas there are no statistically significant correlations in case of the following variables: medicine ball throw from supine lying (MTL), passing through and jumping over (PTJ), obstacle course backwards (OCB), slalom with three medicine balls (S3B), slalom by kicking two balls (S2B), hand tapping (HTA), foot tapping (FTA), bent forward on the bench (BFB), straddle sit-and-reach (SSR), shoulder circumduction backwards with a stick (SCB) and agility in the air (AGA).

Table 2: Structure of canonical factors (Fc) of coordination abilities and morphological characteristics

Variables	Fc - 1	Fc - 2
Coordination variables		
PTJ	0.56	0.78
AGA	-0.68	0.70
OCB	0.36	0.74
S3B	0.32	0.36
S2B	0.33	0.35
HDR	0.20	0.56
Morphological variables		
BOH	0.11	0.67
SHW	0.20	0.62
PGW	0.27	0.77
BOM	0.35	0.88
FOC	0.30	0.64
UPC	0.32	0.80
THC	0.29	0.81
CAC	0.29	0.81
WAC	-0.68	0.67
UAS	0.34	0.75
SUS	0.49	0.71
ABS	0.35	0.84

Fc 1, 2 = canonical factors

With the help of Bartlett's chi-square test (χ^2=329.54, χ^2=149.86) the statistic significance of quotient of canonical correlation (Rc=.88, Rc=.76) has been assessed; this correlation explains linear combinations between sets of variables, that is to say, links between two different systems of variables – the system of coordination variables and system of morphological variables. Solving the characteristic equations of cross-correlation matrix, one can get the roots of these equations and squares (determination quotients) of canonical correlation (Rc^2 =.79, Rc^2 =.58), which explain mutual variance of variables from two sets of total variability of analyzed systems of variables. Consequently, one will identify two independent and statistically significant structures of canonical factors (p=.00, p=.00) within the system of coordination variables (the system of criterion variables) on the one hand and the system of morphological variables (the system of predictor variables) on the other hand.

Table 3: Structure of canonical factors (Fc) of coordination and motor abilities

Variables	Fc - 1	Fc - 2
Coordination variables		
PTJ	0.84	-0.14
AGA	0.42	-0.02
OCB	0.82	0.10
S3B	0.63	0.43
S2B	0.59	-0.54
HDR	0.70	-0.25
Motor variables		
HTA	-0.47	-0.34
FTA	-0.57	-0.40
FTW	-0.63	-0.09
SLJ	-0.79	-0.08
MTL	-0.22	-0.07
20R	0.81	-0.28
ASB	-0.81	0.14
AHB	-0.83	-0.03
UCB	-0.85	-0.14
BFB	-0.46	0.24
SSR	-0.36	0.44
SCB	0.55	-0.04

Fc 1, 2 = canonical factors

From what can be seen in the matrix of canonical factors of the variable of coordination abilities and variable of morphological characteristics (Table 2), there is a statistically significant correlation between all applied manifest variables of coordination abilities only in case of the second canonical factor so in the area of coordination abilities it may be interpreted as a canonical factor of integral coordination. In the same table there is a matrix of structure of canonical factors of morphological characteristics which shows that there is a high correlation among all applied manifest morphological variables and identified first canonical factor, except waist circumference (WAC). Regarding the fact that the structure of the first isolated canonical factor consists of almost all applied manifest variables of morphological characteristics, it can be interpreted as integral canonical factor of growth and development. Since the structure of the first canonical factor consists only of the variable waist circumference (WAC), it cannot be interpreted in the correct way. On the basis of obtained results within the matrix of canonical factors of coordination and motor abilities (Table 3), it can be noticed in the area of coordination abilities that there is a statistically significant correlation only between applied variables and first canonical factor so it may be interpreted as canonical factor of integral coordination. Bearing in mind the fact that the structure of the first isolated canonical factor is composed of all applied manifest variables of motor abilities, except the variable straddle sit-and-reach (SSR), it may be interpreted as canonical factor of motor abilities.

Discussion and conclusions

When interpreting the relations between canonical factors from two different anthropological areas, obtained by the application of canonical correlative analysis, logistic is performed in the way that a linear increase in the value of resulting vector of variables of canonical factor from the first area corresponds to proportionately linear increase in the value of resulting vector of variables of canonical factor from the second area, supposing that the correlation between two examined systems of variables in different areas is statistically significant. The same procedure is exercised in the inverse direction of relations – linear decrease in the value of results in a canonical factor of the first area corresponds proportionately to the linear decrease in the value of results in the first canonical factor of the second area. The relations between the second canonical factor in the system of criterion variables of coordination abilities, interpreted as canonical factor of integral coordination, and the first canonical factor in the system of variables of morphological characteristics, interpreted as integral canonical factor of growth and development, shows that boys achieve good results in the integral coordination if they have reduced values in all applied variables of morphological characteristics; and conversely, boys achieve poorer results in the integral coordination if they have increased values in all applied variables of morphological characteristics. This procedure is usually applied only in a given moment and under existing conditions because if there are dramatic changes in morphological characteristics (increase or decrease in fatty tissue, accepted or unaccepted increase of longitudinal skeleton, etc), they can become disturbing factor in achieving larger values in certain relevant motor abilities, especially in coordination abilities. Within immediate educational and/or training activity it means that certain specific (segment) motor ability must be adapted to morphological characteristics of individuals or a group because it is almost impossible to do it reversely since due to genetic limits morphological characteristics cannot be changed considerably or adapt to situations in sports activities. The relations between the first canonical factor from the system of variables of coordination abilities, interpreted as canonical factor of integral coordination, and the first canonical factor from the system of variables of motor abilities, interpreted as integral canonical factor of motor abilities, show that boys achieve good results in motor abilities of integral coordination thanks to increased level of all applied motor variables. In addition to all above-mentioned general statements, the results of research showed that the applied programme activities are well-balanced, which can mean that they are directed to the development of motor abilities that correlate with motor abilities of coordination and are considered the basis in teaching / training process of boys. Likewise training and programme activities were directed to the development of coordination abilities and they had a considerable impact on achieving better results in most motor abilities.

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KANONIČKE RELACIJE IZMEĐU VARIJABLI KOORDINACIJSKIH SPOSOBNOSTI, VARIJABLI MORFOLOŠKIH KARAKTERISTIKA I MOTORIČKIH SPOSOBNOSTI KOD DJEČAKA UZRASTA 11-12 GODINA

Sažetak

Na uzorku 125 dječaka, uzrasta 11 godina ± 6 mjeseci, bio je primjenjen sustav od 30 varijabli, od toga 6 kriterijskih varijabli koordinacijskih sposobnosti, 12 prediktorskih varijabli morfoloških karakteristika i 12 prediktorskih varijabli motoričkih sposobnosti, s ciljem utvrđivanja kanoničkih relacija između sustava varijabli koordinacijskih sposobnosti, sustava morfoloških varijabli i sustava motoričkih varijabli, radi formiranja racionalnih procedura za optimalnu sportsku orijentaciju i selekciju, kao i planiranje i programiranje edukacijskih i trenažnih sadržaja. Podaci su obrađeni primjenom kanoničke korelacijske analize. Primjenom Bartlettovog Hi-kvadrat testa (χ^2), između kriterijskog sustava varijabli koordinacijskih sposobnosti i prediktorskog sustava morfoloških varijabli dobivene su dvije kanoničke korelacije (prva Rc= .88, a druga Rc=.76), koje su statistički značajne na razini p=.00. Između kriterijskog sustava varijabli koordinacijskih sposobnosti i prediktorskog sustava motoričkih varijabli dobivene su također dvije kanoničke korelacije (prva Rc=.87, a druga Rc=.51), koje su statistički značajne na razini p=.00, odnosno p=.04. Istraživanje je pokazalo da dječaci bolje rezultate u koordinacijskim sposobnostima postižu jer posjeduju upravo one morfološke karakteristike (integralni kanonički faktor rasta i razvoja) i motoričke (integralni motorički kanonički faktor) sposobnosti koje su bile ispitivane putem primjenjenih sustava morfoloških i motoričkih varijabli.

Ključne riječi:*koordinacijske sposobnosti, morfološke karakteristike, motoričke sposobnosti, relacije, dječaci*

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CORRELATION BETWEEN THE CONATIVE CHARACTERISTICS AT TOP SENIOR BASKETBALL PLAYERS

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Original scientific paper

Abstract
Conative dimensions play a significant part in a basketball play. The aim of this study was to investigate the correlations between the conative dimensions and characteristics of Croatian elite male senior basketball players. We choose few relevant conative characteristics: hardiness, Big Five factor model, perceived group cohesion, multidimensional perfectionism in sport situations, one-dimensional perfectionism. We have examined the purposeful sample of 74 basketball players, who played in 9 teams of A-1 Croatian Men's Basketball League, with the corresponding measuring instruments. The main finding of this research is that there are statistically significant and positive correlations between some conative characteristics (perfectionism and hardiness, as same as between hardiness and Big Five personality characteristics). However, perceived group cohesion was not significantly associated with any of these constructs.

Key words*: psychological traits, basketball, association, cohesion*

Introduction

Basketball is a complex polystructural variable activity characteristic for its cyclic and acyclic motion types that are preceding the main goal of the game, shooting the ball into the basket, as well as preventing the opponent player to make a shot. The game itself is divided into three main stages: defense, attack and transition (Jukić, 1998). Basketball has complex demands that require a combination of individual skills, team plays, tactics, and motivational aspects (Trninić, Perica & Dizdar, 2001). During basketball game, a lot of constant changes of typical and atypical game situations take place, and a »critical« situation with great emotional pressure. So, basketball makes demands for specific energy mobilization, cooperation between players, and responsibility in critical game situations etc. The players must quickly perceive, analyze and adequately act or react in the given situations. Certainly, success in basketball depends mostly on the levels of specific basketball motor abilities and skills, but also on the particular psychological factors, like cognitive abilities and conative dimensions (Becker, 1981; Svoboda, 1993; Karalejić, & Jakovljević, 2008). Conative dimensions are manifest and latent structures which make a construct of human personality and are responsible for human behavior, they help to explain how knowledge and emotions are translated into behavior in human beings (Jakovljević, Karalejić, & Lazarević, 2010). Coaches and sport psychologists discus the specific psychological structure of an athlete's personality. It may be a special combination of personality dispositions which should represent good conditions for successful work, especially in the process of selection. One of the most important approaches in basketball training is the relationship between coaches and players.

Studies of psychological profiles and the personalities of athletes is present in many sports (Junge et al. 2000) and then in basketball as well (Svoboda 1993; Maddi & Hess, 1992). Svoboda (1993) has indicated a significant difference in personality characteristics between excellent (stars) and poor quality (feeble) basketball players. Conative dimensions play a significant part in a basketball player's actions/ reactions (Becker, 1981; Horga & Milanović 1983). These studies show the importance of conative dimensions for a basketball player's performance and successes. In our research we have chosen a few important conative characteristics and their inter-relations at the elite male senior basketball players in A1 Croatian Championship. These characteristics are: 1. The *Big Five Model* or the *Five-Factor Model* (FFM) is substantially descriptive, with the emphasis on the taxonomic aspect, that is, on the way in which personality can be divided into a smaller number of fundamental constructs. According to that theory, personality can be described by means of five factors: *extraversion*, *agreeableness*, *conscientiousness*, *emotional stability* and *intellect* (Pervin & John, 1997); 2. *Hardiness* is an individual differences variable that develops early in life and is reasonably stable over time, though amenable to change under certain conditions (Maddi & Kobasa, 1987). Hardy persons have a high sense of life and work commitment, greater sense of control, and are more open to change and challenges in life (Maddi, 1999). They tend to interpret stressful and painful experiences as a normal part of life, which is overall interesting and worthwhile. Maddi & Hess (1992) refer to the relation between personality hardiness and basketl performance; 3. *Perceived Group Cohesion* is described by Carron, Widmeyer & Brawley, (1985).

They developed the Group Environment Questionnaire (GEQ), which is based on a conceptual model in which cohesion is considered to be a result of four primary constructs: Individual Attractions to the Group-Task, which reflects a member's feelings about his or her personal involvement with the group's task; Individual Attractions to the Group-Social, a member's feelings about his or her personal social interactions with the group; Group Integration-Task, a member's perceptions of the similarity and unification of the group as a whole around its tasks and objectives; and Group Integration-Social, a member's perception of the similarity and unification of the group as a social unit; *4. Multidimensional Perfectionism in Sport (MPS)* is the perfectionism trait that is exposed only in a sport situations. It has four aspects: Personal Standards, Concern Over Mistakes, Perceived Parental Pressure and Perceived Coach Pressure. Dunn et al. (2006) administered three versions of the Hewitt-MPS. The original Hewitt-MPS was used as a global measure of perfectionism, with the remaining versions of the instrument modified to measure perfectionist tendencies in sport and academic settings, respectively. Results showed that male and female athletes had significantly higher perfectionism scores in the context of sport in comparison to general-life and school settings. Clearly, these results indicate that there may be merit in conceptualizing and measuring perfectionism in sport as a domain-specific construct; 5. *One-dimensional Perfectionism* is a concept made by Burns, and it describes generalized but negative perfectionism (Ivanov & Penezić, 2004).

The aim and methods

The aim of this study was to investigate the latent structure of conative dimensions of Croatian elite male senior basketball players. Consequently, the other goal of this research was to determine and to interpret the relationship between all the dimensions of all conative characteristics at basketball players that play in A-1 Croatian basketball league.

Method

Participants and procedure

Population from which the purposeful sample of participants was drawn represented by sport success top Croatian senior basketball players, who played in nine men's senior teams of A-1 Croatian Men's Basketball League in 2006/2007: «Cedevita», «Svjetlost», «Borik», «Kvarner», «Dubrava», «Dubrovnik», «Alkar», «Sibenik» and «Osijek». The average chronological age was 23. The final sample of participants (74 basketball players) was selected from the initial sample of 107 players. The criteria for selection of a player into the final sample of respondents was the number of minutes in play (minimum ten minutes per game), i.e. the number of games played (minimum eight games played in championship).

The players were examined between sixth and eighth round of A-1 league championship (from December 2006 until mid January 2007). We have done a correlative research design.

Variables

In Table 1 we show the main characteristics of the measuring instruments (number of items, estimation scales) for all the dimensions of chosen conative characteristics, with the reliabilities measured in the our research. We have found that all the instruments for measuring all conative dimensions have a satisfying reliability, except the one dimension of hardiness (commitment).

Data analysis

Standard descriptive statistics were applied: mean (M), standard deviation (SD), minimal (Min) and maximal (Max) values. To evaluate the latent structure of conative dimensions, a Principal Components analysis was used, with Varimax Rotation. We have used Pearson correlations for calculating intercorrelations between specific dimensions in each conative characteristics. We have used canonical correlations to measure the correlations between the sets of dimensions, that belong to each conative characteristic (i.e. between all the conative characteristics in general). Data processing was done in the statistical program Statistica.

Results and Discussion

Descriptive statistics

Table 2 provides the average values, standard deviations and data about the normality of the distributions for each variable, i.e. the dimensions of certain measuring instruments for the measurement of perfectionism, hardiness and perceived group cohesion. Of all the dimensions of mental strength (hardiness), our subjects have the highest values in averages of the dimensions commitment and control.

Of all the dimensions of Big Five personality traits, our subjects have a highest average value in agreeableness and conscientiousness, while the least value is found in extraversion. Of all the dimensions of the multidimensional perfectionism, our subjects have a highest average value in personal standards, while the least value is found in perceived parental pressure. Of all the dimensions of perceived group cohesion, players a highest average value in group integration in social terms, while other dimensions are equally emphasized.

Table 8 shows that significantly deviate from the normal distribution only two variables from the Short scale of hardiness: commitment and control (both with $p < 0.05$), while the results for the other psychological dimensions are normally distributed. Psychometric properties of the measuring instruments used to measure selected conative characteristics and perceived group cohesion can be considered as satisfactory, on average (data about reliability are presented in Table 1).

Table 1. Review of the conative characteristics, their dimensions and characteristics of the measuring instruments

Conative characteristics and instruments				
Characteristic	**Reliability** (Cronbach's α)	**Variables (scales)**	**Measuring Instruments**	**Number of items**
Hardiness	.45	Commitment	Short Hardiness Scale (Bartone, 1995, translated and adopted by Kardum, I.) – SHC *4-point Likert scale anchored at the extremes by `strongly disagree' (0) and `strongly agree' (3)*	5
	.52	Control		5
	.68	Challenge		5
Perfectionism	.69	One-dimensional Perfectionism	Burns's Perfectionism Scale (translated and adopted by Penezic, Ivanov, & Prorokovic, 1998) – BPS *5-point Likert scale anchored at the extremes by `strongly disagree' (1) and `strongly agree' (5)*	10
	.62	Personal Standards	Multidimensional Sport Perfectionism Scale (Dunn, Causgrove Dunn, & Syrotnik, 2002, translated and adopted by Sindik, J.) – MSSP *5-point Likert scale anchored at the extremes by `strongly disagree' (1) and `strongly agree' (5)*	7
	.77	Concern Over Mistakes		8
	.61	Perceived Parental Pressure		9
	.68	Perceived Coach Pressure		6
Big Five Personality Traits	.56	Extraversion	IPIP Big-Five Factor Markers 50 items (translated and adopted by Mlacic, B., 2002) – IPIP50 *5-point Likert scale anchored at the extremes by `strongly disagree' (1) and `strongly agree' (5)*	10
	.73	Agreeableness		10
	.71	Conscientiousness		10
	.65	Emotional Stability		10
	.68	Intellect		10
Perceived Group Cohesion	.55	Individual Attractions to the Group-Social	The Group Environment Questionnaire (Carron, Brawley & Widmeyer, 1985, translated and adopted by Sindik, J.) – GEQ *9-point Likert scale anchored at the extremes by `strongly disagree' (1) and `strongly agree' (9)*	5
	.66	Individual Attractions to the Group-Task		4
	.68	Group Integration-Social		4
	.68	Group Integration-Task		5
Total		17 variables	5 instruments	123 items

Table 4. Correlations between the dimensions of the set of conative characteristics and perceived group cohesion at elite senior basketball players in A-1 Croatian championship

Variable	COM	CON	CHA	PER	CMI	PAR	COA	BSP	IAT	IAS	GIS	GIT	EXT	AGR	COS	EMO	INT
COM	1	,33**	-,06	,11	-,03	,02	-,07	,02	,08	,09	,10	,11	,31**	,13	,27*	,37**	,15
CON		1	-,24*	,32**	,07	,06	,07	,25*	,15	,06	,11	,24*	,24*	,33**	,22	,15	,04
CHA			1	-,16	-,01	,03	-,07	-,14	,27	,10	,06	,07	,26*	,24*	-,19	,21	-,10
PER				1	,54**	,33**	,55**	,51**	-,17	-,26*	-,27*	-,32**	,01	-,005	-,01	-,19	-,12
CMI					1	,36**	,50**	,51**	-,32**	-,11	-,44**	-,31**	,05	,02	,10	-,15	-,02
PAR						1	,45**	,08	-,13	-,03	-,07	-,08	,04	-,08	-,05	-,39	,04
COA							1	,48**	-,27*	-,19	-,26*	-,32**	-,14	-,07	-,09	-,05	-,19
BSP								1	-,23*	-,20	-,29*	-,29*	-,01	-,04	-,12	-,26*	-,04
IAT									1	,40**	,56**	,60**	,08	,17	-,00	,08	-,08
IAS										1	,44**	,65**	,27*	,33**	,07	,23*	-,07
GIS											1	,60**	,16	,14	-,02	,28*	-,07
GIT												1	,25*	,36**	,05	,24*	-,17
EXT													1	,32**	,10	,27*	,17
AGR														1	,29*	,21	,12
COS															1	,34**	,27*
EMO																1	,08
INT																	1

** Correlation is significant at the 0.05 level; ** Correlation is significant at the 0.01 level (2-tailed).*
IAS – I; Group Integration-Social; GIT - Group Integration-Task; PER -Personal Standards, CMI - Concern Over Mistakes; PAR - Perceived Parental Pressure; COA - Perceived Coach Pressure; COM – Commitment; CON - Control; CHA – Challenge; BSP – One-dimensional Perfectionism; EXT – Extraversion; AGR – Agreeableness; COS - Conscientiousness; EMO - Emotional Stability; INT - Intellect

Table 2. Descriptive statistics for all the dimensions of all measuring instruments

Variables	Mean	Min	Max	Range	Std.D.	max D	p
Extraversion	33,05	22	44	22	4,51	0,09	> .20
Agreeableness	37,12	23	50	27	4,97	0,09	> .20
Conscientiousness	37,14	23	50	27	5,36	0,09	> .20
Emotional Stability	33,76	23	45	22	5,16	0,07	> .20
Intellect	34,93	25	46	21	4,68	0,09	> .20
Individual Attractions to the Group-Social	33,18	12	45	33	8,16	0,11	> .20
Individual Attractions to the Group-Task	26,46	6	36	30	7,50	0,11	> .20
Group Integration-Social	28,47	8	36	28	6,28	0,15	> .10
Group Integration-Task	32,36	14	45	31	7,63	0,09	> .20
Personal Standards	22,15	9	35	26	5,40	0,09	> .20
Concern Over Mistakes	18,89	8	35	27	6,07	0,10	> .20
Perceived Parental Pressure	16,47	9	28	19	5,09	0,15	> .10
Perceived Coach Pressure	15,51	6	25	19	4,62	0,10	> .20
One-dimensional Perfectionism	33,23	18	46	28	6,07	0,09	> .20
Commitment	12,07	6	15	9	1,60	**0,06**	**< .05**
Control	11,04	6	15	9	1,92	**0,16**	**< .05**
Challenge	7,42	0	15	15	3,38	0,09	> .20

Table 3. Canonical correlations between the sets of dimensions of the set of conative characteristics and perceived group cohesion at elite senior basketball players in A-1 Croatian championship

Characteristic	IPIP50	SHS	MSSP,	GEQ
GEQ	.35	.32	.32	1
MSSP, BPS	.43	.44*	1	
SHS	.64**	1		
IPIP50	1			

* Correlation is significant at the 0.05 level; ** Correlation is significant at the 0.01 level (2-tailed). IPIP50 - IPIP Big-Five Factor Markers 50 items; SHS - Short Hardiness Scale; MSSP - Multidimensional Sport Perfectionism Scale; BSP - Burns's Perfectionism Scale; GEQ - Group Environment Questionnaire

In the canonical correlation analysis, in Table 3 we can see the correlation matrix for the set of the conative characteristics and perceived group cohesion at the senior basketball players that play in A-1 Croatian men's basketball league. We have found two from possible six statistically significant canonical correlations. Both were middle-sized, and they are found between: Short Hardiness Scale and Perfectionism (one-dimensional and multidimensional), and Short Hardiness Scale and Big-Five Factor Markers. Consequently, we can conclude that personality characteristics are quite better correlated between themselves, than with the aspects of group (team) function (group cohesion). In Table 4 we can see the correlation matrix for the set variables (dimensions) of the conative characteristics and perceived cohesion at the senior basketball players that play in A-1 Croatian men's basketball league. We have found 28 (of theoretically possible 72), by a majority, low or medium-sized but statistically significant correlations.

The greatest number of significant correlations with other variables have the variables: personal standards (from Questionnaire of multidimensional perfectionism in sport situations - MSSP). Characteristic group integration in terms of task (from the GEQ, i.e. Group environment questionnaire) also shows 8 significant correlations, positive with all other scales of GEQ, and negative with a three scales of the MSSP. Scales from the Short hardiness scale (SHS) are mutually at least substantially correlated with other scales from the other instruments. It is likely that SHS measures very different aspects of the hardiness. The intercorrelations are the lowest between the dimensions of Big Five personality characteristics, what we expected, because of 'nature' of this personality concept. Among the four dimensions of perceived group cohesion were found positive and moderately high correlations, which can hypothetically be interpreted at least three ways. Namely, the 'logical' is to expect that the construct of perceived group cohesion is unique characteristic, subsequently its dimensions must be significantly interrelated. The results may be a reflection of the real relationship between different dimensions of the questionnaire (1). On the other hand, it is possible that there is a halo-effect in subjects' responding to the items of the questionnaire (2). In addition to the 'traditional' interpretation of the halo-effect as a tendency that assessment on a one item implies estimates on the other items, the possible impact on a responses can have a bias ('personal desirability' of the responses). Basketball player who tries to be a loyal member of the team, tends to prefer the same goals as (he thinks) other members of the team. He can also imply that he 'must' have good social relationships with other teammates and with the team as a whole. It can also affect the high positive correlations between the different dimensions of perceived group cohesion.

A third potential interpretation is very similar to second: it is possible that in addition to 'personally desirable' answers, subjects also tend to give 'socially desirable' responses, regardless of the examiner's guaranteed 'anonymity' of the data (3).Thus, respondents may not only want to present themselves as a consistent within their own belief system (as in the case of halo-effect), but they might like to meet the expectations and assumptions of others (teammates and coaches). An individual tends to be loyal member of the group, in the fulfillment the task of the group, but also in group's specific attitudes, socio-emotional relationships, etc. Correlations between the dimensions in the Multidimensional perfectionism in sport situations, are statistically significant, positive and moderately high. Correlations between the results in three scales, Short hardiness scale are low and mostly statistically significant, but not always positive. Negative and significant correlation is found between the challenge and control, which is an unexpected result, if we consider the nature of these dimensions.

According to this data, we can assume that in our sample we found some complex construct of hardiness, with significantly different dimensions than in foreign studies (Barton et al., 1990; Cassidy, 2000; Callahan, 2000). Probably the cultural hypothesis best way to interpret these results obtained. It is possible that the attitudes and consequent behaviors that describe the dimension of the challenge is not a desirable pattern of behavior in our country, while the control is desirable attitude. On the other hand, it is possible that our sample respond following a presumed relationship between the behaviors that describe the dimensions of control and commitment that is complementary. Maybe in our culture the aspiration 'to want to have control' over a situation, 'means' only reduced risk in aspirations and being sustained seeking new solutions for a problem. So, maybe in our sample greater control 'means' less challenge. In further tables we explained significant canonical correlations. Table 5 shows that in the set of variables of perfectionism, the highest correlation values with the first canonical root, have dimensions concern over mistakes and perceived coach pressure, while in the set of hardiness variables, maximal correlations with the first canonical root have the dimensions of commitment and challenge. All significant correlations with the first canonical root are positive.

Table 5. Canonical correlation analysis between the dimensions of perfectionism and hardiness at basketball players

Variables	Correlations with 1. canonical root
Personal Standards	0,57
Concern Over Mistakes	0,81
Perceived Parental Pressure	0,24
Perceived Coach Pressure	0,75
One-dimensional Perfectionism	-0,05
Commitment	0,79
Control	0,32
Challenge	0,53
Canonical R	0,43
Covariance R^2	19 %
Variance perfectionism	32 %
Variance hardiness	34 %

Table 6 shows that in the set of variables of Big Five personality factors, the highest correlation values with the first canonical root, have dimensions extraversion, emotional stability and agreeableness.

While in the set of hardiness variables, maximal correlations with the first canonical root have all three dimensions. All significant correlations with the first canonical root are positive.

Table 6. Canonical correlation analysis between the dimensions of Big Five personality characteristics and hardiness at basketball players

Variables	Correlations with 1. canonical root	Correlations with 2. canonical root
Extraversion	0,76	0,01
Agreeableness	0,64	-0,34
Conscientiousness	0,28	0,72
Emotional Stability	0,73	0,34
Intellect	0,12	0,50
Commitment	0,69	0,72
Control	0,48	0,01
Challenge	0,55	-0,61
Canonical R	0,64	0,47
Covariance R^2	41 %	22 %
Variance Big Five	33.6 %	29.9 %
Variance hardiness	32.2 %	19.9 %

The main finding of this research is that there are statistically significant and positive relationship between some conative characteristics (perfectionism and hardiness, as same as between hardiness and Big Five personality characteristics). However, perceived group cohesion was not significantly associated with any of these constructs. The basic reason for this result may be just the fact that some personality traits (e.g. perfectionism and mental toughness) are more interrelated than the perception of the quality of group cohesion in the basketball team. Namely, both characteristics contribute in coping with stress in crisis (competitive) situations, the However, it may have different interpretations. The small number of participants can be the main disadvantage of the research, but small number of elite basketball players is the real limitation in this direction.

Conclusion

The main finding of this research is that there are statistically significant and positive correlations between some conative characteristics (perfectionism and mental toughness, as same as between hardiness and Big Five personality characteristics). However, perceived group cohesion was not significantly associated with any of these constructs.

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POVEZANOST IZMEĐU KONATIVNIH KARAKERISTIKA KOD VRHUNSKIH SENIORSKIH KOŠARKAŠA

Sažetak

Konativne dimenzije igraju značajnu ulogu u košarkaškoj igri. Cilj ovog rada bio je istražiti povezanosti između konativnih dimenzija i karakteristika vrhunskih hrvatskih seniorskih košarkaša. Izabrali smo nekoliko relevantnih konativnih karakteristika: mentalnu čvrstoću, Velikih Pet osobina ličnosti, percipiranu grupnu koheziju, višedimenzionalni perfekcionizam u sportskim situacijama, jednodimenzionalni perfekcionizam. Ispitali smo namjerni uzorak od 74 košarkaša, koji su igrali u 9 momčadi A-1 hrvatske košarkaške lige, odgovarajućim mjernim instrumentima. Glavni nalaz ovog istraživanja je da postoji statistički značajna i pozitivna korelacija između nekih konativnih karakteristika (perfekcionizma i mentalne čvrstoće, jednako kao i mentalne čvrstoće i Velikih Pet Five osobina ličnosti). Međutim, percipirana grupna kohezija nije bila značajno povezana niti s jednim od preostalih konstrukata.

Ključne riječi*: psihološke osobine, košarka, povezanost, kohezija*

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MOTOR LEARNING WITHOUT EXTERNAL FEEDBACK WHEN TESTING MOTOR COORDINATION

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Abstract
The purpose of this study was to find out whether tests appropriate for assessment of motor response and speed of motor learning are those in which items differ in structure or those in which the same movement is repeated several times. A sample of 172 male students (mean age was 19 years; SD=2.11) performed coordination tasks, each consisting of three different movements. Data were interpreted as showing that motor learning contributed to maintaining consistency and accuracy of performance. This is due to the coordination of the whole body and the speed of motor learning. The results of tests were affected by the speed of motor learning and the development of motor programs that are closely linked to complex motor structures as well as to the familiarization with the test.

Key words*: motor learning, testing, motor coordination*

Introduction

Researchers of motor skills have long attempted to define the mechanism for structuring of movement called coordination which involves efficiency of performing complex motor movements and the speed with which some people adopt new movement structures of varying complexity. In other words, the speed of forming one's own motor programs is questioned. This is why Metikoš and Hošek (1972) assessed the factor structure of several coordination tests, but did not find a single general factor; however they did prove the existence of several factors of coordination. Fleischman (1964) divided motor abilities into perceptual motor abilities (Schmidt & Wrisberg, 2000) and physical implementation abilities (Schmidt & Wrisberg, 2000). Busch and Strauss (2005) stated that the concept of coordination is based on quantitative models such as the factor analysis which merely assumes that a person possesses the same number of capabilities as the number of dimensions to be analyzed. This has presented a substantial problem in research on motor learning. Keele and Hawkins (1982), Keele et al. (1987) found general factors of coordination such as the speed of movement (movement rate), motor timing, perceptual timing, and force control. Keele's most important contribution was identification of the constant level of solving an individual's task. He suggested a general factor, called time-keeping. Coordination is closely connected with the speed of motor learning, which refers to the use of concrete skills exercise (Schmidt, 1988), a series of internal processes associated with practice or experience that leads to a relatively permanent improvement in performance (Winstein, 1991; Lee et al., 1991), as well as the adoption of complex motion models suitable for performing various tasks and their use in various situations.

(Wolpert et al., 2001). Research in the field of motor learning is mainly focused on providing feedback in terms of the knowledge of results or knowledge of performance. Winstein (1991) stated that the internal feedback includes visual kinaesthetic, cutaneous, vestibular, and auditory signals, while the external feedback is built on the internal one. The internal feedback motivates an individual to perform, while the external feedback informs about errors. Wolpert et al. (2001) warned that the internal sensory feedback from one action is not only necessary to evaluate that action but it also initiates a subsequent action. The authors De Oliveira et al. (2008) generally agree that, when learning a new motor movement, it is not desirable to provide a high frequency of knowledge of results. In a study of complex motor movements De Oliveira et al. (2008) found that participants given reduced knowledge of results were more actively involved in finding associated internal feedback to detect and correct errors. Sullivan et al. (2008) also examined knowledge of results frequency while training and retention of motor information. The information in a new motor task on a previously acquired and formed motor program has a significant role in improving performance. This phenomenon is especially pronounced in the practice of structurally similar tasks. Fleischman and Mumford (1989) researched how individual differences in abilities affect the adoption of motor skills at different levels using the causal model which assumes that performance on the first level causes the quality of performance on the second and the third level. The problem of contextual interference is dealt with by many authors. Thus Lee et al. (1991) state that it relates to engaging in a situation in which one activity results in a successful performance in other activities thus improving the learning process.

Resolving problems plays an important role in the development of skills. Brady (2008) explained that the phenomenon of contextual interference refers to the relatively consistent findings in the performance of several related tasks in random order. This results in poorer performance in the stage of adoption, but improves retention and transfer of information compared with the blocked or repeated practice. Many authors have also studied the impact of practice on the complex coordination ability. Busch et al. (2005) explored the qualitative differences in the performance of coordination tasks. Similar results were obtained by Entyre and Pointdexter (1995) on a specific task, balance being considered as coordination ability. They studied the performance after different intensity of practice, and the impact of the warm-up decrement and reminder reminiscence on the performance. Subjects learned the task during the first session of training, and showed improved performance from the 1st to the 5th or 10th trial. Vera et al. (2008) tried to analyze the difference between groups engaged in complex coordination tasks, with repeated practice, under high or low levels of contextual interference. The results at a later stage yielded better results than during the phase of acquisition. De Oliveira et al. (2009) used simple and complex motor tasks to investigate the hypothesis that the complex motor movements require high frequency of knowledge of results. The primary objective of this study was to find whether appropriate tests for the assessment of motor response and speed of motor learning are the tests in which the items are different in structure or the tests in which the same movement is repeated several times. The secondary aim of this study was to analyze the latent structure of some tests to assess the speed of motor learning. The reason is that larger tests with different item structure constantly face the subject with a new movement which reduces the impact of motor learning during the performance test. Some tests introduced by Momirović et al. (1975.) included a number of movement structures aiming to show the differences between people, because the same movements can be manifested in different ways. The participants were expected to quickly learn and perform movements in an optimal manner with minimal discrepancies. For the purpose of this study the Jumping while Squatting test was used for the first time. It is a very demanding test because it involves moving the entire body in space, i.e. the coordination of the whole body.

Methods

Participants

Respondents were 172 first-year male students of the Faculty of Kinesiology, University of Zagreb (mean age was 19 years; SD=2.11), who volunteered to participate in the study.

Measurements

The authors decided to use complex tests with different items, where every item is structurally more complex than the previous one. This is one way to reduce the effect of learning on the test results. The number of repetitions determined for the task adaptation is an indicator of the speed of motor learning. For this survey, three multiple-item tests were used in the area of coordination. Each task consisted of three logically related parts. These were: jumping over the stick (JUMSTI): 1 – jumping over the stick with both feet forward while holding the stick with both hands in front of the body, 2 – jumping backwards over the stick with both feet, while holding the stick behind the body, 3 – jumping over the stick with both feet forward and backward; jumping over the leg (JUMLEG): - 1 – jumping over the left leg with the right one while the participant holds his left foot with his right hand; after the jump the participant must return to the initial position to complete the task, 2 – jumping over the left leg four times in a row, while holding the left foot and without interrupting the rhythm, jumping over the left leg as in the first task, 3 – jumping over the left leg backwards, but from the final position in the second task: jumping while squatting (JUMSQU): JUMSQUA - three consecutive jumps forward while in the squatting position and holding the top of the feet; the hands must be in contact with the feet, JUMSQUB – jumping from the squatting position with both feet and making a full circle to the left; the number of jumps is not important, but the return to the original position in the proper way is, JUMSQUC - similar to the previous task, but this time turn is to the right (full round of jumps with both feet and in the squatting position.

Procedure

The tests presented three coordinating complex movements; each movement involved of simple to complex movement. The task required successful execution of a set of tests. For each test the participants had 10 trials to achieve successful performance, after which they then executed the next, more complex task. No external feedback as knowledge of results and knowledge of performance was given. Participants had a maximum of 10 trials for each task, and the score was the number of trials necessary to execute a task. If a participant failed to perform the task in 10 trials, the score was 0.

Statistical Analysis

Data processing was done with the statistical package SPSS, Version 11.5 for Microsoft Windows. The arithmetic mean, standard deviation, minimum and maximum score, and Pearson correlation coefficient were calculated. A factor analysis was applied to the component model, a significant number of factors was determined by the Kaiser criterion and diamond rotation, yielding the optimal factor structure.

Results

The test items were constructed in such a way that the first item had the simplest structure and every subsequent one a more complex structure.

Table 1 - Basic statistical parameters

Variables	Mean	Min	Max	SD
JUMSTI1	2.09	1.00	10.00	2.18
JUMSTI2	4.08	1.00	10.00	3.46
JUMSTI3	3.81	1.00	10.00	3.40
JUMLEG1	5.53	1.00	10.00	3.77
JUMLEG2	8.84	1.00	10.00	2.52
JUMLEG3	8.56	1.00	10.00	2.96
JUMSQUA	1.75	1.00	10.00	1.79
JUMSQUB	3.13	1.00	10.00	2.82
JUMSQUC	4.06	1.00	10.00	3.47

The participants mastered the items of the first and third tests with greatest ease (JUMSTI1; JUMSQUA, see Table 1), but they engaged in more trials when mastering the second and third test items (JUMLEG).

Table 2 - Correlation Matrix

Variables	jst1	jst2	jst3	jlg1	jlg2	jlg3	jsqa	jsqb	jsqc
JUMSTI1	1.0	.53	.59	.28	.16	.21	.33	.29	.11
JUMSTI2	.53	1.0	.71	.35	.15	.23	.25	.28	.20
JUMSTI3	.59	.71	1.0	.40	.12	.21	.21	.23	.20
JUMLEG1	.28	.35	.40	1.0	.33	.40	.11	.31	.23
JUMLEG2	.16	.15	.12	.33	1.0	.62	.09	.19	.04
JUMLEG3	.21	.23	.21	.40	.62	1.0	.12	.22	.12
JUMSQUA	.33	.25	.21	.11	.09	.12	1.0	.42	.23
JUMSQUB	.29	.28	.23	.31	.19	.22	.42	1.0	.46
JUMSQUC	.11	.20	.20	.23	.04	.12	.23	.46	1.0

The matrix in Table 2 shows correlations among the test items are statistically significant. It is also evident that the highest correlation is between the 2nd and 3rd items within each test, JUMSTI2 and JUMSTI3 r = .71, JUMLEG2 and JUMLEG3 r = .62 and JUMSQU2 and JUMSQU3 r = .46. Although the other obtained correlations are statistically significant, it is evident that the correlations between the items in a single test are higher than the correlations among items of different tests when assessing motor learning. Factor analysis yielded three factors (their eigenvalues being greater than 1) which explained 66.67% of the variance (Table 3).

Table 3 Eigenvalues

Eigenvalues	% total Variance	Cumulative Eigenvalues	Cumul. %
3.28	36.44	3.28	36.44
1.45	16.14	4.73	52.57
1.27	14.10	6.00	66.67

Table 4 Correlations of test items with the first principal component

Variables	Factor 1
JUMSTI1	.69
JUMSTI2	.74
JUMSTI3	.74
JUMLEG1	.64
JUMLEG2	.46
JUMLEG3	.55
JUMSQUA	.48
JUMSQUB	.61
JUMSQUC	.43

The position of variables in the first principal component (Table 4) shows a high correlation of test items with the main component despite the fact that the 2nd and 3rd items of the first test have the highest loadings (JUMSTI2 and JUMSTI3 r = .74) and the correlations decrease with the complexity of motion (JUMSQUA1 r = .48 and r = .43 JUMSQUA2). As is evident from Table 5, the first factor is mostly explained by the following items: JUMSTI3, JUMSTI2 and JUMSTI1. The second factor is also explained by the second test items in the same order: JUMLEG3, JUMLEG2 and JUMLEG1. The third factor is defined mostly by the second item (JUMSQUA), then the third (JUMSQUC) and in the end the first item test (JUMSQUA).

Table 5 The factors structure matrix

	Factor		
Variables	1	2	3
JUMSTI1	.61	.28	.42
JUMSTI2	.70	.31	.44
JUMSTI3	.73	.30	.43
JUMLEG1	.43	.45	.37
JUMLEG2	.21	.58	.21
JUMLEG3	.29	.61	.28
JUMSQUA	.30	.16	.42
JUMSQUB	.36	.30	.56
JUMSQUC	.25	.16	.44

Discussion

The larger correlations of items of each test, applied to assess coordination, rather than among items of different tests (Table 2) suggested the existence of the effect of motor learning. The results in the second item were affected by the motor experience from the first item, while the results in the last third item were affected by the motor experience of the previous two items. This effect aims at reducing the use of different items of the same test. Based on these correlation coefficients, it can be concluded that in order to estimate the speed of motor learning it is justified to repeat a complex motor task, but via a set of three different motor tasks. The correlations among items in reality are even greater because we defined the manner of carrying out tests in order to estimate the speed of motor learning, reduce the variance tests, and limit the number of repetitions available to test the performance of every item at the 10th repetition. The first factor was explained by the items of the first test, i.e. to the largest extent by the most complex item (JUMSTI3, r = .73), and then the less complex test items. The same situation occurred with the second factor that was explained by the items of the second test, where the most complex item had the most significant contribution (JUMLEG3, r = .62), followed by the less complex motions. A similar situation occurred with the third factor, although the second item (JUMSQUA, r = .56) had the highest loading, followed by the third and finally the first item, which was also the simplest. Most variance in explaining the space of coordination refers to the first test, which is the most familiar test to the study group: in addition to the

participants' coordination, it demands explosive strength and flexibility. The second test proved to be the most demanding one, requiring intensive information processing besides coordination and strength. The third test was the simplest in the sense of coordination, but it also demanded motor learning for its quality performance. The results indicate that is represented by a factor that has a high correlation with three items of the same test composed of contextually similar movements. The obtained results thus indicate that the influence of motor learning contributes to maintaining the consistency and accuracy of task performance regardless of their complexity and diversity. Although the participants did not receive any external feedback, the results were highly correlated in each item. It is obvious that the internal feedback allows the participants more quality information on knowledge of results, allowing them to increase cognitive effort and process information from visual sources and proprioceptors. This helps them create a picture of their movement and allows error detection and performance improvement (Sullivan et al. 2008). Such information processing leads to an individual's perception of the quality of knowledge of performance and, accordingly, to the successful realization of the tasks mentioned. Patterson and Carter (2010) also established the improved performance in the transfer and retention phase in conditions when participants have estimated when they needed a knowlege of results. They also generalized learning strategy during the adoption of complex motor tasks. Contextual interference plays an important role in the task (Brady 2008, Vera et al. 2008). It is assumed that the participants in the learning process use the information from the previously formed motor program, although these tasks are not the same, and the next task builds upon the previously acquired one. A similar pattern was shown in the studies by Malsovat et al. (2004), which confirmed that learning yields better results when exercising in the conditions of high interference than in the conditions of low interference. Schmidt (1975) and Lee et al. (1991) suggested that an increase in the complexity of tasks imposed on a novice causes an interference with the previous skills and makes the novice run variations of movement thus improving motor learning. This was also confirmed in the study by Fleischman and Mumford (1998). Thus the previously derived motor movements in short-term memory create a motor program allowing subjects to perform complex motor movements. Coordination as a motor ability is part of motor learning, but in case of the analysis in this paper the speed of motor learning and quality of task performance can be partly attributed both to the fact that the participants in this analysis had above average motor abilities due to the fact that they were physical education students and to their daily physical activity regimen. For these reasons, the results of such studies carried out on average population would be indirectly affected by the explosive force and conative personality traits, and the fear of performance, caused by the very unusual and very demanding structure of movement in tasks. Our results confirmed the research by Vera et al. (2008) who pointed out that participants with better motor skills can adapt to high contextual interference more easily than the participants with lower motor abilities. Moreover, Entyre and Pointdexter (1995) warn that the reason for the differences between the groups obtained in their research in which they used a balance task may be the fact that the group with a better score consisted mostly of athletes. Since no coordination tests or motor learning tests with a clear factor structure could be found, complex tests with different items were introduced, where each following item is structurally more complex than the previous one. This is one way to reduce the effect of learning on the results of the test. The number of repetitions per task is an indicator of the speed of motor learning. During the speed of motor learning research the subjects must be given complex tests that they take for the first time and where a pre-motor experience will not affect the result of the test. The jumping while squatting test was used for the first time for the purposes of this study.

Conclusion

Research on coordination and motor learning is more and more frequent and it aims to identify the cognitive abilities of information processing and to analyze the appropriateness of tests that are used to assess the quality of human motor skills. The general factor of coordination, among other things, depends on how fast people can form their own motor programs. Since coordination consists of the speed of motor learning and the reorganization of stereotypes, this study aimed at determining the role of motor learning during the performance of different motor structures in order to assess coordination. The results of tests that evaluate the ability via the performance of complex motor movements are affected by the speed of motor learning and the formation of motor programs that serve as a basis to more complex motor structures on the one hand, and by the familiarization with the test on the other. The jumping while squatting test, which was used in this study, proved to be a quality means of assessing the speed of motor learning. The factor of coordination of the whole body in space had the largest impact on the results of motor learning tests.

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MOTORIČKO UČENJE BEZ VANJSKOG FEED-BACKA U TESTIRANJU MOTORIČKE KOORDINACIJE

Sažetak
Svrha ovog istraživanja je bila utvrđivanje jesu li odgovarajući testovi za procjenu motoričkih odgovora i brzine motoričkog učenja oni kod kojih se čestice razlikuju u strukturi ili oni kod kojih se isto gibanje ponavlja nekoliko puta. Uzorak od 172 muška studenta (prosječnog uzrasta 19 godina, SD =2.11) izvodio je zadaće koordinacije, od kojih se svaka sastojala od tri različita gibanja. Podaci su interpretirani, kako se vidi, na način da motoričko učenje doprinosi očuvanju konzistencije i točnosti izvođenja. Ovo je iz razloga koordinacije cijelog tijela i brzine motoričkog učenja. Rezultati testova su bili pod utjecajem brzine motoričkog učenja i razvoja motoričkih programa koji su blisko povezani s kompleksnim motoričkim strukturama baš kao i poznatošću testovnih zadataka.

Ključne riječi*: motoričko učenja, testiranje, motorička koordinacija*

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ANALYSIS OF CERTAIN INDICATORS OF THE LOAD IN THE PLAY OF EXTERNAL ATTACKER IN TODAY'S WATER POLO

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Abstract
On the base of the objective measuring on the representative sample of entities and analyze of the central and dispersive parameters of all registrated and derived indicators is realized the first aim set up in this research. Determined are the basically parameters of the load in the play of the external attacker defined by different types and quantities of the movements trough different intensities, frequencies and durations, as well in horizontal therefore in vertical phase of the game. For the purposes of perceived deviations from the normal distributions for multivariate analysis it was not possible applied all of measured variables. The set of indicators, constructed for data collecting, according the given results, can be recommended for using in favor of registration and analysis the different aspects of the load of any player in water polo, what gives scientifically importance of this work. Practical importance of this work is in the possibility for direct applications of given results to the sport practice, planning, programming, selection and specialization for a external attacker role in water polo.

Key words: *water-polo, external attacker, load*

Introduction

Water polo, as an activity, belongs in the category of polystructural complex motions. Motions, in all of sports activities, is possible observe and analyzed from two basic standpoints. Energetically standpoint, which analyze quantity of movements, intensities and duration, as well informaticaly, that analyzed techniques, tactics, strategies and theoretical acquirements of the players. Substantial, both, components always are present together and are divisible in the real conditions of the game, but their mutual relationships are different in different situations. Either training must start with information's about two essential components: Aim of these changes and Characteristics of those we want to change. How this two information would be served for programming of training, they must be explicitly defined to the objective characteristics of those which we changes. Practice in today's pedagogy is in contrast with these principles. Methods and modalities of the work applied in training is possible to divide into: Situational (situational training) and Partial (accessory training). For either type of training, on the base of objective analysis, it is necessary determinate over cover coefficients that are solitary condition for the regular training construction. Regarding task, and their roles in team, this relation varies, what consequently means different trainings for different positions and roles in the game (Lozovina,V. 1984., Lozovina,V. 1995.). In the structure of the game 35% of the time water polo player spends in horizontal phase (all swimming's in all intensities' during the game) as well as 65% in vertical phase (vertical position organized by leg activity) solved technical and tactical tasks (Lozovina, V., 1984). Water polo plays 6 players in the field and goal-keeper.

Typical for water polo game is hers characteristically play course. After attempt, but unrealized, contra attack, it is usual to organize positional attack to find a chance for realization. In this situation one player takes a position on 2-3 m in front of the rival's goal, half left or right regarding the center of the goal. Two wings take a position sideways 3-4 m from goal-out line, 3m away from goalpost. Their dominant role is to transfer the ball to center forward, as well as prevent the contra attack of rival's after ball possession losing. Next tree players are attackers from second line (external attackers) that individually or mutually by swimming tray to create space advantage for receive, pass the ball or shoot on rival's goal.

The total activity of the guard during the international championships matches in the first division of the Adriatic water polo league 2008/09 has been taken to register. Scientific investigation, identical to this, have had been performed by author Lozovina at all. in 2000. against the matches of Croatian I. Water polo league, according old water polo rules, in that time existing, in favor of duration of the game was 4X9 min. New rules significantly change the play. It is to believe that the parameters which have defined the play of the guard in 2000. in today's water polo look quite differently. This sense set forward this research.

Preliminary investigations

Authors Lozovina and Pavičić (1985. and 2000.) establish methodology for estimation of vertical and horizontal component in the game of water polo.

With a similar problem in the sense of the modeling of activity characteristics' of water polo players in vertical phase of the game during the play have be involved in authors Bratuša, Z., Matković, I. i Dopsaj, M. (2002. i 2003.). Lozovina and Pavičić designate the model for analysis of the load in situational conditions regarding intensities, frequencies and time spent in the game as determinant of a load equivalent in the game (Lozovina at all 2002.,2003.,2004.,2006.). Authors and associates have been elaborated and published all fife position (role in the game).

In article „Analysis of indicators of load during the game in the activity of the center in water polo", authors identify that existed resources of variability affiliated wit intensity on the position of the center forward. In intensity is perceived that exists two aspects. One expressed across the quantity of actions and second as engagement level. These two aspects defined first and second factor assigned in this study. As a third latent dimension, arise the time spent in the game. In the article „Analysis of indicators of load during the game in activity of the second line attacker in water polo" authors defined three factors where the latent structures are in relations with intensity of activity and types of actions. In intensity, authors defined two aspects: quantity of actions and level of activity. In the article „Analysis of certain indicators of the load in the play of the wing in water polo" authors defined four factors. First defined as a intensity of activity, second as frequency of actions in vertical position, third as extensity of activity and fourth as a time spent in vertical phase of the game. In the article „Analysis of some indicators of the load in the play of heavy defender in water polo" authors acquire three latent structures and defined them as: quantity of actions, intensity of activity in vertical position and extensity of activity in horizontal phase expressed across slightly swimming.

Series of other articles mentioned authors in addition elaborate theme field directly associated with subject of this investigation. In football several authors analyzed modalities, quantities and intensities of the players movements during the game. According to Bašić M. 2005. Okashi at all 1999. according Castagna at all 2003.) from presented results it is observed that football players from Japan during the game run off a distance between 8,680-11,527 m. Analysis the younger categories of football players (11-12 years) (Bašić 2005. according to Castagna at all 2003.) take out information that in the game in duration of 60 min. Young players run off about 6200 m, from what 5,5% less in the second half time regarding first. During the game the players was standing in the place 11% of totally time spent in the game. At the movies speed higher than 18 km/h they make 18 duels in average duration of 2,5 s with average break of 120 s between two duels. About 9% of the game time players were working on a high level of intensity. Football game comprises of 1000 – 1200 movement changes. Activity changes happen every in 5–6 s short intervals.

Movements consist of a walk (25%), easy running (37 %), subamksimal running (20%), running in sprint (11%), backwards running (7%) (Bašić 2005. according Ekblom, 1994 according Jeffreys, 2004). In handball, differences between extensity and intensity of cyclic activities of handball players, on several playing positions and roles have bean analyzed by Šibila, M., Vuleta, D. i Pori, P. (2004.). Data base were collected by SAGIT-system with computer software supporting. Output data were processed with chosen methods from programs Exel and SPSS. Statistically significant differences between groups were determinate regarding average distance pass trough the game. Mostly run the wings, hence external players, some less circuit attacker and at least goalkeeper. Differences are registries for the average tie of moving in average speed in all of rapidity categories. For second rapidity category were not registries differences between wings, external players and circuit attackers, but these tree groups are significantly different from goalkeepers. Statistically significant differences are registries in all four groups according to average moving speed. From provide it is obviously that the data collection is collected by different operations, as well as the methodologies of data processing are very similar.

Aims, hypotheses and importance of the Work

Aims of this Work will be accomplished thru the determination of basically parameters of the load in the play of the external attacker in water polo. These parameters will be established on the base of objectively measured activities on the representative sample of entities.

Hence, in this work, additional aim is defined treatments for data collecting for such measurement and set out validity of that instrument. It can be presumed that objective description of activity in the play of external attacker in water polo is possible provided really register of the: various types, quantities of movements, upon different intensity's, durations, and frequencies, as wall in horizontal therefore in vertical phase of the game. Based on that we appoint following hypotheses: H_1 Presumed that it will be possible determine latent sources of variability affiliated wit a number of actions (frequencies) in the play of the external attacker H_2 Presumed that it will be possible determine latent sources of variability affiliated wit a levels of the load in the play of the external attacker; H_3 Presumed that it will be possible determine latent sources of variability affiliated wit a quantity of the movements in the play of the external attacker H_4 Presumed that from a wider choice of variables provided for measuring the activity of the wing it will be possible extract a subset with satisfactory factor validity. Importance of the work manifested in the practical implementation of the results as well as in a scope of selection, routing and sports specialization such in planning and programming the training for „workplace" external attacker in water polo.

Methods

Experiment description

In the framework of implemented experiment the aim was objectively measured the quantity and intensities of players activity in the position of external attacker in water polo. That is achieved by registration, respectively monitored of player's activity on international games of Jadran-water polo league in the season in 2009/10. All the games were played in Split. Registration and data sampling was performed by five qualified surveyors, professors of kinesiology, water polo trainers with over annually experience. In the game, in the time whose player spend in the play, was recorded all movements, intensity's and positions of the body in horizontal and vertical positions. The criteria for estimation of work intensity, respectively burden: maximal, sub maximal and slightly, was determined, on the base of swimming speed in the course of actions takeoff. Measurers were trained, measuring the same player on 10 games. Experiment is carried out after completely concordance among surveyors was acquired. They were positioned on the high placed stand which enabled optical coverage of the whole playing field. Standard water polo markers (2 m, 5 m, goal out line, center, etc.) enabled precise recording of swimming distances at various intensities of players. Each official recorded all activities of their designated player. At every moment, they had view of the official time clock which showed a down count of the official, clean game time and smaller time clocks that shows ball possession and attack time. Each official consecutively recorded every action taken by his designated player. In case a player was thrown out of the game or has not been in the game (change of players) time was measured when the player exited the game and reentered the game.

Sample of entities

Entities or basic carriers of information in this experiment are part of the water polo game. According to rules, water polo is played in quarters of 8 minutes each (clean game time) or about 17 minutes real time per quarter. Each quarter starts the same way by swimming toward the ball which is placed in the center of the playing field. The quarter ends with an audible signal. Between the quarters are passive pauses (2 min., 5 min., 2 min.). From these reasons, one quarter is representative of one whole, and methodologically justified to use as an entity for measurement. Sample of entities in this investigation consist of 157 water polo quarters.

Sample of variables

Activities are recorded by the quantity and intensity of activity and movements made by external attacker. Frequency and actions are recorded by type and the quantity of passed distances of the playing field, recorded in meters. Various activities are realized by various types of swimming (crawl, backstroke and breaststroke) in various intensities in modalities (easy, sub maximal and maximal).

The number and duration of duels are measured as well as time spends in the game with players more or less. Movements and intensities were measured in horizontal and vertical positions with respect to the water surface. Based on measured source variables, new variables were produced which relate to intensity, frequency, and time spent in the game with a player more or less, the total number of actions and total quantity of distance swam. Duel is the time spent in contact with the opponent and is defined as over maximal load in the vertical position. Time spent in the game with a player more or less is defined as maximal load in the vertical position. Time spent with a player more or less is measured as real time in the game spent with an uneven number of players on either side.

Table 1. Authentic registered indicators

FKRMAX	frequency unit crawl, maximal
FLEDMAX	frequency unit backstroke, maximal
FKRSMX	frequency unit crawl, sub maximal
FLEDSMX	frequency unit backstroke, sub maximal
FKRLAG	frequency unit crawl, easy
FLELAG	frequency unit backstroke, easy
FPRLAG	frequency unit breaststroke, easy
FDUEL	frequency of duels
FIGVIS	frequency of actions with players more
FIGMAN	frequency of actions with players less
MKRMX	distance in crawl in maximal speed in meters
MLEDMX	distance in backstroke in maximal speed in meters
MKRSMX	distance in crawl in sub maximal speed in meters
MLEDSMX	distance in backstroke in sub maximal speed in meters
MKRLAG	distance in crawl at easy speed in meters
MLEDLAG	distance in backstroke at easy speed in meters
MPRLAG	distance in breaststroke at easy speed in meters
MDUEL	time duration of duels in seconds
SIGVIS	time duration with players more in seconds
SIGMAN	time duration with players less in seconds
SUKUPNO	total time spent in play in seconds

Table 2. Derived indicators

FMXSMX=FKRMX+FLEDMX+FKRSMX+FLEDSMX	Total of frequency units in crawl and backstroke in maximal and sub maximal
MMXSMX=MKRMX+MLEDMX+MKRSMX+MLEDSMX	Total distance in meters in crawl and backstroke at maximal and sub maximal
FLAGAN=FKRLAG+FLEDLAG+FPRLAG	Total frequency units in crawl, backstroke, and breaststroke at easy
MLAGAN=MKRLAG+MLEDLAG+MPRLAG	Total distance in meters in crawl, backstroke, and breaststroke at easy
FIGVM=FIGVIS+FIGMAN	Total frequency with players more or less during the quarter
SIGVM=SIGVIS+SIGMAN	Total seconds played with players more or less
FAKCIJA=FMXSMX+FLAG+FIGVM	Total frequency units of distances at sub maximal, maximal, and easy plus frequency with players more or less
METARA=MMXSMX+MLAGAN	Total distance in meters in maximal, sub maximal and easy intensities

Data analysis

Methods of data processing are harmonizing wit the aim in this investigation. On the measured sample basic statistical parameters and distributions of measured variables are calculated, namely: arithmetical mean (A.S.), standard deviation (S.D), Kurtosis (K.) and Skewness (S.), minimal and maximal result of all of variables. With intention to identify latent structure calculated was: intercorelations matrix, factor analysis under the component model was performed, the communalities of all variables was calculated, on the base of characteristics Eigen values of intercorelations matrix the percent of explained variance was calculated for any retained factor an cumulative, final factor solution is fixed by Oblimin solution, correlations between factor in Oblimion solution were calculated, For analysis standard statistical SPSS package were used.

Results and discussions

In Table 3. are display statistical parameters of all measured and derived variables: arithmetical means, (A.M.) , standard deviations (S. D.), Kurtosis (K.) and Skewness (S.) of distributions, minimal and maximal results.

Table 3. Central and dispersive parameters of all of indicators

varijable	A.M.	S.D.	S	K	Min.	Max.
FKRMAX	2,75	2,43	1,01	,99	0	13
FLEDMAX	,08	,31	4,42*	20,61*	0	2
FKRSMAX	7,17	4,50	,54	-,51	0	20
FLEDSMAX	,83	1,17	1,40	1,14	0	5
FKRLAG	7,11	4,44	,72	,01	0	20
FLELAG	2,46	1,97	1,15	1,30	0	9
FPRLAG	1,22	1,69	2,33*	7,74*	0	11
FDUEL	1,50	1,75	1,53	2,73	0	9
FIGVIS	1,29	1,13	,62	-,28*	0	5
FIGMAN	,97	,97	1,11	1,62	0	5
MKRMAX	24,64	24,62	1,53	3,40	0	141
MLEDMAX	,25	1,08	4,83*	25,28*	0	8
MKRSMAX	82,98	50,56	,41	-,52	0	211
MLEDSMAX	4,80	9,05	3,57*	17,47*	0	67
MKRLAG	62,61	41,46	,56	-,59	0	183
MLEDLAG	12,50	11,01	1,95*	6,94*	0	75
MPRLAG	5,97	7,83	1,75*	3,32	0	39
MDUEL	6,20	8,03	1,69	2,94	0	40
SIGVIS	18,24	17.69	,91	,75	0	98
SIGMAN	14,85	15,71	,98	,52	0	72
SUKUPNO	324,62	127,85	-,31	-1,11	61	480
FMXSMAX	10,82	6,46	,60	-,49	0	26
MMXSMAX	112,67	59,87	,38	-,50	0	253
FLAGAN	10,80	6,01	1,01	2,28	1	39
MLAGAN	81,08	48,45	,55	-,53	4	216
FIGVM	2,26	1,67	,50	-,18*	0	8
SIGVM	33,08	26,42	.69	,50	0	136
FAKCIJA	23,87	10,28	,34	-,50	3	50
METARA	193,75	78,82	-,08	-,92	8	352

*** =** aberration from normal distribution

By inspection of Table 3. is establish that the variables FLEDMAX, FPRLAG, FIGVIS, MLEDMAX, MLEDSMAX, MLEDLAG, MPRLAG and FIGVM have pronouncedly deviation from normal distribution, due to their rare prevalence in the game. Minimal results showed that almost all direct measured variables (underived) have results and null (0), respectively did not appear in every monitored quarter.

Extremely high frequency have the variables by which is monitored activity crawl maximal and crawl sub maximal as well as number of duels. High frequency is noted in variables which measured play with player more or les. Statistics of en masse derived variables showed that all of them have normal or approximate normal distributions. For further and final multivariate analysis 11 variables are retain.

Table 4. Indicators retained for final analysis

FDUEL	frequency of duels
MDUEL	time duration of duels in seconds
sigvm	Total seconds played with players more or less
SUKUPNO	total time spent in play in seconds
fmxsmx	Total of frequency units in crawl and backstroke in maximal and sub maximal
mmxsmx	Total distance in meters in crawl and backstroke at maximal and sub maximal
flagan	Total frequency units in crawl, backstroke, and breaststroke at easy
mlagan	Total distance in meters in crawl, backstroke, and breaststroke at easy
figvm	Total frequency with players more or less during the quarter
fakcija	Total frequency units of distances at sub maximal, maximal, and easy plus frequency with players more or less
metara	Total distance in meters in maximal, sub maximal and easy intensities

By analysis of central and dispersive parameters it is possible to conclude: During the game external attacker in the play spends 21,64 min of a clean time, thus, full two quarters of the 8 min of the clean play and 5,06 min over. That is a great quantity of the time in respect to great intensities and loads of the wing during the game. Usually, I-division time's dispose of more than five good and good trained external attackers, who changed during the game providing own maximum in every moment of the game. During the game external attacker swam average 775 m from what: in sub maximal and maximal intensity, totally, 450,68 m, respectively pro quarter average 112,67 m; in light intensity during the game external attacker swam 324,32 m , respectively pro quarter average 81,08 m; in the play with player more or less (vertical component) external attacker in the game spent 132,32 s, respectively, 33,08 s average pro quarter; in duels external attacker spend average 24,8 s or 6,20 s average pro quarter;

Table 5. Correlation matrix

		1	2	3	4	5	6	7	8	9	10
1	FDUE	1,00									
2	MDUE	0,87	1,00								
3	sigvm	-0,06	-	1,00							
4	sukupn	0,23	0,25	0,45	1,00						
5	fmxsm	0,32	0,21	0,22	0,55	1,00					
6	mmxs	0,29	0,24	0,29	0,65	0,89	1,00				
7	flagan	0,29	0,23	0,14	0,64	0,20	0,22	1,00			
8	mlaga	0,14	0,16	0,21	0,62	-0,06	0,05	0,86	1,00		
9	figvm	-0,04	0,01	0,94	0,48	0,26	0,33	0,19	0,23	1,00	
10	fakcija	0,37	0,27	0,37	0,80	0,79	0,74	0,74	0,50	0,44	1,00
11	metara	0,31	0,28	0,35	0,88	0,64	0,79	0,70	0,65	0,40	0,87

In vertical position at maximal load (player more or less) and over maximal load (duels) external attacker in the game spent totally 157,12 s. Other vertical or quasi vertical positions, which external attacker during the game proceeds, are treated as positions upon light load, are not especially reiterated nor processed in this work. Intercoorelations matrix of reduced indicators reunion was calculated (Table 5). Inspection of correlations matrix display big range of indicators connections, from null (0) correlation of indicator FDUEL with indicators sigvm and figvm as very low correlations of indicator flagan with indicators figvm and sigvm until significantly great values of connection of indicator FDUEL with indicator MDUEL, indicator SUKUPNO with almost all indicators except indicator FDUEL and MDUEL. Group of indicators SUKUPNO, fmxsmx, mmxsmx, flagan,mlagan and fakcija are high correlated with indicator metara.

Table 6. Initial Eigen values, percent of variance, cumulative variance and number of retained factors by GK criterion

Component	Initial Eigenvalues	% of Variance	Cumulative %
1	5,41	49,16	49,16
2	1,98	17,99	67,15
3	1,71	15,59	82,73
4	1,19	10,86	93,59
5	0,33	3,02	96,61
6	0,15	1,34	97,95
7	0,11	0,97	98,92
8	0,06	0,57	99,48
9	0,06	0,52	100,00
10	0,00	0,00	100,00
11	0,00	0,00	100,00

From the Table 6. is possible to conclude that in the accordance of GK criterion four components' explain 93,59 % of variance from total system. First main component explain 49,16 % second 18,00 % third 15,59 % and fourth 10,86% of variance. From the Table 7. is perceive that communalities of all indicators are high and in the range from 0,84 (SUKUPNO) to 0,97 (figvm and sigvm). First principal component are good defined with high projections of all of indicators, except indicators MDUEL, FDUEL, SUKUPNO sigvm, and figvm.

This factor, dominantly, and by high coefficients of participation defined indicators fakcija, metara and SUKUPNO (.,95 , .95 , .90). Them are added, with somewhat lower, but high coefficients indicators mmxsmx, fmxsmx, and flagan (.77 , .71 , .71). Second principal component are bipolar, and defined by relatively high projections of indicators FDUEL i MDUEL (.75 , .70) with positive omen, and with indicators sigvm and figvm (-.68 , -.65) negative omen. Second principal component can be defined as those which is responsible for variability in indicators who's talking about intensities in vertical phase of the game, hence duels and play with player more or les. Third principal component are also bipolar and defined by indicators fmxsmx i mmxsmx (.60 , .54) with positive omen and with indicators mlagan and flagan (-.68 , -.62) with negative omen, hence by frequencies and meters swam in maximal and submaximal intensity and opposite orientated frequencies of distances swam in light intensity. Fourth principal component is defined by indicators MDUEL, FDUEL, sigvm i figvm (.54 , .43 , .50 , .48). It is possible to interpret it as that which describes intensities in vertical phase in the play of the wing in modalities over maximal and maximal.

Table 7. Pattern matrix (factors F 1–4) of Oblimin solution and communalities (h^2)

	F 1	F 2	F 3	F 4	h^2
FDUEL	0,06	**0,95**	-0,00	-0,06	0,94
MDUEL	-0,07	**0,99**	0,01	0,05	0,94
sigvm	-0,04	-0,01	0,04	**1,00**	0,97
SUKUPNO	0,46	0,01	**-0,54**	0,23	0,84
fmxsmx	**1,00**	0,04	0,16	-0,03	0,95
mmxsmx	**0,97**	0,03	0,08	0,05	0,94
flagan	0,05	0,06	**-0,95**	-0,09	0,92
mlagan	-0,22	0,00	**-1,00**	0,06	0,96
figvm	0,01	0,00	0,02	**0,99**	0,97
fakcija	**0,67**	0,06	-0,45	0,09	0,93
metara	**0,60**	0,03	-0,56	0,07	0,94

From the Oblimin pattern matrix (Table 7.), after slantwise rotation, it is perceive simplicity of the solution. On the first factor the biggest projections have indicators: mmxsmx, flagan, fakcija, metara i fmxsmx (1.00, .97, .67 , .60 , .46). This factor are dominantly describe by indicators anticipated for measuring the intensity of sub maximal and maximal swimming throughout the frequencies, number of actions and total swam meters in the time spent in the game. This factor we entitled as „quantity of actions, or action". If in such constellation of the first factor we search for type of external attacker, it is possible to define him as a external attacker defined by great number of actions which characterized great quantity of swimming in high intensity (maxl and submaximal), less light swimming as well as absence of duels. Second factor is dominantly defined by high projections of indicators MDUEL i FDUEL (.99, .95). It can be defined as „intensity of the activity in vertical phase (NM)", hear expressed trough the modality on the overmaximal level. If in this constellation of the factor, we demand a type of the external attacker, it is possible to describe him as external attacker with great number of the duels whose realize in defense actions apart from actions in positional attack. Third factor defined high projections of indicators: figvm i mlagan (-1.00, -.95) and somewhat lower projections with negative omen of indicators: metara, fmxsmx i fakcija (-.56 , -.54 , -.45). Other indicators have neutral influence on this factor. Dominant attribute of this factor, in the context of indicators projections, are „intensity (extensity) of activity in horizontal phase", her expressed thru the light swimming, and certain quantity of submaximal and maxima swimming, on the base which, this type of external attacker, realize swam meters and frequencies of total actions in the time spent in the play.

If in such constellation of the third factor we search for type of external attacker, it is possible to define him as untypical external attacker who did not enter in duels and did not forced counterattack to opponent player. Fourth factor, dominantly and by great participation coefficients defined indicators SUKUPNO i sigvm (1.00, .99). This factor we defined as „ spend time and intensity of activity in vertical phase in the game (M)" , here's expressed trough the modality maximal (player more/less). In the constellation of the fourth factor we can recognized the type of external attacker who spent a lot of time in the game where play great number with player more or less. His play is not typical for external attacker.

Table 8. Factors correlations

	F 1	F 2	F 3	F 4
F 1	1,00			
F 2	0,28	1,00		
F 3	-0,29	-0,21	1,00	
F 4	0,32	-0,01	-0,27	1,00

Correlation between factors (Table 8.) are low what suggest that all of them exited in own sense. According to the aims appointed in this research, results approved that wit a measurement, very good, are cowered main subject of measuring. It is affirm that existed resources of variability affiliated with intensity in the play of the external attacker. Two aspects existed in the intensity. First, expressed through the quantity of actions, which defined first factor assigned in this investigation, and second assigned as a level of engagement, defined by second, third and fourth factor assigned in this research. It is interesting to notice that did not existed correlations between those structures about what speak, practically null correlations between factors.

Conclusion

On the base of the objective measuring on the representative sample of entities and analyze of the central and dispersive parameters of all registrated and derived indicators is realized the first aim set up in this research. Determined are the basically parameters of the load in the play of the external attacker defined by different types and quantities of the movements trough different intensities, frequencies and durations, as well in horizontal therefore in vertical phase of the game. For the purposes of perceived deviations from the normal distributions for multivariate analysis it was not possible applied all of measured variables. For the final, multivariate, analysis was retained 11 variables, normal or approximately normal distributed. The latent space, given by factor analyses, resulted with a for factors explaining 93,59% of variance, where, first factor explaining 49,16% , second 18,00%, third 15,57% and fourth 10,86% of variance from the total system. From the pattern matrix in Oblimin solution, after slantwise rotation, it is perceive the simplicity of the solution which enabled defining and nomination of the latent structures. Given factors nominated as: „quantity of actions, or action", „intensity of the activity in vertical phase of the game (NM)" , „intensity (extensity) of activity in horizontal phase of the game" and „time spent in the game and intensity of activity in vertical phase of the game (M)", satisfactorily describes four different manners in the play of the external attacker in water polo. All four hypotheses appointed in this research are confirmed. Defined are the resources of variability affiliated with the number of actions (frequencies), resources of variability affiliated with a levels of the load and quantity of the movements in the play of the external attacker as well in horizontal so in vertical phase of his play. Hypothesis that from a wide selection of variables for measuring a total activity of the external attacker it is possible to set a subgroup of variables with satisfactory factor validity which describes all important activity aspects of the external attacker in water polo, is affirm in this investigation.. The set of indicators, constructed for data collecting, according the given results, can be recommended for using in favor of registration and analysis the different aspects of the load of any player in water polo, what gives scientifically importance of this work. Practical importance of this work it's in the possibility four direct applications of given results to the sport practice, planning, programming, selection and specialization for a external attacker role in water polo.

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ANALIZA ODREĐENIH INDIKATORA OPTEREĆENJA U IGRI VANJSKOG NAPADAČA U DANAŠNJEM VATERPOLU

Sažetak
Na temelju objektivnog mjerenja na reprezentativnom uzorku entiteta i analize centralnih i disperzivnih parametara svih registriranih i deriviranih indikatora, ostvaren je prvi cilj ovog istraživanja. Utvrđeni su temeljni parametric opterećenaj u igri vanjskog napadača definirani različitim tipovima i kvantitetom gibanja kroz različite intenzitete, frekvencije i trajanja, kao i kroz horizontalne i vertikalne faze igre. Za svrhe objašnjenja opaženih odstupanja od normalne distribucije, a u cilje primjene multivarijantnih postupaka, nije moguće primjeniti sve mjerene varijable. Skup indiaktora, konstruiran za prikupljanje podataka, sukladno rezultatima, može se preporučiti za korištenje u svrhu registracije i analize različitih aspekata opterećenja u vaterpolu, što daje značajnu važnost ovom radu. Praktične implikacije rada su u mogućnosti direktne primjene rezultata u sportskoj praksi, planiranju, programiranju, selekciji i specijalizaciji uloge vanjskog napadača u vaterpolu.

Ključne riječi: *vaterpolo, vanjski napadač, opterećenje*

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THE EFFICIENCY OF A DANCE TRAINING ON SOME MOTOR ABILITIES OF FOLK DANCERS

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Original scientific paper

Abstract
The purpose of this research was to determine how additional training of dance aerobics influences the motor abilities of folk dancers (test subjects were members of the professional folk dance group Lado). 15 male and 17 female dancers in perfect condition aged from 18 to 45 years participated in the research. Motor abilities were researched with a combination of 14 tests covering coordination, rhythm, balance, frequency of movements, flexibility, explosive power and general power. The experiment lasted 3 years and 7 measurements in different time periods were made. The additional training process was carefully planned and performed daily, except when on tours or on vacation (about 95 days a year). According to Guttman-Kaiser criterion, 3 latent dimensions were determined with factor analysis. The first dimension is especially important, because it is defined by the most relevant factors of successful dancing (explosive power, coordination, frequency of movement). Discriminant analysis during individual measurements has shown that discrepancies occur especially between the initial state and the first 4 measurements, meaning that quantitative progress was made in frequency of movement, balance and explosive power. The last measurements have shown some regression probably on account of low motivation of dancers for measurements.

Key words*: folk dance, motor abilities, dance aerobics, practice planning*

Introduction

Dance, and specifically folk dance, is a relatively unknown field. Because it is not a competitive sport (no competitions are held), the training process is usually adapted to preparations for performances and the development of motor skills is neglected. Moreover, group leaders often don't possess the adequate knowledge for motor abilities practice. An additional planned practice of dance aerobics was included in the training process of professional folk dancers with the purpose of improving the development of those motor abilities, which are the most important for a successful performance. The test subjects were part of a specific population, all of them members of the folk dance group LADO. They have never before used such a training process. We strived to keep the exercises close to the original activities of the dancers, and on the other hand, to make the exercises also special and different from what they usually do in order to make the work process interesting. Changes made by dance aerobics depend on the laws of the training process, meaning that a work program and a list of goals will bring results. The use of dance aerobics (continuous movement following the rhythm of music according to a specific choreography) as an aerobic activity turned out to be an ideal training process as it also allows to control the dosage, which was important considering that the dancers were aged from 18 to 45 years. It is important to stress that all dancers regardless of age have the same workload when performing on stage or on concerts. Only few researches regarding transformational effects of dance aerobics on motor abilities exist.

Bezjak (1971) determined that there is a distinctive statistical correlation between dance aerobics and dance. Brennan (1980) compared three groups of trained females (dance aerobics, gymnastics, other sports) with untrained females on the basis of results of the 14 tests of motor abilities (power, balance, flexibility, rhythm) and found out that there is a distinctive statistical difference between trained and untrained females. Čačija (1985) exposes the usefulness of dance aerobics for an increase in flexibility, balance, leg coordination and muscular endurance based on a sample of 140 schoolgirls. Vankova, Tomova and Vankov (1986) used a dance aerobics program in the experimental group and a conventional program in the controlled group of female students of the University of Sofia and came to a conclusion that there is a distinctive difference regarding motor abilities between the experimental and control group. Oreb (1989) researched correlations between primary motor abilities and criteria of dance evaluation and found out that coordination, rhythmical structures, balance and explosive power determine successful dance performances. Moreover, Oreb and Kilibarda (1996) researched relations between rhythmical abilities and successful dance performances on a sample of 104 students of Faculty of Sport in Zagreb and came to a conclusion that on the basis of rhythmical abilities, dance performances can be relatively precisely determined. Other factors include motor and general dance abilities. Blarežina (1993) established a positive influence of dance aerobics on some motor abilities on a sample of 100 students of the Faculty of Arts in Zagreb.

A month of dance aerobics training proved that the program triggered distinctive statistical changes of variables for evaluation of rhythmical abilities, frequency of movement, explosive power, flexibility and coordination. Oreb and Marušić (1994) researched the effect of dance aerobics on dance training process on a sample of 17 female folk dancers. Six basic motor abilities tests were used for the evaluation of the effects at the beginning and at the end of the training process. They concluded that the program triggered distinctive statistical changes regarding the explosive power, the ability to feel the rhythm and flexibility. The present research is a part of a research project to determine the effects of the training process in dance training. As such, its basic goal is to determine the factors of motor abilities, which are relevant for successful dance performances, and later to analyze the effectiveness of the training process in seven different training periods. It was assumed that the most important motor abilities for dancing are coordination, speed, explosive power and balance, and that repeated measurements will show progress of dancers as time passes.

Methods

Participants and instruments

Test subjects (15 male, 17 female) were members of the folk singing and dancing group LADO. They were physically healthy professional dancers aged from 18 to 45 years, all being able to perform on stage or in concerts. Motor abilities were researched with a combination of 14 tests covering coordination, rhythm, balance, frequency of movement, flexibility, explosive power and muscular endurance. The chosen tests had a record of reliable measurements (Metikoš, Hofman, Prot, Pintar & Oreb, 1989). The following tests were chosen for the evaluation of motor abilities: -coordination: MAGKUS – side steps; MAGONT – agility on the floor; MAGOSS – running in a figure of eight; -rhythmical structures: MKRBNR – drumming with feet and hands; -balance: MBAU1Z – standing on a foot on the balance bench with eyes closed; -movement frequency: MBFTAP – hand tapping; MBTAN – foot tapping; -flexibility: MFLISK – lunge; MFLPRK – sit and reach; -explosive power: MFESDM – standing long jump; MFESVM – Sergeant test; MFE20V – 20m standing start sprint; -muscular endurance: MRCDTT – body lifting with weights. The basic kinesiological exercises comprised of dance aerobics. The additional training lasted 3 years (60 minutes daily, between 9 and 10 a.m., except on concert days and during tours and vacation). The exercises were meticulously planned and had 3 parts: preparation, main part and finish. Exercises were meant to improve the basic physical form. Preparation (3-5min) consisted of basic movement exercises, so that the body would be prepared for the main part. Joints, and in particular knees and ankles, were given extra attention. The main part (35-45 min) consisted of dance aerobics (dancing steps and choreography), which eventually became more complicated and where special attention was given to the balanced load of the muscle groups on the left and right side of the body and to alternating (high/low) intensity. The goal in the finishing part (10-15min) was to stabilize and calm down the body. In order to achieve this, relaxation and stretching exercises according to the topological principle were used. In addition to the quality exercises, suitable load and variety in the training process was achieved with music selection: preparation 100-120 BPM, main part 118-180 BPM and in the finishing part instrumental music with slow tempo, which helped with relaxation. The music selection enabled a permanently interesting training process and music was also a great motivation. Various accessories (weights, elastic bands) that were added to the interval and circular trainings complemented towards increased variety. Dance aerobics was combined with strength exercises.

Data Processing Methods

The data was analyzed with the statistical software package STATISTICA FOR WINDOWS. The basic descriptive parameters were determined. Factor analysis (Guttman-Kaiser criterion, 1963) was used to analyze the latent structure of motor abilities. The discriminant analysis was used to determine the different effects of the training process in various time periods.

Results and discussion

Table 1 shows that the tests are good, because they tend not to deviate from normal distribution. Especially reliable are the coordination tests (MAGKUS – side steps, MAGONT – agility on the flour, MAGOSS – running in a figure of eight) and rhythm tests (MKRBNR – drum beating with hands and feat). Only the explosive power (MFE20V – 20m standing start sprint) and muscular endurance (MRCDTT – body lifting with weghts) tests show an unusual level of asymmetry. In the case of the explosive power, this is probably the result of some dancers being naturally more explosive than others and in the case of the muscular endurance, it is a result of the excellent overall physical shape.

Table 1. Central and dispersive parameters for motor the skills evaluation of the dancers at all seven points in time

	AM	SD	MIN	MAX	SKEW	KURT
MAGKUS	10.06	1.36	7.30	15.0	.60	.49
MKRBNR	14.89	4.43	3.0	30.0	.32	.39
MBFTAN	33.79	10.67	15.0	51.3	-.22	-1.69
MAGOSS	20.10	2.85	12.1	28.6	.19	.11
MFESVM	39.24	8.82	22.0	63.0	.51	-.12
FLEXI	13.44	6.07	1.3	26.2	-.12	-.98

Arithmetic mean(AM), standard deviation (SD), minimal (MIN) in maximal (MAX) values in coefficient of asimetricity (SKEW) and scewness (KURT)

The factor analysis with the use of Guttman-Kaiser criterion gives three latent factors. The variance of the whole factor space (GK lambda greater than or equal to 1) is 65%. The first factor takes 40.55% of the whole variance, whereas the other two factors have only a small percentage of information (first 16.52%, second 8.43%).

Table 2: Eigenvalues, percent of variance explained, cumulative percent of factor analyses of motor tests

	Eigen values	% total Variance	Cumulative eigenvalues	Cumulative %
factor 1	5.67	40.54	5.67	40.54
factor 2	2.31	16.52	7.98	57.07
factor 3	1.18	8.43	9.17	65.50

The first factor is defined by the explosive power, coordination and movement frequency parameters, as seen in table 3. This was expected, as these are the most important motor abilities for successful dancing.

Table 3: Factor Structure (F 1-30 factors)

VARIABLES	F 1	F 2	F 3
S7MAGKUS	-.54	.03	-.63
S7MAGONT	-.65	.26	-.31
S7MKRBNR	.30	-.02	.71
S7MFLPRK	-.00	-.87	-.05
S7MBFTAP	.71	.12	.12
S7MBFTAN	.31	-.27	-.18
S7MBAU1Z	.03	.16	-.18
S7MFESDM	.91	.08	.14
S7MRCDTT	.52	.10	.09
S7MFLISK	.19	.37	.73
S7MAGOSS	-.83	.05	-.08
S7MFESVM	.73	.29	.31
S7MFE20V	-.78	.16	-.17
S7FLEXI	-.06	-.90	-.17

It is essential to stress that such results were gained on a sample of dancers of folk dances, which demand extraordinary explosiveness (high jumps), coordination (various steps and rhythmical combinations) and fast performance of choreographies. The second factor takes just 16.5% of the whole variance and is defined by the negative values of the MFLPRK (sit and reach) and FLEXI (flexibility) variables. The results are unsurprising as it is not essential to be extremely flexible in folk dancing. The third factor is defined by the variables of rhythm, balance and flexibility and takes just 8% of the whole variance. Although unexpected at first glance, the results can be justified by the fact that the basic condition for people to begin dancing is their archetypal connection with rhythm and balance, which are certainly genetically based and can be continuously developed and improved. Once more it is important to stress that the test subjects were professional dancers, so it is understandable that there are no big differences in motor abilities. Moreover, some tests may not have been difficult enough for greater differences in variable values to arise. The transformational effects of the motor abilities training with dance aerobics were analyzed using discriminant analysis. The analysis enabled the selection of the variables, which show the difference between individual tests of the same test subjects at 7 points in time during the 28 months of research (February, June, October first year, July, September, December second year, July third year). Data processing revealed two distinctive statistical discriminant functions (D1 and D2).

In order to determine the difference in motor abilities conditions between various individual measurements, (G1-G7) the discriminant functions were drawn in a graph. The state of individual measurements on D1 and D2 was determined by inputting their centroids (the arithmetical mean of the results of individual measurements) in the figure 1.

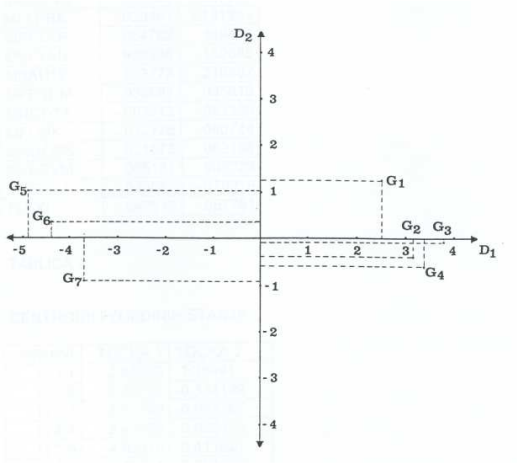

Figure 1. Plot of discriminant functions

The figure 1. shows that the state of the first measurements (G1) in the first quadrant (D1 and D2 are positive) is determined by the movement frequency, explosive power, balance and coordination (Table 4). It can be concluded, that the whole group improved in those categories. The reason is probably the rich choreography of the dance aerobics, which changed from practice to practice and demanded agility and coordination in regard to changes of directions of movement and orientation in space. Moreover, such a training process is completely different from the usual dance practice (repeating choreographies with fixed movement). Various dance steps, levels of difficulty and tempo also added to a higher frequency of movement.

Table 4. Discriminant functions

VARIABLES	D1	D2
MAGKUS	.00	.48
MAGONT	.01	.08
MKRBNR	-.09	-.38
MFLPRK	-.02	-.13
MBFTAP	-.06	-.36
MBFTAN	.93	-.13
MBAU1Z	.03	.21
MFESDM	.03	.03
MRCDTT	-.00	-.09
MFLISK	-.01	-.08
MAGOSS	.02	.06
MFESVM	.00	.00
MFE20V	.02	-.07
FLEXI	-.04	-.06

The second measurement G2 (D1=2.30 and D2=-0.33) is located in the second quadrant and is defined by the frequency of movement, explosive power, balance, coordination, rhythm, flexibility and muscular endurance. A significant quantitative progress concerning those motor abilities that are relevant for successful dancing is seen in this time period.

Table 5. Centriods of individual measurements:

GROUP	POINT 1	POINT 2
G 1:1	2.65	1.35
G 2:2	3.20	-.33
G 3:3	3.81	-.09
G 4:4	3.43	-.06
G 5:5	-4.95	.41
G 6:6	-4.43	.25
G 7:7	-3.73	-.90

It is interesting that a progress is seen in those abilities which are genetically based, meaning that they can't develop much (just to a certain endogenous barrier (Oreb, 1992). This phenomenon can be explained by the fact that the previous practices of the group did not include physical training. The initial state of motor abilities was relatively low, so it was relatively easy to trigger a progress in motor abilities. The same can be said for the measurements G3 and G4, both of them also being in the second quadrant (D1 positive, D2 negative). The same tests were used, which means that the group improved only some strictly specific abilities. The first four measurements showed positive changes and confirmed that progress was made. All of the last three measurements (G5, G6, G7) showed changes. D1 was becoming increasingly negative and indicated weaker effects of the training process in the categories of rhythm, movement frequency, flexibility, muscular endurance, coordination and balance. A regressive trend in the G5 measurement can be attributed to the fact that the measurements were made after a month-and-a-half long break (September second year – vacation) and that it was only the start of the dancing season. The next two measurements, which also showed a regressive trend in motor abilities, were also made during holidays or vacation, which was probably a negative motivation.

Conclusion

The goal of the research, which was a part of a broader project of determining effects of the training processes on dancers, was to analyze the factor structure of motor abilities, which are relevant for successful dancing. Moreover, it tried to analyze the effectiveness if the training process in seven different time periods. On a sample of 15 male and 17 female dancers, various motor abilities were measured in order to determine how additional training of dance aerobics coupled with some fitness exercises influences the motor abilities of folk dancers. The additional training process lasted three years and was performed daily except on vacation and on tours. The factor analysis showed that the practice regime could focus on explosive power, coordination and movement frequency. Positive effects, which were analyzed using discriminant analysis, appeared especially in the first and second year of the additional training. Low motivation and bad timing of measurements were the reason behind the worse results in the last year. A progress in the most dance-important motor abilities can be attributed to carefully planned additional practices, which were new to dancers. It can be concluded that the most important motor abilities in dancing are rhythmic abilities, coordination, speed, explosive power and balance and that the training process developed in the research is good and also recommended to all dancers.

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UČINKOVITOST PLESNOG TRENINGA NA NEKE MOTORIČKE SPOSOBNOSTI PLESAČA NARODNOG PLESA

Sažetak

Cilj rada je bio utvrditi utjecaj sistematskog treninga plesne aerobike na promjenu motoričkih sposobnosti plesačica i plesača narodnog plesa-članova ansambla nrodnih pjesama i plesova LADO. U eksperiment je bilo uključeno 15 plesača i 17 plesačica starosne dobi 18-45 godina, koji su bili sposobni za izvršavanje svojih obveza na nastupima i koncertima. Motorički prostor je procijenjen baterijom od 14 testova za procjenu motoričkih sposobnosti, kojima je bio pokriven prostor koordinacije, ritma, ravnoteže, frekvencije pokreta, fleksibilnosti, eksplozivne snage i ukupne snage. Eksperiment je trajao tri godine , mjerenja su bila provedena u 7 vremeniskih točaka. Proces treninga plesnog aerobika je bio precizno planiran te je provođen svakodnevno uz izuzetke nastupa i godišnjih odmora (cca 95 dana godišnje). Faktorskom analizom ekstrahirane su tri latentne dimenzije od kojih je prva definirana prostorom eksplozivne snage, koordinacije i frekvencije pokreta, odnosno dimenzijama za koje je bilo predviđeno da su relevantne za plesnu uspješnost. Diskriminacijskom analizom utvrđene su dvije diskriminacijske funkcije kojima je utvrđena razlika između inicijalnog stanja i prva 4 mjerenja te je utvrđen kvantitativni napredak u sposobnostima frekvencije pokreta, ravnoteže i eksplozivne snage. U zadnjim mjerenjima je došlo do pada razine motoričkih sposobnosti koje je moguće pripisati prije svega padom motiviranosti za mjerenje kod plesača.

Ključne riječi: *narodni ples, motoričke sposobnosti, plesna aerobika, plan treninga*

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COMPARING THE EFFECT OF MASSED & DISTRIBUTED PRACTICE IN DIFFERENT STAGES OF DISCRETE MOTOR TASK LEARNING

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Original scientific paper

Abstract
How to distribute the duration of practice and rest at each session is a matter of concern in organizing the practice of motor skills. In this connection, most studies have introduced the nature of motor task as a determining factor and suggested that if the discrete skills are practiced according to massed method and continued skills according to distributed method, then better results can be obtained. But, it seems that the stage of the learner prior to the test, also as one of the effective variables in this process, has not been taken into consideration. To this end and in order to determine the role of learning stage in the mechanism of distributing practice and rest during a session, 60 male students of Tabriz University were placed randomly in two groups. One group repeated one of the discrete motor tasks (throwing dart) during five sessions with two blocks at each session according to the massed and group two according to the distributed method. Off course, each block contained ten trials. During this course, the results of the subject's performance were recorded with repeated pre-and-post tests, and eventually, the subject's rate of learning became known by giving a retention test. After collecting the data and analysis of them according to T-Student method, the following results were obtained: the findings showed that the performance of both groups in pre-test and post-test had a significant difference. But, the performance of both groups of subjects did not have a significant difference in any of the stages of repeated pre-tests and post-tests. Off course, it should be noted that the group which had practiced according to massed method, did better than the distributed group on the delayed retention test which was taken at the interval of 48 hours after the last practice session although, this better result was not significant statistically. So, according to the findings of this research, the learner's stage while learning discrete motor task, is not considered as an effective and significant factor in the way of distributing the practice and rest duration. Although, for the subject to be clearer, much more & exact researches are recommended.

Key words*: massed practice, distributed practice, discrete motor task, the stages of motor learning*

Introduction

Organizing practice is one of the subjects that has a special status in education and rehabilitation process in addition to the sport milieus, so that Seabrook et al (2005) recently by conducting a research declared: efficiency of teaching in classrooms would lead to a significant increase by increasing the distribution degree of courses and sessions (Heidi, 1992). But, some coaches are interested in increasing practice duration by usefulness of a certain amount of practice rather than the effectiveness of practice. However, it seems that the duration of practice is not the most important factor in planning rather, the quality of practice should also be taken in to account. So, organizing practice in order to increase its effectiveness is of high importance (Schmidt, 2005). One of the variables which is of high importance in organizing practice, is the quality of distributing practice and rest duration in a session and practice distribution is a popular subject for researches concerning motor learning. The argument about the amount of rest in the middle of practice trials due to providing a letter environment for practice, has directed a vast attention to this subject. Now, the question is whether massed practice or distributed practice is better for motor learning? Some researches claim that distributed practice is better than massed practice while, others believe that distributing the practice, does not make a difference in learning. While the first argument emphasizes on distributing practice between trials, it is important to understand that distributing the practice deals also with the amount of practice in each session and the amount of rest amidst sessions (Schmidt, 2005). Shea et al. (2000) by conducting a research in this respect, declared in the year 2000 that distributing the practice during the days of the week, causes an increase in the amount of learning and improves the subjects performance in the delayed retention test (Shea et al., 2000). But, before any other discussion, it seems necessary to give a brief definition of these two methods of practice and compare them with each other. Some researchers believe that one should act in a relative way when using these two words. It means that massed practice includes less session than distributed practice program (Magil, 2001; Magnuson & Wright, 2004; Magnuson et al., 2004). Likewise, "Kerr" believes that there is not a certain policy to distinguish between these two kinds of practice from each other but, generally speaking. One can say that the amount of rest in distributed practice is more than the massed method (Kerr, 1982). However, "Singer" thinks that the distinction between massed and distributed practice, is in existence or non-existence of rest amidst intervals of practice.

On this basis if at the intervals of practice, rest is included, the practice will be distributed but, massed practice lacks rest between practice courses. In general, the distinction between massed and distributed practice can easily be specified in table (Heidi, 1992).

Table 1. the distinction between massed and distributed practice

Method of practice	During one session of practice	Between practice sessions
Massed	Duration of rest≤ Duration of practice	practice sessions consecutive3
Distributed	Duration of rest>Duration of practice	Setting certain days to rest or non-practice

It should be remembered that, many of the researches designed for testing the effect of massed and distributed practice on motor skills learning, used simple motor tasks such as Rotary-pursuit apparatus, drawing from mirror and other dedicated motor tasks. These tasks make it impossible to control many of the variables but, at the same time, present the possibility of generalizing these findings to motor tasks in sport, industry and rehabilitation. However, regarding most delicate motor tasks which were studied, the results show that the performance of the distributed method improves after a couple of sessions. On the other hand, the results associated with learning are not so definite. It seems that there is little real difference between the two programs. Since most primitive researches did not discriminate between performance and learning, only the data associated with the performance would be reported. So, the superiority of distributed practice over performance has been generalized also in terms of learning (Sage, 1999). But in view to the cases mentioned above, it is necessary to review the findings of another research in which both performance and learning of different sport and motor tasks are taken into account and extraneous variables are controlled highly and the nature of motor skill used in that study is also taken into consideration as an effective factor. The researches conducted about continued motor skills, are far more than discrete motor skills. Perhaps the reason for this is related to the form of its definition. Because if massed practice program does not give rest between trials, in this case, the duration of rest in both programs will almost be the same Because, discrete skill is short and does not take a long time to perform a trial of its. So, when the skill under study is discrete, it becomes important to define massed and distributed skill operationally. Probably one of the reasons why the researchers have not faced with difficulty in this respect is that (except in a few cases) they have never used discrete tasks in order to compare massed and distributed practice (Magil, 2001). "Lea and Genovese" after reviewing the current literature in this regard in (1988), found only one research in which discrete task had been used. These two researchers also observed a strong effect in the in retention-test context by conducting a research and declared that massed practice leads to a better result only when the test is taken according to the massed method of the practice trials in discrete motor tasks not only does not delay learning, but in fact, is in favor of it (Magil, 2001). Another research conducted recently, belongs to Dail Teresa & Robert Christina the results of which were published in the sport and practice research quarterly (2004). These two researchers compared the role of massed and distributed practice in long-term learning and instructing discrete motor tasks. In this research, the golf hit was used as a discrete task the results of which showed that those who had practiced according to the distributed method displayed a better performance than the group which had practiced according to the massed method. But, in retention test, no significant difference was observed between these two groups. In other words by the passage of time, the performance of both groups was similar (Dial & Christina, 2004). But, Adams and Renolds by conducting a research on using continued motor task, declared that mass of practice results in a deficiency on the performance not learning (Magil, 2001). "Stelmech",s findings which was performed by the task of ascending the stairs down to the grass showed that decreasing rest decreases the rate of improvement vehemently between learning trials (Schmidt, 2005). Also, in an other research, Shea et al. (2000) declared that the distribution of practice sessions in period's results in improvement of performance and retention test too bears positive results for learning (Shea et al., 2000). "Magil" point out that by reviewing the conducted researches, he recommends massed practice approach for learning discrete motor tasks and the distributed practice for learning continued motor tasks (Magil, 2001; Farhad, 2003) and the researches mentioned here, also approves of this claim. But, it seems that for some reasons it is necessary to do some researches in this respect so that we can apply Magil's declaration as a practical & applied recommendation in different fields of sport, rehabilitation and industries and those reasons include; 1- by recitation to a couple of researches and their results which were mentioned in this paper too, one can not provide practical and applied conclusions. 2- Separating learning and acquisition stages is a subject focused on in the previous researches. So, regarding new studies, a mechanism should be used to distinguish between temporary & constant effects. 3- according to Smith's recommendation, in cognitive-verbal stage regarding errors associated with motor planning, a feedback repeatedly should be given so that the athlete and learner of the skill can take this stage rapidly (Kerr, 1982; Mumford et al., 1994; Christina & Corcos, 2004).so, if in organizing practice, the coach pays attention to the stage in which the athlete is, but it is not taken into consideration, and if according to the above recommendations, he applies massed practice in this stage in which there is no opportunity to receive added feedbacks between trials, can we consider the omission of these gold opportunities in

cognitive-verbal stage between trials in favor of learning? Thus, by citing to the above-mentioned reasons and cases in this study, we decided to compare the usefulness of these two approaches i.e. massed & distributed practice by considering the stage in which the learner is as well as separating learning stage from that of teaching. In the following sections, the methodology of the findings of this study will be explained briefly.

Materials and Methods

The method used in this study was quasi-experimental in which the two-group pattern of pre-and-post test had been used. In order to detect the effects of different practice methods (as independent variable), two groups were randomly selected and after a tentative period in which the independent variable was exercised on them, the dependent variable (rate of learning and performance of the subjects) was measured and compared with each other. Thus, in this research, the two groups were given tests- both pre and post tests- and between the two tests, the independent variable was exercised and the resulting data were compared with each other.

Subjects
All non-athlete undergraduate male students of Tabriz University studying in the second semester of the academic year 2005-2006 who had no precedent of membership in the sport teams of the university or out of the university, constituted the statistical population of the current research who were invited to cooperation. Off course, it is to be noted that from among the qualified candidates, 60 persons were selected randomly and in the continuation also, they were replaced in the same way in two groups (i.e. massed practice and distributed practice group). By the way, during the course of practice, one of the students from massed practice group renounced continuing cooperation thus, the number of the subjects in the massed group was 29 and in the distributed group were 30. By the way, some of the characteristics of the subjects were as follow: their average age was 20, their average height was 177 cm with the standard deviation of 5/3 cm and their educational average was 15/065 with the standard deviation of 1/2.

The variables of the research
The variables of the research in this study include: methods of organizing practice in other words, the way of distributing rest and practice during a session (which includes two kinds of practice i.e. massed and distributed) , the other variable included the speed and rate of learning and performing in different stages during the process of instructing and performing). So, the two basic variables of this research include: A) Independent variable: The methods of massed and distributed practice, in other words, the way of distributing practice and rest duration during the practice sessions, were considered as independent variable. By different organizing of these two factors (i.e. practice and rest), the methods called massed and distributed practice, were exercised on these two groups of subjects. So, the massed method is when rest durations between repetitions are less than the duration of trials in a session and vice versa , if rest durations between trials is considered equal to or more than trials duration, then the practice will be considered as distributed one (6). B) Dependent variable: The rate of performance at the end of each session, the speed of improvement of performance and also the amount of instructing participants in one of the discrete motor skills (throwing dart) was as dependent variable. Indeed we have studied the effects of distributing and organizing the amount of rest and practice at different sessions on this variable.

Procedures
After administering pre – test and determining the subject's amount of familiarity with the intended skill, the qualified persons were selected. Not having previous familiarity with the skill. Was the criterion for the selection. The right performance of the skill was displayed by one of the experts and coaches of the association and the principles of throwing were completely explained. In order to make sure of the right conveyance of the materials, the subjects were requested to display what they had learned from the coach and in this stage, every one of them performed three throwing in order for their points of weakness and strength to be detected. Then, in the stage of practice and learning, every one of the subjects performed 100 practice trials on the blocks of 10 during 5 sessions. Each session included 2 blocks of practice. It should be noted that during the course of practice, the average performance of the subjects in both groups (massed and distributed) was regularly recorded at the end of every session and the subjects received feedbacks for their own performance. Having finished the course of practice, the subjects after 48 hours of rest and non- practice, participated in a session of retention test under the conditions of practice, and the average of their points was obtained groups. Thus, in this study for every subject, 12 points, were recorded one of which belonged to his pre – test and the other 10 points belonged to his performance in practice sessions and the last point which was recorded, was relating to his retention test which were used and compared with each other in the section of statistics and analysis of data. In this study, throwing dart was selected as one of the discrete skills which according to the regulations of the dart association of Islamic republic of Iran, was installed on the wall so that the height of the dartboard center from the surface of the earth was 172 and the distance of throwing line from the wall was 2 m and 37 cm behind which the subjects stood up and did the act of throwing while standing.

Statistical Analysis
Based on the hypotheses of the current research and in proportion to the scale of the data obtained from the performance of the two groups of subjects, in classification and regulating and

providing the average of determining the inclination to the centre of data and deviation from their centre and also in drawing, descriptive statistics procedures were used. Also in order to compare the graphs, difference of the points in 2 groups of subjects, T- student approach for testing hypothesis's was used. Of course, it is to be noted that in all hypothesis's, decisions have been made based on 5 % Alfa.

Results

A) By reviewing figure 1 and descriptive section of information on table 5, one can claim that although the massed group's points on pre – test were, lower than the distributed group (through having used the referential statistics procedures, it transpired that this difference was not significant) and this difference in performance also has somewhat continued up to the last session of practice , the results of retention test demonstrates that the performance of the group which had practiced according to the massed method, was better and higher than the group which had practiced according to the distributed method.

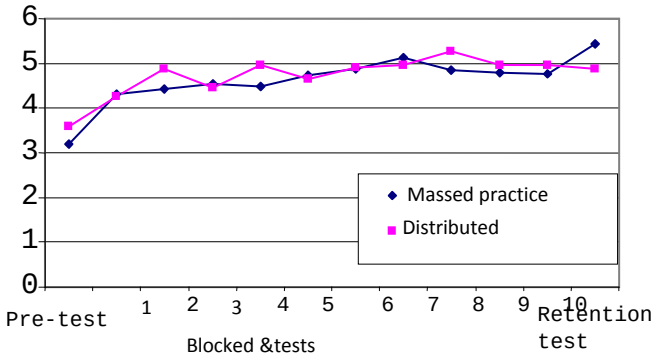

Figure 1. average performance of the subjects of both massed and distributed practice group in different stages of the research

B) By comparing the performance and points of the subjects who had practiced according to the massed method, it transpired that there was a significant difference between the points of pre – test stage and the detention test with the assurance of 95 %. In other words, based on the contents of table 2, it transpires that by exercising independent variable i.e. instructing and practicing , the motor behavior of the subjects underwent a significant change and they acquired the dart skill as a discrete motor task during the course.

Table 2. Comparison of the points of massed group in pre – test stage with instructing stage

Groups	$\overline{X}$	S	N	df	Sig
Massed	3/19	1/46	30	58	0/021
Distributed	5/45	1/1	30		

C) Comparison of the obtained points on the part of the subjects of the distributed practice group (table 3) demonstrates that during an acquisition stage, the subjects could display a significant change in their motor behavior (throwing dart).

In other words, practicing and repeating the intended skill in this research, could leave their effects on the subjects' learning.

Table 3. Comparison of the points of the distributed group subjects in pre- test stage with instructing stage:

Groups	$\overline{X}$	S	N	df	Sig
Massed	3/19	1/63	29	56	0/031
Distributed	4/48	1/14	29		

D) One of the basic assumptions of this research, in other words, the main goal of this research was to compare the effects of these 2 methods (massed and distributed in different stages of the skill of throwing dart (as discrete skill) which after analysis and comparison of the averages in different stages by T – student method, it was known that there was no significant difference between the averages of these 2 groups with each other in any of the stages. In other words, despite the existence of a slight descriptive difference between the averages, these differences are not meaningful. That is to say, the massed practice method or distributed practice method statistically have no superiority over each other in any of the stages. You can observe the results of the related statistical analysis on table 4.

Table 4. Comparison of the averages of the two groups of subjects in different stages of learning and training the skill of throwing dart:

Stage	Group of	average	Standard	df	2-tailed
Pre-test	Massed	3/19	1/46	57	0/319
	distributed	3/59	1/63		
Practice one blocked	massed	4/23	1/22	57	0/888
	distributed	4/27	1/27		
Practice two blocked	massed	4/44	0/96	57	0/065
	distributed	4/88	0/86		
Practice three blocked	massed	4/55	0/99	57	0/773
	distributed	4/46	1/31		
Practice four blocked	massed	4/48	0/92	57	0/091
	distributed	4/95	1/17		
Practice five blocked	massed	4/73	1/25	57	0/786
	distributed	4/65	0/92		
Practice six blocked	massed	4/88	1/16	57	0/919
	distributed	4/91	0/88		
Practice seven blocked	massed	5/14	0/96	57	0/478
	distributed	4/95	1/06		
Practice eight blocked	massed	4/86	0/9	57	0/091
	distributed	5/27	0/92		
Practice nine blocked	massed	4/7	0/93	57	0/527
	distributed	4/96	1/17		
Practice ten blocked	massed	4/98	1/02	57	0/490
	distributed	4/97	1/06		
Retention test	massed	5/45	1/1	57	0/061
	distributed	4/88	1/14		

Discussion

What was obtained in a part of this study and showed that the subjects after 100 trials managed

to learn how to perform their intended motor task, is concordant with other findings that are often referred to in motor behavior sciences which introduced practice repetition as a factor of learning a skill (Schmidt, 2005; Jarvis, 2002; Magil, 2001; Shea et al., 2000; Kadota et al., 2004). Although in some studies, this number of repetitions has not been mentioned as a fixed number. The number of selected trials for this study is almost the average of figures we face with in the literature related to the intended task. In other part of this study, the obtained results demonstrated that there was no significant difference between the performances of the subjects after finishing the Practice trails.In other words, massed or distributed practices do not have different effects on acquisition discrete skill. However, descriptively the group which had practiced according to the massed method got better and higher points on retention test. This part of findings with a little overlooking corresponds with "Lea and Genoves"s findings in (1989). They benefited from a discrete task in their research which was performable within 0/5 second. They moved a hand lever from a metal sheet towards another metal sheet within 500 thousand second (Magil, 2001). Another research has also been conducted in this regard which" Magil" has mentioned in his book of motor learning. In this research, the subject gets a nail out of a hole and after turning it up – side down, returns it back. Of course, it takes almost 1/3 to 1/7 seconds to perform this task.The researcher by doing this study came to the conclusion that using massed practice would have better and useful effects both in the course of practice and learning.Of course, the results of the present study also correspond with this research in some parts and conflict with it in other parts. The average performance of the groups of subjects of the present study in the acquisition stage showed that distributed practice in this stage is more effective than massed practice which conflicts with MagiLs, finding.Of course this confliction may be related to the duration of the performance and the nature of the skill because; dart skill despite being a discrete task, takes a short time to perform and also it seems simpler than the task mentioned in that research.But, MagiL points out that these two methods do not show a significant difference in retention stage. This part of the findings corresponds with the results of the present research too (Magil, 2001). Of course, it should be remembered that the results of this research corresponds with Dail Tresa and Robert Christina's studies which has been reported recently (2004) and they confirm each other. Christina et al. (2004) declare in this report that those who had practiced the skill of golf hit as a discrete skill according to the distributed method displayed a better performance in comparison with those who had practiced it according to take massed method. Contrarily, these two groups did not show a significant difference on their performance in the retention stage. The result of the present study also proved the same point that these two groups do not have a significant difference in acquisition stage. As you saw, the findings of the present research in comparison with the few studies which have been done across the world correspond with their findings in some cases and conflict with them in other coses. But, in interpreting and justifying the findings of various studies and comparing them with each other, in addition to the nature of the skill and the used tasked, other conditions also should be taken into account some of which relate to the learner and some others relate to the environment of practice and acquisition. Because the extent of complexity or simplicity of the skill itself is it continued or discrete, has a special statue as an effective factor in the theoretical literature of the topic. Also, the amount of the discovery involved which again to some extent relates to the nature and organization of the skill is one of the other effective factors. The age of the learners also has been considered as one of the effective variables in the theoretical resources associated with the motor learning science (Heidi, 1992). So in interpreting the results and comparing the findings with the each other, one should act cautiously and take all the circumstances into consideration. So, perhaps, the reason for not seeing a significant difference in using these two methods of practice in the stage of acquisition and retention the motor skill of dart throwing, relates to the nature of the intended skill.Because, based on the available literature, the distributed practice can have the most effect only when its skill and performance is followed by exhaustion rather it includes and this exhaustion is not limited only to physical and muscular exhaustion nervous and cognitive broadness too. So, it seems that the intended skill in this research did not entail a noticeable exhaustion in this respect. For this reason, lack of difference in using these two methods, may be related to the same phenomenon. Complexity of the skill also is one of the variables effective on the usefulness and superiority of the distributed method over massed method. The intended skill seemed rather simple in this study too. Generally speaking, in the end, one should acknowledge that based on the findings of the few studies which have been done across the world and the results of this research , although massed practice is in favor of learning discrete motor skills, in applying and generalizing these findings, one should be very cautious because, the researches and findings in this regard are not much enough so that it is not easy to definitely make a recommendation about the method of practice with this class of skills. So, in order to trust and make sure of the findings of this study and other studies that have been done, ample and repeated researches are needed and what was declared as final result in this study, probably has been resulted from various factors such as the age of the learners, the extent of the complexity of the intended skill, the duration of practice, motivation of the subjects, the way of controlling the amount and proportion of rest during performance of the projects etc. So, it is advised that other researches be done to complete and confirm these results so that the findings of this research can be applied operationally in sport and in practice.

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USPOREDBA EFEKATA NAGOMILANOG I DISTRIBUIRANOG VJEŽBANJA U RAZLIČITIM STANJIMA DISKRETNIH MOTORIČKIH ZADATAKA

Sažetak
Kako rasporediti trajanje vježbanja i odmora u svakoj sesiji je stvar od interesa u organizaciji vježbanja motoričkih vještina. U ovom smislu, većina studija predstavlja prirodu motoričkih zadaža kao faktor koji je određen i predlaže da, ako se diskretne vještine vježbaju u skladu s metodom nagomilavanja i trajnih vještina u skladu s distribuiranom metodom, tada će biti postignut bolji rezultat. Međutim, čini se da stanje učenika prije izvođenja testa također kao jedna od postojećih varijabli u ovom procesu, nije uzeta u razmatranje. U ovom smislu i u cilju određivanja uloge stanja učenja u mehanizmu distribuiranog vježbanja i odmora za trajanja sesije, 60 muških studenata Tabriz Univerziteta po slučajnom ključu je podijeljeno u dvije grupe. Jedna grupa je ponavljala jedan od motoričkih zadataka (bacanje strelice) kroz pet sesija sa dva bloka u svakoj sesiji u skladu s metodom nagomilavanja, a druga grupa u sklad us distribuiranom metodom. Naravno, svaki je blok sadržavao po deset pokušaja. Za vrijeme ovog tečaja, rezultati izvedbe subjekata su snimani ponovljenim i pre-i-post testom, i konačno, stopa učenja subjekata postajla je poznata korištenje testa retencije. Nakon prikupljanja podataka i analize u skladu s t-testom, dobiveni su slijedeći razultati: nalazi su pokazali da izvedba u obje grupe u pre-testu i post-testu ima značajnu razliku. Ali, izvedba u obje grupe subjekata nije pokazala nikakvu značajnu razliku u bilo kojem od stanja ili ponovljenih pre i post-testova. Naravno, treba primjetiti da grupa koja je vježbala u skladu s metodom nagomilavanja, postigla je bolji rezultat od grupe s distibuiranom metodom na odgođenom testu retencije što je bilo registrirano u interval od 48 sati nakon zadnje vježbe u sesiji, iako ovaj bolji rezultat nije bio statistički značajan. Dakle, sukladno nalazima ovog istraživanja, stanje učenika dok uči motoričke zadatke, ne smatra se efikasnim i značajnim faktorom na način distribucije vježbi i trajanja odmora. Iako, da bi tema bila čišća, preporučuju se mnogo brojnija i egzaktnija istraživanja.

Ključne riječi*: nagomilavanje, distribuirana vježba, diskretni motorički zadatak, stanje motoričkog učenja*

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THE INFLUENCE OF INERTIAL LOAD APPLICATION ON KINEMATIC AND DYNAMIC PERFORMANCES OF RUNNING AT MAXIMUM SPEED PHASE

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Original scientific paper

Abstract
The objective of this research was to produce changes in kinematic and dynamic performances of maximum running speed in training with additional inertial loads application, as well as to determine the adaptive processes that were supposed to significantly influence the maximum running speed in the observed variables. The change of kinematic variables recorded by non-contact telemetry measurement (two-dimensional system) of a cycle of strides during sprint step in the phase of maximum running speed was analyzed, as a consequence of programmed training procedures application with an additional load at two different positions. The obtained results indicate that the applied experimental factor within the specific six week period caused statistically significant changes in experimental (EA) and (EL) groups. It is obvious that the different location of inertial load in experimental groups affected the changes in the observed variables differently, as well as that the applied additional load selectively affected the change in the observed variables.

Key words : *running speed, stride frequency, stride length*

Introduction

It can be assumed that the kinematic and dynamic variables of maximum running speed change under the influence of additional loads, depending on their weight and fixing position. Different results were obtained about it, and they are probably caused by the application of different methodologies in researches. This implied the application of different load weight, the fixing position as well as various running speed at which experiments were conducted. However, in most researches the measurements were conducted at a moderate speed during treadmill running, with the exception of some in which the change of kinematic variables in terms of maximum speed and acceleration with the additional load was analyzed (Majdell & Alexander, 1991; Ropret et al., 1998). The results indicating increased frequency and reduced stride length were obtained in most papers (Rusko & Bosco, 1987; Cooke et al., 1991, etc.). The opposite results, when the frequency was reduced and stride length increased, have been reported in the researches (Stegman, 1981; Winter, 1983; Martin, 1985, etc.). The result when the increased arm load and leg load in particular caused a reduction in running speed, while the stride length remained unchanged and frequency reduced, was obtained (Ropret et al., 1998). In some studies the results showed no change in stride length and frequency (Catlin & Dressendorfen, 1979; Cavanagh & Kram, 1989; Martin & Cavanagh, 1990). Majdell & Alexander (1991) verified the change of the kinematics of 40 m running at a maximum speed, under the influence of training with the additional load.

Six-week training with the additional load (10 pounds, 4.5 kg) was applied in the experiment. The treatment influenced the maximum speed of running to be statistically significantly increased (from 5.16 m/s^{-1} to 5:26), to shorten the contact phase (from 0.13 to 0.11sec), to statistically significantly reduce the upper leg angle of the take off leg in a moment of take-off (from 4.27 to 4.12 degrees), as well as and to increase the maximum angle of the lower leg flexion (from 2.62 to 3.28 degrees). The application of external load of participants during maximum speed running has already been suggested as a potential method of training (Bosco et al., 1986; Ropret et al., 1998; Pajić, 2000). Such a training of running at maximum speed with the additional load should be effective in order to enable the conversion of the increased muscle strength into muscle power (Delecluse et al., 1995; Ropret et al., 1998). The objective of this research was to analyze the effects of additional inertial load in the training process on the maximum running speed. The applied experimental factor should cause changes in kinematic and dynamic performances of maximum running speed in order to determine the adaptive processes in the observed variables.

Methods

Sample of participants
The sample of participants in this study consisted of students of Faculty of Sport and Physical Education in Belgrade (Table 1). From the current population a sample of students was defined (n = 18).

With respect to the initial sprint time the participants were classified into three groups depending on the running speed. The groups were formed in attempt to make the equal abilities distribution among them.

Table 1 Descriptive indicators for each group of participants

	AM for each group ± S.D. (N=6)		
Variables	C	EA	EL
Age	20.8±1.8	20.2±1.12	20.4±1.7
Height (cm)	176.3±9.0	177.8±11.2	178.4±8.12
Mass (kg)	69.36±11.7	72.7±7.8	71.4±8.5
50m - time (s)	6.83±0.24	6.63±0.65	6.81±0.44

C – control group; (E-A) – experimental group with arms load; E-L – experimental group with legs load

Measurement conditions and variables

The system of three pairs of solar cells was applied for time parameters measurement – measurement system (Brower timing system). The following variables were measured: Running speed in the maximum speed phase (VR), The average stride length in the maximum speed phase (SL), Stride frequency in the maximum speed phase (SF). For the number of strides (NS) measurement, the system of three video cameras was used, one of which recorded the distance of 25-50m in order to determine the number of strides between the first and the last contact, while the first and the last contact were identified by the other two cameras. The average stride length (SL) was calculated by dividing the distance between the first and the last foot contact with a number of strides. Stride frequency (SF) was calculated by dividing the speed of running with the length of strides. Based on the time for which the distance was run, the maximum speed of running was calculated (VR). For kinematic parameters measurement Mac Reflex 3.2 Measurement System Software with the Macintosh version 3.0 (for 2D and 3D system) was applied. The measurement procedure with this system provides a non-contact (telemetric) movement measurement. The basic principle of the system is recording the position of a number of well-defined points in space.

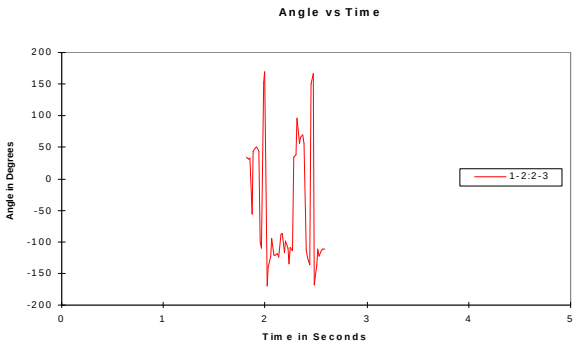

Figure 1. Presentation of realised elbow joint angles in time (between the 1. and the 2. and 2. and 3. reflective markers on arm, while performing maximum running speed, obtained by telemetric measurements of the movement, using Mac Reflex system.

The measured points are marked with reflective markers, and their movements are registered by a special video camera (Figure 1). The kinematic variables measured on the track in conditions of maximum running speed: angle in the knee joint center at take-off time (AKTT), angle in the knee joint center at the time of contact (AKTC), angle of maximum flexion of the lower leg during the back swing (AMFL), angle of maximum flexion of the forearm during the back swing (AMFA). Based on the previous measurements and software data acquisition with the applied software Mac Reflex 3D.V.3.1B2 and Microsoft Excel software adaptable, the values for variables (AKTT, AMFL, AMFA, and AKTC) were determined.

The experiment protocol

The experiment with parallel groups was carried out during which the effect of the experimental factor (inertial load) was on two levels. The first control group (C) realized the sprint training without additional load application. Second experimental group (EA) ran with the additional load attached to the arms. The third experimental group (EL) ran with the additional load attached to the legs.

Experimental factor

In order to increase the moment of the arms and legs inertia in the training procedure the additional load was applied in the form of bands with plates, fixed to the ankle and wrist. In line with previous researches and results (Catlin and Dressendorfen, 1979; Cavanagh & Kram, 1989; Stegemann, 1981; Martin, 1985; Ropret et al., 1998) a load of 1.8kg was applied, for which it was calculated that it changed the average torque inertia for about 50%.

Testing procedure

The research included initial and final measurements of all variables. Both measurements were realized in two days, the initial measurement (pre-test) one day prior to the beginning of training procedures application, and the final one two days after the end of the training procedure. The measurement of dynamic and kinematic variables was realized in running at maximum speed on the track from the 25th to 50th meter. Each participant ran two times, and for the final processing, better result was used. Measuring devices (photocells - Brower Timing System) were set at the start, to register the stand position start (0.5m), at 25m and at the end of 50m. The values were measured with an accuracy of 0.01 s.

Training procedures

After the warm up, the athletes performed their specific training procedures. During the six-week-long experiment the trainings were performed three times a week. Training intensity was progressively increased, and the workload was increased after every two weeks. In the first two weeks, each participant was performing a series of five repetitions of their specific training regime. During the third and the fourth week of training the load was increased during two series, and in the last two weeks during three series of five repetitions.

Running was performed at maximum speed at 50m from semi-crouched position start with a 2-3 min. rest period between each run and with 8-10 min. of recovery between the series.

Acquisition of experimental results
Out of the descriptive statistical indicators, the measures of central tendency (arithmetic mean – AM) as well as measures of dispersion (standard deviation - SD) were applied. Out of the qualitative methods of statistical analysis, the *t-test* for dependent samples was applied. The level of significance ($p < 0.05$) was applied to determine the significance of differences between pre-test and post-test for each group. Statistical analysis was performed in the statistical program SPSS 16.

Results and discussion

Table 2. Descriptive statistics at the initial and the final measurement for the control group (C), experimental (EA) and experimental (EL) groups.

vars.	measur.	control (C)		experimental		experimental	
		M	SD	M	SD	M	SD
VR	final	8.11	0.45	8.45	0.27	8.29	0.30
	initial	8.10	0.35	8.45	0.35	8.33	0.37
SL	final	2.01	0.12	2.16	0.14	1.98	0.23
	initial	1.96	0.20	2.08	0.14	1.88	0.24
SF	final	4.02	0.20	3.92	0.24	4.22	0.46
	initial	4.19	0.27	4.07	0.29	4.47	0.47
AKTT	final	160.83	4.66	166.20	1.16	161.00	1.41
	initial	160.66	4.63	160.30	1.03	162.66	1.03
AKTC	final	158.33	3.50	164.00	2.09	155.33	1.75
	initial	156.83	4.87	157.00	2.28	159.00	1.09
AMFL	final	38.83	2.85	43.00	3.63	45.66	3.72
	initial	39.66	2.33	42.16	4.87	42.50	4.08
AMFA	final	104.83	3.48	97.50	3.78	113.16	4.21
	initial	106.33	3.72	106.30	4.50	106.00	6.09

Table 3: T- test for small dependent samples at the initial and the final measurement for the control group (C), experimental (EA) and experimental (EL) groups.

	control (C)			experimental (EA)			experimental. (EL)		
vars.	t	df	Sig. (2-tailed)	t	df	Sig. (2-tailed)	t	df	Sig. (2-tailed)
VR	-0.87	5	0.42	-0.02	5	0.99	-0.63	5	0.56
SL	1.27	5	0.26	3.27	5	0.02	5.42	5	0.00
SF	-1.57	5	0.18	-5.89	5	0.00	-8.00	5	0.00
AKTT	0.42	5	0.70	10.75	5	0.00	-2.71	5	0.04
AKTC	1.31	5	0.25	8.57	5	0.00	-8.70	5	0.00
AMFL	-1.75	5	0.14	1.19	5	0.29	10.30	5	0.00
AMFA	-2.42	5	0.06	-22.01	5	0.00	3.91	5	0.01

The results of the descriptive statistics for all three groups at the initial and the final measurement are displayed in Table 2. The results of t-test for dependent samples at the initial and the final measurement are shown in the Table 3. It is evident that the applied training procedure in the phase of maximum speed did not cause statistically significant changes in the running speed (VR) in any group. From the above it is evident that the participants of the group (EL) reduced the running speed, but not within the range of statistical significance. The comparison of results from the initial and final measurements showed that there were no statistically significant changes in the observed variables in the control group.

In the experimental groups there are statistically significant differences in variables for the average stride length (SL) as follows – on average the participants had a lower score on the initial measurement (EA - $p < .022$) and (EL - $p < .003$) and the stride frequency variable (SF) – the participants on average had higher scores on the initial measurement (EA - $p < .002$) and (EL - $p < .000$). Therefore, there was an extension of strides and the reduction of their frequency. If the running speed approaches the value of 7 $m.s^{-1}$, the speed increases due to the increased stride length, provided that the frequency is not significantly changed (Jarić, 1997). The mentioned speed represents entering the zone of the upper limit for the maximum stride extension, because when running speed exceeds 7$m.s^{-1}$, the stride length begins to grow more slowly, while at 8-9$m.s^{-1}$ it reaches its maximum. The further speed increase is achieved by increasing stride frequency, which continues to grow rapidly, because only at the expense of its increase the maximum running speed is achieved (Luhtanen & Komi, 1978; Williams, 1985; Mero & Komi, 1985; Majdell & Alexander, 1991; Mero et al., 1992; Jarić, 1997). Apparently, the participants have reached the maximum speed of 8-9$m.s^{-1}$, and thus the stride length. Given that there are no statistically significant changes in the speed of running (VR) in these groups, it can be assumed that the cause for that was statistically significant increased stride length, and consequently reduced number of strides, as well as reduced frequency of strides on the distance run, especially in groups (C) and (EL). The fall of frequency was probably due to the increased moment of inertia of legs, and thus to reduction of the angular speed of segments. The reasons for the speed reduction in the experimental group (EL) might be found in the assumption that the applied load caused an inadequate adaptation of the nervous system in movement control, i.e. there was a violation of techniques and movement coordination. Another reason could be a deficit of the speed (reactive) force which is necessary in the changed conditions of overcoming the gravitational forces, ground reaction forces and the inertia of the lower extremities. According to Stegman (1981), the increased moment of inertia results in lower natural frequency of the leg which acts like a pendulum. This suggests that the swing length increases, while the stride frequency is reduced. Under the assumption that the speed of motion is unchanged, the stride frequency reduction is followed by stride length increase. This claim was proved by Martin (1985) in an experiment - a load of 1 kg was applied on a foot, which increased the inertia moment by 13%.The inertial properties of a leg were significantly modified, the participants "reluctantly" adapted themselves to this new optimal stride frequency. Bobbert et al. (1986) stated that the insufficient leg speed in the swing, since it was burdened with inertia load, could be the limiting factor for further increase of the running speed. The assumption is that these changes are consequences of adaptation of the nervous system to manage movements with the

aim, in conditions of maintaining a constant speed, to create the most economical movement structure (frequency x stride length) for each type of load. The adaptation, among other things, due to inertia of the changed conditions for the legs, is performed in extended swing (resting) phase, which also causes the decrease of stride frequency. If the speed is the same or slightly decreased, any reduction of frequency results in the stride extension. It can be assumed that, together with the prolonged duration of training factor influence, there would be a correction in speed power expression, and consequently an easier correction of altered inertial conditions for the loaded leg. It would cause a better adaptation, i.e., more efficient movement realization in the changed conditions to overcome the gravitational forces, leg inertia and ground reaction forces, and thus the relative increase in movement frequency. This would probably increase the running speed. Based on the results presented, higher importance of frequency than stride length during running at maximum speed can be emphasized, which corresponds to the findings of many authors (Armstrong & Cooksey, 1983; Čoh, 1985; Mero, Komi, Rusko & Hirvonen, 1987; Mero & Komi, 1994; Ropret et al., 1998). The applied training procedures in the phase of maximum speed in the experimental groups (EA) and (EL) caused a statistically significant change of the knee joint center angle at the time of take-off variable (AKTT) – in average, the participants in the initial measurement had lower scores (EA - p <. 000) and higher scores (EL - p <.042). For higher speed of running at the time of take-off it is very important that the critical angle of the body is greater at take-off, namely a greater knee joint angle at take-off (AKTT), i.e. lower flexion, because the effect of the horizontal component of ground force reaction on the speed of running in the ventral direction is more positive. From this follows that lowering the center of gravity causes greater flexion of the knee joint (AKTT), lower critical body angle and less positive effect of the horizontal ground reaction force in ventral direction. The results indicate that the angle increase in (EA) influenced positively, while the reduction in (EL) influenced the speed of running negatively. The applied training procedure of the experimental groups (EA) and (EL) caused a statistically significant change in the variable the center of the knee joint angle at the time of contact (AKTC) – the participants on average had a lower score in (ER - p <.000) and higher score in the initial (EN - p <.000). During running, at landing and in the moment of contact with the ground (AKTC) a certain horizontal deceleration, i.e. speed reduction of the body center happens, namely a depreciation phase is realized. For greater speed of running at the moment of contact with the ground it is essential that the body angle upon contact is less critical, namely a greater knee joint angle at contact (AKTC) i.e. lower flexion, because it reduces the negative impact of the horizontal component of ground force reaction on the speed of running in the dorsal direction. The results indicate that the increase in angle in (EA) influenced positively, while the reduction in (EL) influenced the speed of running negatively. From the aforementioned results it is noted that the participants in the experimental group (EL) increased the average angle of maximum flexion of the lower leg during the last swing (AMFL) within the statistical significance – the participants on average had a lower score on the initial (EL - p <.000). This change has a negative effect on running speed since the moment of leg inertia is increased, the angular speed and thus the leg frequency are reduced. The maximum forearm angle flexion during the back swing (AMFA) changed significantly – the participants on average had higher scores in the initial measurement (EA - p <.000) and lower scores (EL - p <.011). Since smaller angle reduces the moment of arm inertia, greater speed is achieved, that is, a shorter duration of arm swing phase. This results in body segments movement frequency increase, i.e., in positive impact on higher running speed. It is interesting that, despite the foregoing, the experimental group (EL) significantly increased the average angle of maximum forearm flexion during the back swing (AMFA) within the statistical significance. It could be expected that the participants would adapt themselves to the changed inertia conditions and make adequate flexion of the elbow joint, reduce the angle and moment of inertia. However, due to the significant increase of leg flexion angle in the swing phase, and thus the moment of inertia, probably due to synchronous activity of collateral limbs, the increase of position moment of arms inertia represents a compensating attempt to counter the increased inertia forces of the leg moving in the opposite direction. Therefore, this could affect better movement synchronization of contra lateral segments, to a more stable overall movement of a lever system of the entire body. The increased arms frequency that counters legs frequency causes higher level of neural activity (reciprocal inhibition) and thus affects the kinematics of the legs.

Table 4: Descriptive statistics for all three groups of participants at the final measurement

	control (K)		experimental (EA)		experimental (EL)	
vars.	M	SD	M	SD	M	SD
VR	8.11	0.45	8.45	0.27	8.29	0.30
SL	2.01	0.12	2.16	0.14	1.98	0.23
SF	4.02	0.20	3.92	0.24	4.22	0.46
AKTT	160.83	4.66	166.16	1.16	161.00	1.41
AKTC	158.33	3.50	164.00	2.09	155.33	1.75
AMFL	38.83	2.85	43.00	3.63	45.66	3.72
AMFA	104.83	3.48	97.50	3.78	113.16	4.21

Bearing in mind that the reduction of the swing amplitude is more possible in the elbow joint than in the knee and hip joints (Majdell & Alexander, 1991), it can be assumed that these adaptive processes, as a result of arm load, can influence the change in leg kinematics. The results of the descriptive statistics for all three groups at the final measurement are shown in the Table 4.

Table 5. T- test for small independent samples among all three groups at the final measurement

vars.	C-EA			C-EL			EA-EL		
	t	df	Sig. (2-tailed)	t	df	Sig. (2-tailed	t	df	Sig. (2-tailed
VR	-1.59	10	0.14	-0.81	10	0.44	0.98	10	0.35
SL	-1.86	10	0.09	0.29	10	0.78	1.58	10	0.15
SF	0.76	10	0.47	-0.95	10	0.36	-1.39	10	0.20
AKTT	-2.72	10	0.02	-0.08	10	0.94	6.90	10	0.00
AKTC	-3.40	10	0.01	1.88	10	0.09	7.77	10	0.00
AMFL	-2.21	10	0.05	-3.57	10	0.01	-1.26	10	0.24
AMFA	3.49	10	0.01	-3.73	10	0.00	-6.78	10	0.00

The comparison of the final measurement results for all three groups in all variables are shown in Table 5. There are statistically significant differences between the control group (C) and experimental group (EA) and the experimental group (EL) in the following variables: the center of the knee joint angle at the time of take-off (AKTT) – the participants in the control group (C) on average had a lower score than the participants in the group (EA) - ($p < .022$), while the group of participants (EL) on average had a lower score than the participants of the group (EA) - ($p < .000$); the center of the knee joint angle at the time of contact (AKTC) – the participants in the control group (C) on average had a lower score than the participants in the group (EA) – ($p < .007$), while the group of participants (EL) on average had a lower score compared to the athletes in the group (EA) – ($p < .000$). The angle of maximum lower leg flexion during the back swing (AMFL) – the participants in the control group (C) on average had a lower score than the participants of the group (EL) – ($p < .005$); The angle of maximum forearm flexion during the back swing (AMFA) – the participants in the control group (C) on average had higher scores than the participants of the group (EA) – ($p < .006$) and lower score in comparison to the participants of the group (EL) – ($p < .004$). The participants in group (EL) on average had higher scores than the participants of the group (EA) – ($p < .000$). It is evident that the key differences between the groups were in the last variable (AMFA) and that the effect of the experiment was the most prominent there. Additionally, for (EA) group the significant results are the variables of the center of the knee joint angle at the time of take-off (AKTT) and the center of the knee joint angle at the time of contact (AKTC), since they are significantly different for this group unlike for the other two groups. For (EL) group the characteristic variable is the angle of maximum lower leg flexion during the back swing (AMFL), but only in relation to the control (C).

Conclusion

The change of kinematic variables recorded by non-contact telemetric measurement (two-dimensional system) of one cycle of strides during sprint strides in the phase of maximum running speed was analyzed, as a consequence of programmed training procedures application with an additional load at two different places. The obtained results indicate that the applied experimental factor in the specific six week period caused statistically significant changes in experimental (EA) and (EL) groups. It is obvious that the different place of inertial load in the experimental group affected differently the changes in the observed variables, as well as that the applied additional load selectively affected the change of the observed variables. The applied load significantly influenced the kinematic variables, the influence of which is obvious for factors that favor, as well as those that interfere with the performance of maximum running speed efficiency (angular momentum, moment of inertia, force reaction, gravity, the effects of one-joint and biarticulated muscles, body movement activities, kinetic chain activities). We can assume that the variables AKTT, AKTC, AMFL and AMFA are predictable for the maximum running speed and that there is their significant connection with running at maximum speed. The results of this study face a new dilemma. It is not clear whether the same load for arms and legs is adequate, since the arm adjustment to the changed conditions of moment of inertia, and therefore the gravitational forces is much higher compared to the leg adjustment, as well as whether different time is needed for full adaptation of both arms and legs. In this research an attempt to increase the momentum by changing the inertia conditions is significant. Momentum cannot be improved by higher moment of inertia that is created when applying even a very small additional load (even if it is only a few hundred grams), especially if applied at the end of the kinetic chain, because in this case very inadequate high angular velocities are obtained. The introduction of the absolute value of the load, without calculating the actual mass of each locomotive apparatus individually, raises doubts because the moment of inertia increases by mr^2, i.e., the value of the applied load is squared, even if it is only one gram. The squared changes cause the multiplication of errors.

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UTJECAJ PRIMJENE INERCIJSKOG OPTEREĆENJA NA KINEMATIČKU I DINAMIČKU IZVEDBU TRČANJA U FAZI MAKSIMALNE BRZINE

Sažetak
Cilj ovog istraživanja je bio izazivanje promjena u kinemtičkoj i dinamičkoj izvedbi maksimalne brzine trčanja u treningu s dodatnom primjenom inercijskog opterećenja, kao i određivanje adaptivnih procesa za koje se očekivalo da će značajno utjecati na maksimalnu brzinu trčanja u praćenim varijablama. Promjene kinematičkih varijabli snimljene ne-kontaktnim telemetrijskim uređajima (dvo-dimenzionalni sustav) ciklusa koraka za vrijeme sprinta u trenutku trčanja maksimalnom brzinom su analizirane kao primjenu sekvenci procedura trenažnog programa s dodatnim opterećenjem na dvije različite pozicije. Dobiveni rezultati ukazuju da je primjenjeni eksperimentalni factor unutar specifičnog razdoblja rada u trajanju šest tjedana uzrokovao statistički značajne promjene kod eksperimrntalnih EA i EL grupe. Očito je da različite lokacije inercijskog opterećenja kod eksperimentalnih grupa različito djeluju na promjene promatranih varijabli, kao id a primjna dodatnog opterećenja selektivno djeluje na promjene praćenih varijabli.

Ključne riječi: *brzina trčanja, frekvencija koraka, duljina koraka*

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