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Man cannot discover new oceans unless he has
the courage to lose sight of the shore.
(Lord Chesterfield)

Dear reader,

In December, in the time with different holydays, when we all have an opportunity to refresh our memories and share them with those who we love and care we publish our and yours journal Sport Science. In such environment, to all people of different ages, all cultures and confessions, all races and occupations, with Vol. 2, Issue 2, in the name of all cooperatives, we wish pleasant moments and with enjoyment fulfilled new 2010. Continuing with our activities on internationally recognized journal we hope and believe that, with articles assortment we can make at least little touch to your scientific interests. Equally as thus far, we hope we can encourage young people to try on in areas of scientific space. This issue too, offers interesting contributions inside several domains. Methodologically oriented articles addresses themes about parameterization of tree-dimensional trajectories, interaction of sportsman genetic and non-genetic potential, uncertainty coefficient for competition optimization, and we represent global nonlinear model of success evaluation. Anthropologically oriented articles addresses themes on rheumatoid factor and reactive arthritis, accuracy of feed-back mechanism in sensorimotor exercises, about primary school pupil's postural status and energetic sources as a basis for football. Closely to training technology domain you can find articles of solving 2 on 2 game situations in ice-hockey, about morphological characteristics of 10-years footballers, lost of waterpolo attractiveness, conative characteristics related to efficacy in boxing, and relations about perception and specific motor dimensions in volleyball sitting players. In education domain you can find articles about motion sensor outputs of adolescents, changes of functional abilities of female students under Thae-Bo exercises application and attitudes of teachers connected with inclusion of children with difficulties in PE lessons. Finally, management in sport is presented with articles about management of development phases in sport and analysis of innovative model of sport organization. We believe that almost anyone can find somewhat interesting in such set of articles.

Executive Editor
Danijela Bonacin, MSc st.

Nova mora moći ćeš otkriti tek kad stekneš
dovoljno hrabrosti da iz vida izgubiš obalu.
(Lord Chesterfield)

Dragi čitatelju,

U prosincu, u vrijeme kad imamo prigodu uz različite blagdane osvježiti naša sjećanja i podijeliti ih s onima koje volimo i koji su nam dragi, publicira se naš i vaš časopis Sport Science. U takvom ozračju, ljudima svih uzrasta, oba spola, svih kultura i vjeroispovijesti, svih rasa i zanimanja, uz Vol. 2, Issue 2, u ime svih suradnika želimo ugodne trenutke i zadovoljstvom ispunjenu novu 2010 godinu. Nastavljajući aktivnosti sad već međunarodno prepoznatljivog časopisa, nadamo se i vjerujemo da ćemo odabirom priloga barem malo dotaknuti vaše znanstvene interese. Jednako tako kao i do sada, da ćemo potaknuti mlade ljude da se okušaju u vrletima znanstvenih prostranstava. I ovaj broj nudi zanimljive priloge unutar nekoliko područja. Metodološki orijentirani članci govore o parametrizaciji trodimenzionalnih trajektorija, interakciji genetskog i negenetskog potencijala sportaša, koeficijentu nesigurnosti za optimizaciju natjecanja, a predstavljen je i globalni nelinearni model evaluacije uspjeha. Antropološki usmjereni članci govore o reumatoidnom faktoru i reaktivnom artritisu, preciznosti mehanizma povrate veze u senzomotornim aktivnostima, o posturalnom statusu učenika osnovnih škola i energetskim izvorima kao temelju treninga nogometaša. Trenažnom tehnologijom u užem smislu bave se članci o rješavanju zadataka 2 na 2 u hokeju na ledu, o morfološkim značajkama 10-godišnjih nogometaša, gubitku atraktivnosti u vaterpolu, odnosu konativnih značajki i efikasnosti u boksu, te relacijama percepcije i specifične motorike igrača sjedeće odbojke. Edukacijski orijentirani članci govore o odzivu senzora gibanja kod djece oba spola, promjenama funkcionalnih sposobnosti studentica pod utjecajem Tae-Boa i stavovima nastavnika prema uključivanju djece s poteškoćama u nastavu. Konačno, menadžment u sportu je zastupljen člancima o upravljanju razvojnim fazama u sportu i analizi inovativnog modela sportske organizacije. Vjerujemo da gotovo za svakoga ima ponešto zanimljivo u ovakvom skupu priloga.

Izvršni urednik
Danijela Bonacin, MSc st.

PARAMETERISATION OF THREE-DIMENSIONAL TRAJECTORY OF A POINT PLACED ON HUMAN BODY USING FOURIER SERIES

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Original scientific paper

Abstract

In the article a parametric model of human movement is presented with particular interest given to behavior of vertebral column. The model is based on Fourier trigonometric series and applied to real data set collected in experiments performed on a big group of volunteers in a stereovision laboratory. A special application for parameterization and visualization of results is described. Examples of results are presented in a form of three dimensional trajectories of chosen points on a patient's body.

Key words: *bioengineering, stereovision, vertebral column pathologies, Fourier analysis*

Introduction

Spine diseases can affect almost everyone irrespectively of age. If untreated they can lead to permanent and painful deformations and also to different kinds of circulatory, pulmonary or neurological disorders. Most common problems of vertebral column pathologies are connected with deformations such as kyphosis (the extreme curvature of the upper back also known as a hunchback), lordosis (an abnormal forward curvature of the spine in the lumbar region, also called hollow back, saddle back) and scoliosis (a side-to-side curvature of the spine). Deformations are measured in Cobb's (Tran, 1997) scale as regarded as diseases if exceeding 10 degrees in this scale. The risk of deformation is the highest in the period of adolescence, when the body grows fast, especially if the absence of proper physical activity and treatment. Until now spine column examination was performed by an orthopedic and in the case of suspected pathology complemented by additional X-ray examination. In the latter case diagnostics was based on static X-ray images. In this paper a new approach is proposed which allows for examination not only the shape of vertebral column but also its dynamics. The idea consists of observing the movement of vertebrae of a patient walking on the track, by a set of cameras. Special software is designed in order to enable visual inspection of the movement and selection of proper data. The proposed method is noninvasive so it can be applied without restrictions, as frequently as needed, if only a patient is capable of walking. It is particularly important in the case of earlier revealed pathologies, in post surgery diagnostics, after applying therapies such as rehabilitation exercises and for keeping track of changes.

The additional advantage of the method is its low cost which is especially important if many series of examinations are needed for example screening of children or adolescences. The proposed method is similar to the technique applied recently in computer animation where movements of an animated character mimic a real person – an actor, whose movements are recorded by set of sensors on her/his body.

Problem and goal

The goal of this study is to create a parametric description of three dimensional trajectory of an arbitrarily chosen point placed on a patient's body. Parameterization allows for a mathematical description of the movement of the point in the space. Parameterization is applied to moving vertebrae of a given patient to create a mathematical model of her/his spine which can be further analyzed in order to detect possible imperfections and disorders. Parametric description of trajectory makes it possible to encode movement as a collection of numbers which can be later compared or used to other computations. Parameterization also enables significant compression of stream of real input data.

Special computer application is designed in order to enable analysis of signals coming from points on a human body changing position during movement and approximation of trajectories by a continuous function. This approximation is fully automated but can be controlled by adjusting some parameters. The possibility of graphical representation of results (signals, trajectories and animation of movement) is also important.

Significant restrictions in realization of this program are related to availability of real data. Data should come from specialized laboratory which is for the time being situated only at the University of Valencia (Spain).

Methods

Real data which are to be analyzed are collected in specially prepared stereovision laboratory. Permission for conducting this research was granted by the following institutions: University of Valencia, La Fe Hospital, and the Ministry (Generalitat Valenciana). The group of volunteers - first year's students of the University of Valencia was assembled for the experiment (Gonzalez, et al., 2006). The equipment of the lab consists of the set of four cameras, a PC computer and a track. The cameras, see Fig.1, are placed at the perimeter of a rectangle, in front of the track, in a way which enables observation of all reflection points on a patient's body, see Fig. 2. Every camera is equipped with an electronic system emitting infrared light and an infrared filter. The signal from the cameras is transmitted to the computer where it is processed and stored. The cameras record position of the points (so-called reflectors) which are made from a material which reflects infrared light coming from the emitters. Because of the filter the cameras register only infrared light, either reflected or emitted by another object. The computer processing the signal is equipped with software for registering sequences of point images which come from all the cameras.



Fig. 1. A camera with a system emitting infrared light and an infrared filter (source: own)

By a point image we mean a collection of coordinates (x, y) for every observed point at a given moment of time. The cameras record black and white images and, because a point is visible as a spot of light of size usually bigger than 1 pixel, for the coordinates the system takes the baricenter of a homogeneous set of pixels of given brightness. In this way four sequences of point images are recorded in the lab, one sequence for every camera.

Three-dimensional images are constructed by application of stereovision that is simultaneous observation of three-dimensional scene by a multiple cameras. For every pair of two dimensional images it is possible to reconstruct a three dimensional model (*bifocal analysis*) of course only for the set of points which are recorded by both the cameras. Four suitably placed cameras enable full reconstruction of three dimensional models (Mery, 2002).

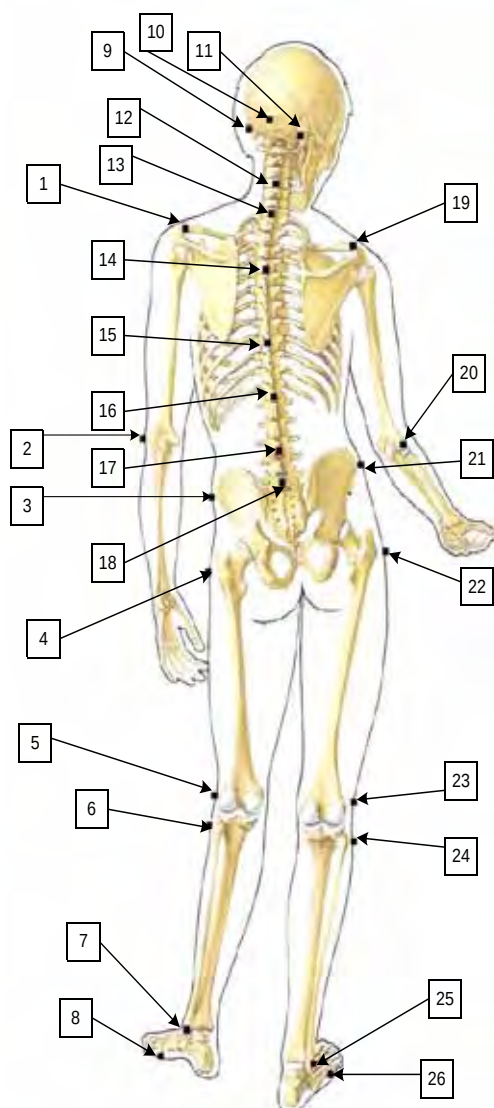


Fig. 2. A patient with marked reflection points walking on the track (source: own)

The algorithms which enable correct recognition of points placed on the body of observed patient are developed in Valencia. After placing the set of receptors on a patients body, see Fig. 2, on points, see Fig.3, she/he enters onto the track which is situated in such a way that the cameras can observe the back of her/his body and she/he starts walking. While the patient walks, an employee of laboratory registers the sequence of point images seeing by the cameras. During the process of collecting data, two subsequent series of images is recorded. Every series consisting of 500 shots. Observation of a trajectory of points on a body of a walking person allows us to notice some regularity. Every coordinate of the signal is approximately periodic although a little bit distorted.

Changes along x coordinate represent the side to side movement, changes along y coordinate – up and down movement, along z – forward and backward movement. All these signals oscillate around some mean value. This suggests the idea to approximate signals by sinusoidal functions using trigonometric Fourier series (Cooley & Tukey, 1965; Smith, 2007).

It is well known that series of this form can approximate any periodic function, if parameters are suitable chosen. Parameterization of quasi-periodic real signals and their approximation by strictly periodic functions is performed automatically (Stawska, 2006; Press & Teukolsky, 2002). Analysis of data is conducted in the following five steps (2.1.- 2.5.).



Number	Markers location
1	acromion
2	epicondylus lateralis humeri
3	spina iliaca anterior superior
4	trochanter major
5	condylus lateralis femori
6	caput fibulae
7	malleolus lateralis
8	tuberositas ossis metatarsalis V
9	processes mastoideus
10	inion
11	processes mastoideus
12	C4
13	C7
14	T4
15	T8
16	T12
17	L3
18	L5
19	acromion
20	epicondylus lateralis humeri
21	spina iliaca anterior superior
22	trochanter major
23	condylus lateralis femori
24	caput fibulae
25	malleolus lateralis
26	tuberositas ossia metatarsalis V

Fig. 3. Placement of reflection points on the patient's body (source: Wikipedia and own modification)

Change of the system of coordinates

This procedure ensures initial filtration of data. In this way we eliminate a slowly changing component of movement along x caused by moves of the patient from one side of the track to the other. We eliminate also the influence of a moving track, up and down jumps of the patient, along the y axis. Every violent movements of the whole body forward and backward along z axis are also softened. However we do not eliminate bending and swerving of the spinal column itself.

Normalization of data is performed for every snapshot by subtracting from every coordinate of every point the corresponding pseudo-barycenter. Since we do not know exactly the position of the barycenter, as its approximation we use arithmetic mean of chosen 4 points. They are *spina iliaca anterior superior* and *trochanter major* on the left and right side of the patient's body. By subtracting from every coordinate that of the barycenter we shift the origin of the coordinate system just to this point.

Increasing of the number of sequences and segmentation

The equipment in the lab allows for recording subsequent image in intervals of about 60 ms. The frequency of recording is too low what influences precision of measurement of duration time of "double step" that is the sequence "left-right"- the smallest analyzed unit of movement. To determine more precisely the mean duration of "double step", the number of image sequences is artificially multiplied by linear interpolation of the signal in between adjacent sequences. This procedure can be repeated several times to multiply the number of data 2, 4 or 8-fold. Segmentation is partitioning of the matrix of data to submatrices which describe the movement of the patient in subsequent "double steps".

Approximation by Fourier series

For every "double step" the discrete Fourier transform (DFT) is computed to describe the marked points and their coordinates. It is a transformation which assigns n complex values to n samples describing the signal in "double step". On the basis of these values the amplitude and the argument (phase) of the spectrum of the signal can be computed. In this spectrum after subtracting the constant component, the first spectrum line corresponds to the first harmonic component with frequency related with mean time of duration of "double step".

Filtration

Filtration consists of deleting from the spectrum some values which are considered as noise. As noise we treat all spectrum lines which have amplitude below a threshold, defined as some percent of the amplitude of the highest spectrum line. To establish the threshold, an experiment was conducted in which the different coefficient of filtration ζ was used and the corresponding mean square approximation error of the signal was computed. With assumed level of mean square error equal to 5%, it turned out that the number of spectrum lines which fulfill this criterion is equal to 3,4,4 respectively for coordinates x,y,z . The software allows choosing arbitrarily the coefficient of filtration and the number of harmonic components.

Averaging of the "double step"

From the viewpoint of the signal analysis, because of its periodicity, we are interested in the behavior of trajectories during one period. Theoretically, it is enough to analyze only one "double step" of a patient.

Unfortunately this step should be chosen as a "model step" for a given person. The problem is how to choose such a model step and how to verify that it is indeed correctly chosen. In fact for any person the steps are never identical and ideal. Because we are interested in the trajectory of a point during one period, we approximate the *mean* "double step" of a patient. In this way we reduce all disturbances which may occur in one of the steps but they are not typical for the other steps.

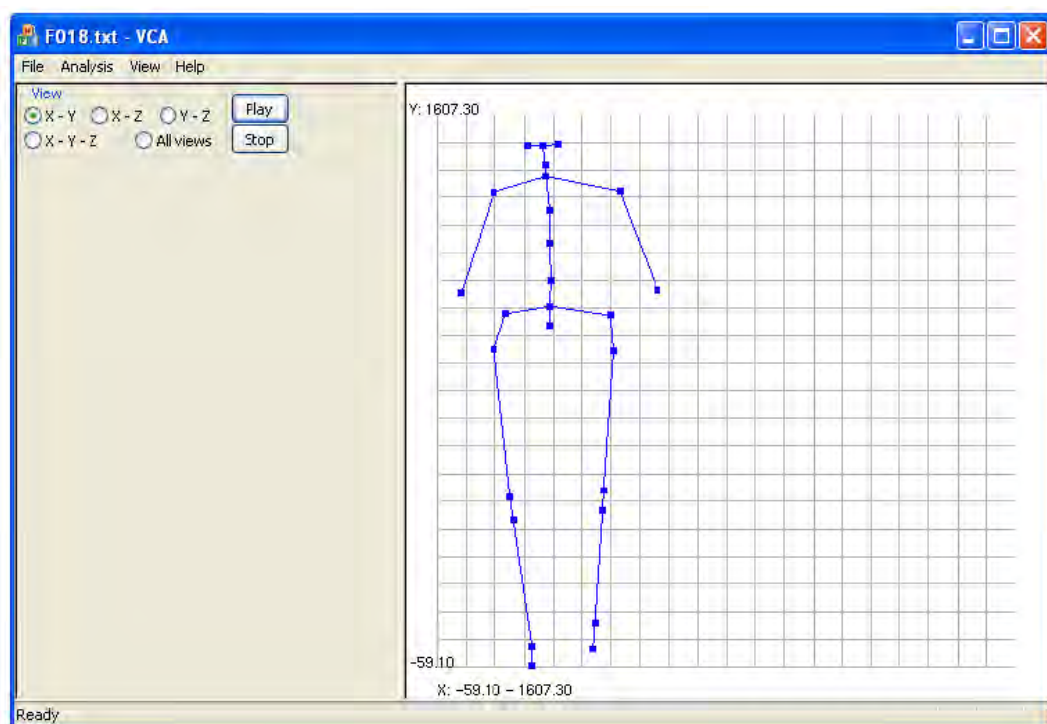


Fig. 4. Animation of patient's walk (source: own)

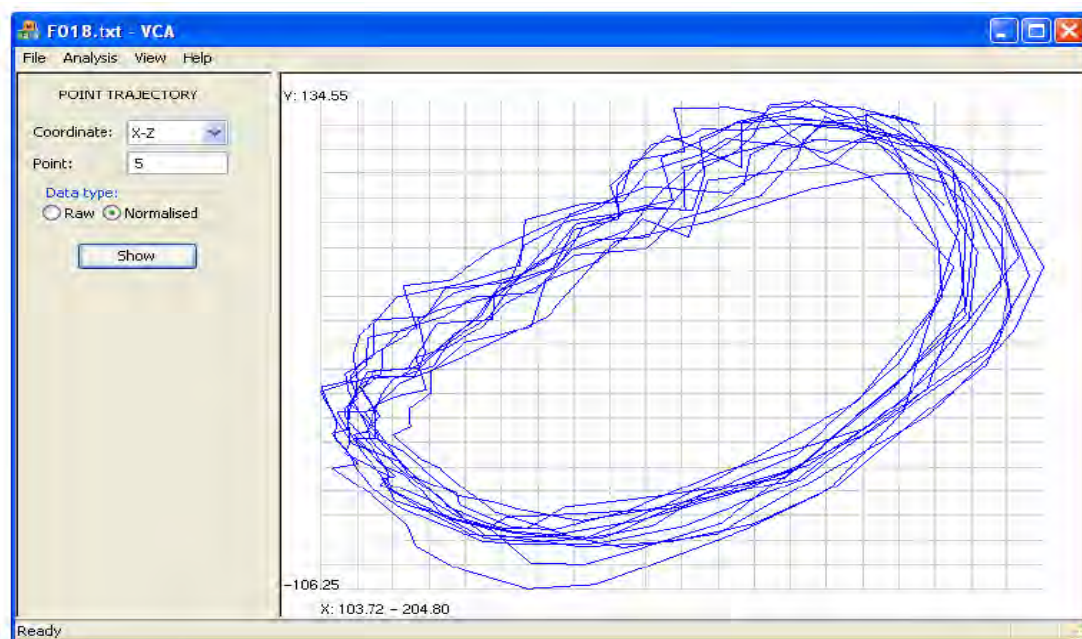


Fig. 5. Example of trajectory of a point (source: own)

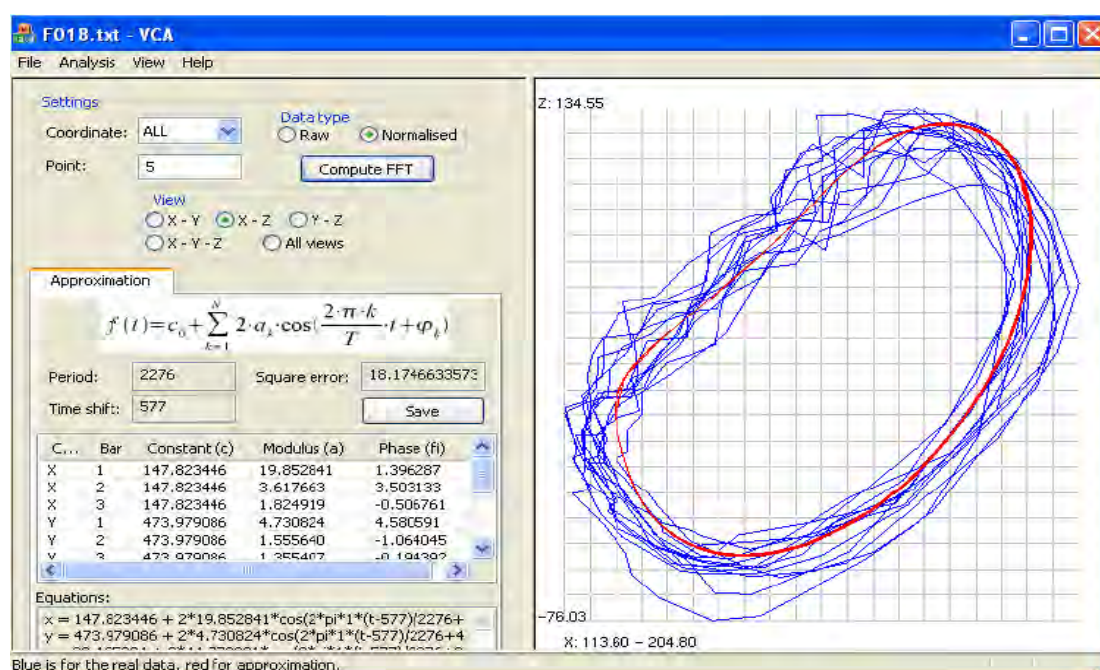


Fig. 6. Approximation of trajectory of a point (source: own)

To obtain the mean of “double step” one should superimpose segmented “double step” and compute the average. This average is approximated by a continuous function using fast Fourier transform (FFT) and a trigonometric series. When computing the mean (average) we use bounded spectrum and the knowledge of the

mean duration time of the “double step”. The result of parameterization of a trajectory of any point is a vector of numbers which describe the duration of “double step” and values of the amplitudes and phases of the trigonometric series.

Results

The method proposed in this paper gives the possibility of animation of patient's movement, observation of signals, trajectories of movement in 2 and 3 dimensions of chosen reflectors, observation of a function which approximates a trajectory in comparison with the actual trajectory, and comparing the real data with the obtained model. Some examples are shown in Fig. 4, 5, 6, 7.

The software also generates a file with parameters describing the amplitudes and phases of harmonic components. An example of such a parametric description of a trajectory of one vertebra in a vector form is given below:

```
[1548 155]
[32.166000    2.110723  1.660006  0.145875
0.252281  0.314748  2.080967]
```

```
[-309.136873  2.606541  4.445047  0.419571
-0.691575  0.086736  1.803758  0.036781
0.530916]
[-108.767609  1.677720  -0.505491  2.633526
2.406548  0.162492  -0.785269  0.195062
2.648822]
```

In the first row there is average of the first component and the delay (the parameter necessary for animation of the movement). In the next rows there are parameters related to modeling of components x, y and z of the signal in the following order:

[*constant component, amplitude of the first component, phase of the first component, amplitude of the second component, phase of the second component etc.*].

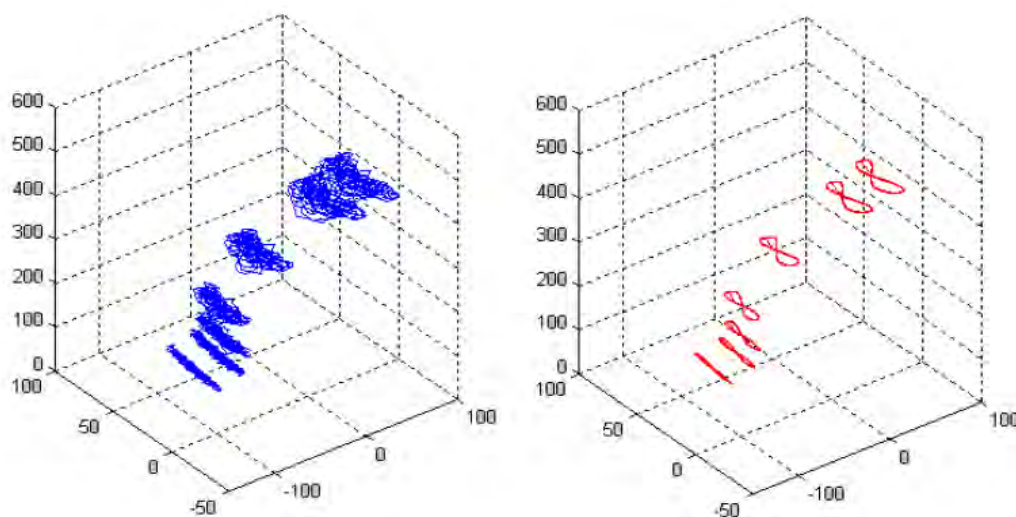


Fig. 7. Actual trajectories and the Fourier model of the points placed on the spinal column (source: own)

Conclusions

The proposed method gives a mathematical model of the movement of points observed by the cameras and description of this movement. Having such a description we can begin work on automatic classification of the behavior of the patient's spinal column. The model can be also used in scientific research directed to understanding the dynamics of the human spine. Because of the fact that the movement of vertebrae is described in the form of parametric trigonometric series, we obtain the *string-type* model of the spine in which we can follow mutual position of vertebrae during movement. The obtained model allows investigating the dynamics of the spine and not only its deviations from a standard (as it is in the case of static images obtained by traditional methods). In this way it becomes possible to examine the

velocities, accelerations and even interactions between vertebrae. Pathological changes can be detected by examining the fluctuations of spine curvatures and their distribution or by using other classification algorithms. Parameterization of a trajectory of a point can be considered as some form of data compression (with some loss of information). By data we mean the set of numbers obtained during a lab session. If for a given patient we record 445 animation images then the set of data consists of 445 (images) x 26 (points) x 3 (coordinates) + 445 (time intervals) = 34710 numbers. As the result of parameterization the model of movement can be described by 26 (points) x 25 (amplitudes + phases + constant components) + 1 (period) = 651 numbers. The degree of compression is thus about 53. It is also worth emphasizing that the simple and user-friendly interface makes it possible to use the software by persons not familiar with computers.

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PARAMETRIZACIJA TRO-DIMENZIONALNE TRAJEKTORIJE TOČAKA POZICIONIRANIH NA TIJELU ČOVJEKA KORIŠTENJEM FOURIEROVIH SERIJA

Sažetak

U ovom članku je predstavljen parametarski model ljudskog gibanja s posebnim zanimanjem za ponašanje kralježnice. Model je utemeljen na Fourierovim trigonometrijskim serijama i primjenjen na stvarnom skupu podataka u eksperimentu provedenom na velikoj grupi dobrovoljaca u stereovizijskoj laboratoriji. Opisana je posebna aplikacija za parametrizaciju i vizualizaciju rezultata. Primjeri rezultata su prikazani u obliku trodimenzionalne trajektorije izabranih točaka na tijelu ispitanika.

Key words: bioinženjering, stereovizija, patologija kralježnice, fourierova analiza

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COMPARATIVE CLINICAL STUDY OF C-REACTIVE PROTEIN AND RHEUMATOID FACTOR IN RHEUMATOID AND REACTIVE ARTHRITIS

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Original scientific paper

Abstract

The purpose of this study is to allow insight into rheumatoid and reactive arthritis, the two diseases which still puzzle many scientists, and are an interesting field of research. Retrospective study incorporated 74 patients suffering from these diseases, out of which 46 were patients with rheumatoid, and 28 with reactive arthritis. The patients were treated at Clinic for Heart Diseases and Rheumatism; at Clinical centre University in Sarajevo during the period of two years (2007/2008). Out of 46 patients with rheumatoid arthritis, 67% were women. Most of the patients (59%) were over 50 years old. There was no significant difference in male to female ratio in patients with reactive arthritis, and the age groups were evenly matched, too. Male to female ratio was 57% to 43%, and the overall percentage of patients up to 30 years old is 35%, identical to the percentage of patients who are over 50 years old. The study demonstrates positive CRP values in 65% of the patients with rheumatoid arthritis. 93% of the patients with reactive arthritis show high CRP value. The average values are 40,5 mg/l (max 147 mg/l) for patients with rheumatoid arthritis, and 41,2 mg/l (max 232 mg/l) for patients with reactive arthritis. It has been proven that the RF test is much more sensitive in diagnosing rheumatoid arthritis. The test was positive in 91,3% of the subjects with rheumatoid arthritis. In the case of reactive arthritis, 29% of the subjects were positive when put to RF test. This is a proof of particular specificity of this test. Anti CCP test is a standard method for diagnosing rheumatoid arthritis worldwide, and in our country, too. The test identified rheumatoid arthritis 91,3% of the cases. Anti CCP was negative in all the patients with reactive arthritis, which is a proof of great specificity of this test.

Key words: arthritis, rheumatoid, reactive, clinical, CR protein

Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory disease of the binding tissue, with unknown aetiology, which attacks locomotive system. In the case of RA, the immune system attacks cartilage, bones, and sometimes internal organs. The characteristic pathological result of this disease is a permanent inflammation of the synovial membrane of the peripheral joints, usually symmetrically dispersed. With the disease striking 0,5% to 1% of the general population, it is the most common systematic autoimmune disease. Seen that the recent studies showed that irreversible joint damage occurs in the first two years of the occurrence of the symptoms, the modern approach to the treatment of the RA implicates utilisation of the aggressive anti-rheumatic therapy within the first months of the occurrence of the disease. Due to potentially toxic medication which might cause serious side effects, a highly specific marker is needed in order to identify RA patients before damage to the joints occur. Today we are able to use a large spectrum of methods for early diagnosis, monitoring, and treatment of RA. C-reactive protein (CRP) is in lab diagnostics recognized as most frequently tested plasmatic protein, serving as an inflammatory marker.

A marker makes it an important indicator of inflammation, tissue necrosis or trauma to the tissue. It has high sensitivity, and low specificity. Taking into consideration many cases of two diseases overlapping, CRP analysis becomes a problem in defining a n exact diagnosis and aetiology. Along with CRP, the standard procedure involves measuring the values of the erythrocyte sedimentation, rheumatoid factor and anti-cyclic citrullinated peptide antibody (anti-CCP), which were in this study correlated with the same values in patients with reactive arthritis. Reactive arthritis is a non-purulent arthritis that occurs as an immunologically conditioned inflammatory response to the infection that occurred in another part of the body in a certain time period. It is an acute, non-secretion, sterile inflammation (without the presence of microorganisms) of one or more joints, which occurs after an inflammatory process usually in the distant part of the body. The patients are usually young adults, up to 35 years old. There is no specific test for diagnosing reactive arthritis. The early diagnosis of RA is possible with the above mentioned serological tests. Anti-CCP is positive in 87% of the patients with RA, and it has a high specificity of ap. 95%.

Anti-CCP is currently the leading serological test used to confirm the clinical diagnosis, and for early diagnosis of RA in general. Only one biomarker found in the blood, Anti-CCP autoantibody, first identified by the group of Dutch scientists, is proven to be more reliable than the rheumatoid factor. It is considered better than the rheumatoid factor, and considered a marker of choice in diagnosing RA.

Methodology

Primary hypotheses

- The values of CRP are significantly different in RA and reactive arthritis patients
- The values of RF are significantly different in RA and reactive arthritis patients
- The values of Anti-CCP test show higher specificity compared to the RF test

Zero hypotheses

- There are no significant differences in quantitative CRP values in RA and reactive arthritis
- There are no significant differences in quantitative RF values in RA and reactive arthritis
- The values of Anti-CCP test do not show higher specificity compared to the RF test

Objectives

Basic objectives of this study are:

- Establishing quantitative CRP value levels in RA and reactive arthritis, and comparing of the results
- Establishing quantitative RF value levels in RA and reactive arthritis, and comparing of the results
- Establishing quantitative Anti-CCP test value levels in RA and reactive arthritis, and comparing of the results

Material and methods

Clinical retrospective comparative study had been performed at the Clinic for Heart Diseases and Rheumatism, at Clinical centre University of Sarajevo. The overall number of patients included was 72 (43 females, 31 male). Their lab results and medical history were processed. two groups of patients were formed:

- patients suffering from reactive arthritis (28 patients)
- patients suffering from rheumatoid arthritis (46 patients)

The diagnosis of rheumatoid arthritis is based on clinical tests, medical history of the patient, x-rays and blood tests. Standards for diagnosing the disease were set by American Rheumatoid Association (1987) and New York Criteria.

In diagnosing reactive arthritis, microbiologic methods to determine the focus in the body are needed along together with the clinical features and lab tests.

Table 1. Referent laboratory research values essential in diagnostics and differential diagnostics of the arthritis:

No	Laboratory research	Referent values
1.	Erythrocyte sedimentation	0 – 15 mm/h
2.	C reactive protein	0 – 6 mg/l
3.	Rheumatoid factor	0 – 8 U/ml
4.	Anti-cyclic citrullinated peptide antibody	> 17 U/ml

Results and discussion

Intention of this paper was to offer an insight into rheumatoid and reactive arthritis - two diseases that intrigue many scientists even today and make for interesting research area in general. Special attention was paid to laboratory parameters (sedimentation of erythrocytes, CRP, RF, anti CCP test), necessary for detection, monitoring and diagnosis of the said diseases.

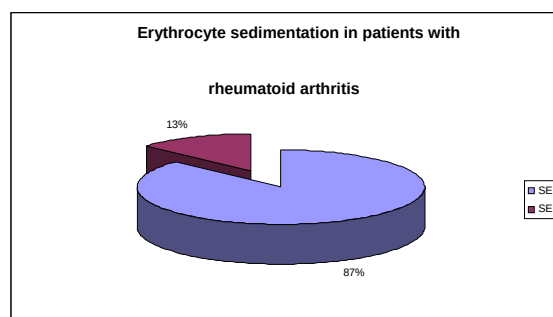


Figure 1. Erythrocyte sedimentation in patients with rheumatoid arthritis

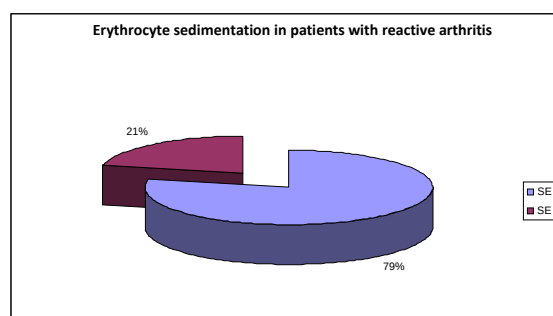


Figure 2. Erythrocyte sedimentation in patients with reactive arthritis

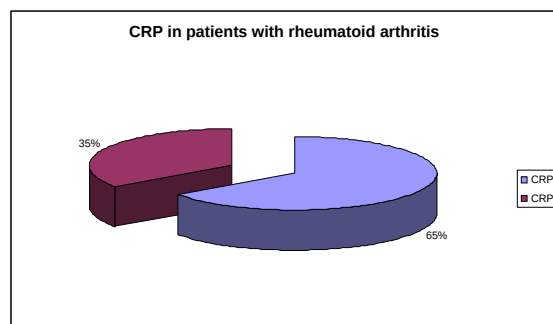


Figure 3. CRP in patients with rheumatoid arthritis

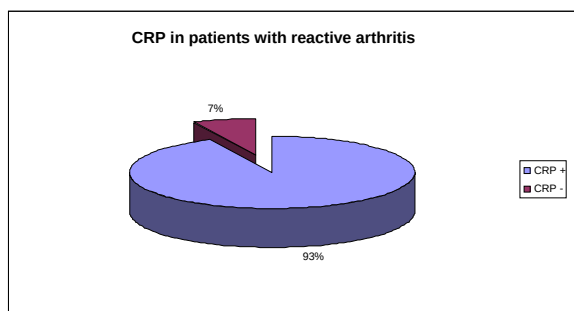


Figure 4. CRP in patients with reactive arthritis

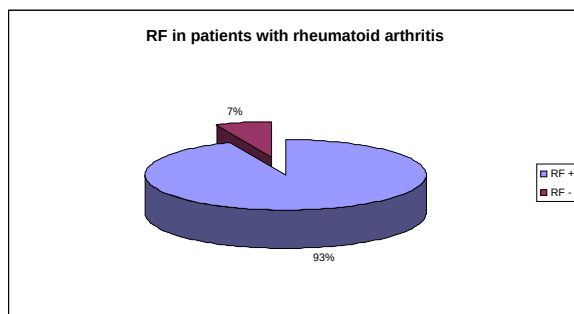


Figure 5. RF in patients with rheumatoid arthritis

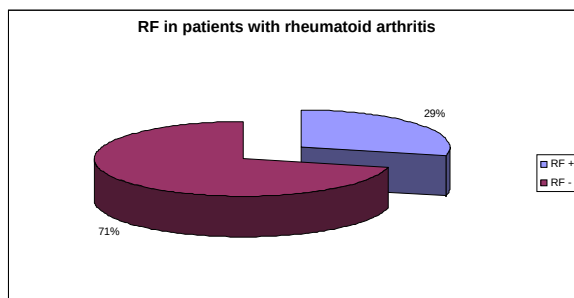


Figure 6. RF in patients with reactive arthritis

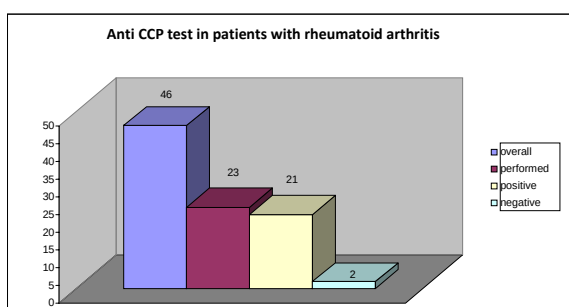


Figure 7. Anti CCP test in patients with rheumatoid arthritis

As a part of retrospective study, 74 patients' medical histories were treated of which 46 cases of rheumatoid arthritis and 28 cases of reactive arthritis. Aforementioned study showed that even in our conditions women are more likely to contract rheumatoid arthritis. Considering the total number of treated patients (46), 67% are women (31 patients). The rest of 33% are male patients, in general aged over 50.

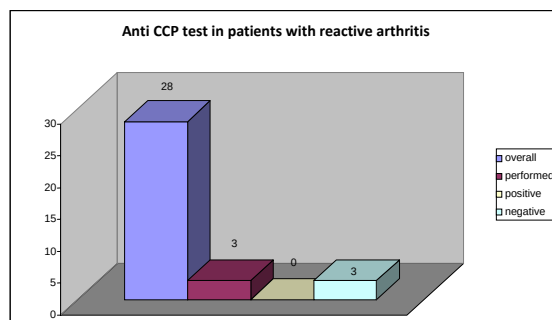


Figure 8. Anti CCP test in patients with reactive arthritis

Analysis of rheumatoid arthritis patients' structure revealed irrelevantly small percentage of patients aged under 30 (2%). Majority of patients of both sexes fall into age group of over 50 (59%). According to data found in professional literature, results reached concerning age groups and sex structures are in balance. Percentage of affected patients per age groups is thus relatively equated. Total number of patients falling under the age group under 30 amounts to 35%, equal to the percentage established for the group of over 50. Number of male and female patients is relatively equated as well (57%, to 43%).

This study focused on comparison of laboratory parameters values, i.e. of inflammation factors, which are necessary in order to detect and monitor inflammatory diseases, like arthritis itself. Following values were monitored and compared: C reactive protein (CRP), rheumatoid factor (RF), sedimentation of erythrocytes and antibodies for cyclic citrullated peptide (anti CCP). Values of CRP show significant increase in the case of acute inflammation, in fact they can increase up to hundred times within just 24 hours. For this reason, CRP is used during diagnostic process as replacement for erythrocytes sedimentation (SE) test that is used as diagnostic procedure for over 50 years. SE is extremely sensitive test for establishing acute inflammations, but it lacks in specific quality. In this study, it yielded positive values for 87% of patients suffering from rheumatoid arthritis, and for 79% of patients suffering from reactive arthritis.

For patients suffering from rheumatoid arthritis, value of SE is in generally higher (+ 10,2 mm/h). Largest average value of SE was established for age group over 50, for patients with rheumatoid arthritis. This value was 54,7mm/h. CRP test is important as screening test for viral and bacterial infections. Namely, in the case of viral infections, which are accompanied by high sedimentation and white cell count, CRP remains in lower limit range when compared with the case of bacterial infection. For bacterial infections, its increase is considerably higher.

It is successfully applied in diagnostic of joints and muscle inflammations, for early detection of joint integument inflammations, as well as auxiliary method for diagnostic of symptoms and diseases of digestive tract. Chinese study (compiled by Qing C, Lei Y, Ma L, Xie P, Deng H), on sample of 66 patients suffering from rheumatoid arthritis, established positive values of CRP in 63,6% of cases. Egyptian study (compiled by Fathi NA, Ezz-Eldin AM, Mosad E, Bakry RM), also yielded similar results concerning values of CRP for patients suffering from rheumatoid arthritis. Positive values were established for 56, 7% of cases.

Our study shows positive values of CRP for 65% of patients suffering from rheumatoid arthritis. It is interesting that CRP is positive for 93% of cases for patients suffering from reactive arthritis. Average values are 40,5 mg/l (max 147 mg/l) for patients suffering from rheumatoid arthritis, and 41,2 mg/l (max 232 mg/l) for patients suffering from reactive arthritis. Apart for detection of acute inflammatory reactions, establishing CRP concentration is useful for monitoring of disease progress i.e. for establishing efficiency of the treatment. For example, by successful application of antibiotic treatment CRP concentration found in serum will decrease faster than erythrocyte sedimentation. So by monitoring CRP concentration, intake of lesser efficient or even inefficient antibiotics may be prevented i.e. they could be replaced by the more efficient one. In this sense, establishing of CRP values is of great importance for diagnostics and monitoring of infection treatments for premature or newly born children. But like Finish study already showed (compiled by Aho K, Palosuo T, Knekt P, Alha P, Aromaa A, Heliövaara M), this study as well showed that CRP cannot predict diagnosis not the course of disease for the patients suffering from rheumatoid arthritis. It is proven that RF test is more sensitive for diagnostic of rheumatoid arthritis. For as many as 93% of patients, it yielded positive values. However, we cannot claim that it has great specific quality because even patients suffering from reactive arthritis in 29% of cases show positive values of RF test. Aforementioned Egyptian study shows that the sensitivity of RF test for patients suffering from rheumatoid arthritis amounts to 71,7%, on sample of 60 patients with RA. Greek study conducted on 155 patients with RA simultaneously monitored sensitivity and specific qualities of RF test and anti CCP test. Average values thus reached for sensitivity are 63, 2% and 59,1% (redom), and for specific quality 95% and 91,2%. Turkish study (compiled by Keskin G, Inal A, Keskin D, Pekel A, Baysal O, Dizer U, Sengül A.) also showed higher sensitivity and specific quality of anti CCP test than RF test.

Our study showcases that CCP test cannot be considered as the standard diagnostic method for RA yet, when we know that the said test was done for 50% of patients suffering from RA. From the entire number of tested patients (23 patients), positive test appeared for 21 patients, i.e. 91,3% of subjects. That it is the case of great specific quality was proven by the fact that anti CCP test was not positive for none of the patients suffering from reactive arthritis. When we speak of reactive arthritis, this study also monitored etiological causes, i.e. diseases that preceded arthritis development. Therefore, we can talk about few common causes of reactive arthritis. Infection of urinary tract was the cause in 32% of patients, Focalosis dentalis, i.e. inflammation of caries infected tooth in 18% of cases. Diseases of thyroid gland, as well as *sarcoidosis* are among common causes of reactive arthritis. Cause could not be determined in 25% of tested cases.

Conclusions

Based on the results reached through this study, as well as results of studies available and conducted by other authors, we can make following conclusions:

- From the entire number of treated patients suffering from rheumatoid arthritis (46 patients), 67% are female patients;
- Within the same tested patient group, patients over 50 constitute majority with 59%, while the percentage of patients under 30 is relatively insignificant with 2%;
- Within the group of patients suffering from reactive arthritis, proportion of male and female patients was relatively equated (57%, 43%);
- Value of erythrocytes sedimentation (SE) was positive for 87% of patients suffering from rheumatoid arthritis, and for 79% of patients suffering from reactive arthritis;
- Values of C-reactive protein (CRP) were positive for 65% of patients suffering from rheumatoid arthritis, and for 93% of patients suffering from reactive arthritis;
- Average values of CRP are 40,5 mg/l (max 147 mg/l) for patients suffering from rheumatoid arthritis, and 41,2 mg/l (max 232 mg/l) for patients suffering from reactive arthritis;
- Values of rheumatoid factors (RF) are positive for 93% of patients suffering from rheumatoid arthritis, but it is established that patients suffering from reactive arthritis in 29% of cases show positive values of RF test;
- Anti CCP test was done for 50% of patients with RA, and from the entire number of tested patients (23 patients), test was positive in 91,3% of cases;
- Anti CCP test was not positive for any patient suffering from reactive arthritis;

- Infection of urinary tract was the cause of reactive arthritis for 32% of patients; Focalis dentalis in 18% of cases; thyroid gland disease for 14%, and sarcoidosis for 11% of patients cause could not be established for 25% of tested patients.
- Positive CRP and negative RF test in 71% of cases is direct indicator of infective or focal aetiology in the case of reactive arthritis.

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KOMPARATIVNA KLINIČKA STUDIJA C-REAKTIVNOG PROTEINA I REUMATOIDNOG FAKTORA U REUMATOIDNOM I REAKTIVNOM ARTRITISU

Sažetak

Ovim radom pokušao se dati uvid u reumatoidni i reaktivni artritis, dvije bolesti koje i danas zaintrigiraju mnoge naučnike, te čine zanimljivo područje za istraživanje. Retrospektivnom studijom su obrađene 74 historije bolesti pacijenata, 46 sa reumatoidnim, a 28 sa reaktivnim artritisom, liječenih na Klinici za bolesti srca i reumatizam, Kliničkog centra Univerziteta u Sarajevu, u periodu od 2 godine (2007. i 2008.). Od ukupnog broja obrađenih pacijenata sa reumatoidnim artritisom (46), čak 67% su činile žene. Većina pacijenata (59%) je u starosnoj grupi preko 50 godina. Udio pacijenata sa reaktivnim artritisom je prilično ravnomjerno podjeljen u starosne i polne grupe. Odnos muških i ženskih pacijenata je 57%, prema 43%. Ukupan broj pacijenata u grupi do 30 godina iznosi 35%, koliki je procenat i u grupi preko 50 godina. Studija pokazuje pozitivne vrijednosti CRP-a kod 65% pacijenata sa reumatoidnim artritisom. CRP je visok čak u 93% slučajeva pacijenata sa reaktivnim artritisom. Prosječne vrijednosti su 40,5 mg/l (max 147 mg/l) za pacijente sa reumatoidnim artritisom, a 41,2 mg/l (max 232 mg/l) za pacijente sa reaktivnim artritisom. Pokazalo se da je RF test puno osjetljiviji za dijagnostiku reumatoidnog artritisa. Čak 93% pacijenta je imalo pozitivne vrijednosti. Ovo govori o specifičnosti, dok pacijenti sa reaktivnim artritisom, u 29% slučajeva pokazuju pozitivne vrijednosti RF testa. Postoji signifikantna razlika u pozitivnosti testa između RA i reaktivnog artritisa. Anti CCP test je standardna metoda dijagnostike RA u svijetu, a također i u našim uslovima, Pozitivan test je bio kod 91,3% ispitanika sa RA. O velikoj specifičnosti govori činjenica da anti CCP test nije bio pozitivan ni kod jednog pacijenta sa reaktivnim artritisom.

Ključne riječi: artritis, reumatoidni, reaktivni, klinički, CR protein

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RELATION OF SOLVING 2 ON 2 GAME SITUATION DURING MATCHES AND WITHIN TRAINING SESSIONS IN ICE-HOCKEY U 18 CATEGORY

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Original scientific paper

Abstract

The aim of this paper is to analyze whether there is a significant relation in solving a typical 2 on 2 games like situations during matches and within training sessions. The research was carried out with the ice-hockey team HK 99 Ružinov Bratislava, which is a member of the Slovak U 18 ice-hockey extra league. The successfulness of solving game situations was evaluated by analyzing 60 games during the regular season using a 2-point scale system (successful or unsuccessful solution). The relation between successful and unsuccessful solutions was assessed by the X^2 -test. The relation was determined by utilizing 4 equal periods (26 one-week sessions) during the regular season. Based on these results indications suggest that there exist a significant relation ($p < 0.05$) between 2 on 2 game situations and the fact whether they were solved during matches or within training sessions.

Key words: sports games, ice hockey, games like situation, training process, hockey game

Introduction

The term situation occurs in sports games in various forms, including match situations, game situations, power play situations, short-handed situations and situations with the same number of players, potentially advantageous or disadvantageous game situations. From these terms further terms are derived, for example standard game situations, decisive situations, the change of situation, critical situations, signs of situations, training of situations and the like. There are an immeasurable number of game situations in ice-hockey games, and each of them has an infinite number of solutions. From simplest situations, which solution is relatively clear, up to the most complicated situations, which solution is demanding, variable, requiring long-time practical experience and high level of players' performance. The course of some situations can be anticipated, however, the development of the game brings many unpredictable moments. Classification of game situations based on the number of players participating in their final solution (Tóth, Peráček 2006):

- **With the equal number of players:** 1 on 1, 2 on 2, 3 on 3, 4 on 4, 5 on 5, etc. The number of defending and attacking players is the same. The character of the game situation is determined by the number of players involved in it.
- **With a different number of players:**
 - a) **Attacking players outnumber defending players:** 1 on 0, 2 on 1, 3 on 2, 4 on 3, 5 on 4, and the like. The solution of the game situation in the offensive game phase based on greater number of attacking players.

- b) **Defending players outnumber attacking players:** 1 on 2, 2 on 3, 3 on 4, 4 on 5, 5 on 6, and the like. The solution of the game situation in the defensive game phase based on greater number of defending players.

The goal, hypothesis and tasks

The goal of our paper is to find out the relation between successfulness of solving typical 2 on 2 game situations during championship matches and the same game situations in the offensive game phase during training sessions of junior ice-hockey players.

We expect that there is a significant relation between successful solved typical 2 on 2 game situations and the fact whether they are solved during championship matches or within training sessions.

The following tasks arise from the goal of the paper:

1. To record successful and unsuccessful solved typical 2 on 2 game situations during championship matches and within training sessions of the extra league junior team HK Ružinov 99 Bratislava in the 2006/07 ice-hockey season from to point of view of the offensive game phase.
2. To find out whether there is a significant relation between successful/unsuccessful solved typical 2 on 2 game situations and the fact whether they are solved during championship matches or within training sessions.

Methodology

Determining the research situation

We carry out the research paper through a research of the ex-post-facto type with a defined object of monitoring, selection and organization of variables. The object of the research monitoring is select typical game situations during championship matches of HK Ružinov `99 as. junior team and within training sessions during the 2006/07 ice-hockey season. The research observation has longitudinal character.

Characteristics of the set

The research set was represented by the extra league junior team HK Ružinov 99` a.s., which played 60 championship matches (each team played two matches at home and two matches away with every other team) and 3 preparation matches during the monitored competition year. Of the total number of 60 championship matches, the team won 21 games, drew 11 games and lost 28 games with 53 points (in the total evaluation). The team shot 207 and collected 224 goals, and ended up at 11th place.

Table 1: Characteristics of the research set

No.	Name and surname	Date of birth	Player post	Years of active sporting activity
1	P.K.	Feb 11, 1990	center forward	11
2	J.S.	Feb 02, 1989	right defenseman	12
3	T.Z.	Aug 24, 1990	right defenseman	10
4	M.K.	Jan 27, 1990	left defenseman	11
5	P.P.	Nov 21, 1990	right defenseman	11
6	F.S.	Jan 31, 1990	left wing	11
7	A.C.	Mar 13, 1990	left defenseman	10
8	R.J.	Jul 08, 1990	left wing	12
9	L.V.	Jun 21, 1989	right defenseman	12
10	R.V.	Aug 27, 1990	right wing	10
11	L.B.	Jul 17, 1989	right wing	12
12	P.K.	Oct 07, 1990	center forward	11
13	P.B.	Apr 07, 1989	left wing	12
14	F.K.	Nov 29, 1990	left wing	10
15	M.V.	Mar 15, 1989	left defenseman	11
16	P.S.	May 18, 1989	left defenseman	11
17	L.B.	Mar 08, 1991	left defenseman	9
18	T.M.	Aug 26, 1990	center forward	10
19	A.H.	Jan 15, 1989	right wing	12
20	B.G.	Jun 07, 1990	center forward	10
21	M.F.	Jan 18, 1990	right defenseman	10
22	J.O.	Jan 08, 1990	right defenseman	10
23	M.A.	Jul 15, 1989	center forward	11
24	J.V.	Apr 11, 1991	left defenseman	10
25	M.M.	Mar 27, 1991	center forward	9

The competition period started September 3, 2006 and ended April 1, 2007. During this period the team had 141 training units on ice – 148.75 hours of special preparation and 78.5 hours of general preparation (exercise room, gymnasium, playground and the like.). Matches of the Slovak junior extra league (the highest Slovak ice-hockey league in this age category – 16 teams) were played regularly on Saturdays and Sundays (some matches were rarely played in advance on Wednesdays). During November, December and February there were several representation breaks. The team was composed of 28 ice-hockey players (3 goaltenders are not included in Table 1) during the 2006/07 ice-hockey season. The average age of players was 16.4 years thus making the youngest team in the extra league (only 4 boys born in 1989 played regularly).

Despite this, the team had quite a high number of shots on goal – 1,872, however only 207 goals were shot (11.05 percent successfulness of shots) and scored the highest number of short-handed goals of all teams in the competition.

Methods of obtaining and processing data

In order to observe select typical game situations we used a combination of direct and indirect observation and evaluation of game performance of players and group of players. During the training process we used the method of direct observation under natural conditions. During championship matches we used the method of indirect observation with the help of Sony video camera. The camera was placed approximately ten meters over the level of ice area (on the stands) so that the whole playground could be shot.

Its position was constant. To record evaluation of select typical game situations we created a record sheet. We evaluated only the offensive game phase on the offensive half of the team. Every match was documented on an independent record sheet. Video recordings of all matches were converted to the .avi format, which was then easier to analyze on the computer (we used BS Player PRO). While solving typical game situations of the team in the training process and within championship matches, the subject matter of our evaluation using the record sheet was the individual game performance of players – successfulness of players in a typical 2 on 2 game situation from the point of view of attack (the number of successful/unsuccessful solutions of game situations in the offensive game phase). After every match and training unit we processed and evaluated the data. During this phase we obtained summary values of monitored indicators. This processed data was then recorded to a computer where we further modified it using Microsoft Office Excel. While processing and evaluating obtained empirical data we not only applied basic logical methods but also analyses, syntheses, inductive and deductive procedures, heuristic and relevant standard mathematical-statistical methods. In the first part of the successfulness analysis of solving select typical game situations we calculated the basic statistics – frequency of occurrence and its percentage expression, and, if necessary, also arithmetic average, extreme values and the like. The actual analysis of relations was evaluated by the chi - square (χ^2) in a table and graphical implementation. In case of significant results we tried to find out whether the total value of χ^2 was influenced more by the frequency of occurrence of successful or unsuccessful solutions of game situations (contribution to χ^2), which we marked as χ^2_c .

Results

The relation between successful/unsuccessful solved typical 2 on 2 games like situation during championship matches and within the training process

We discovered a significant relation between successfulness of solving select typical 2 on 2 games like situation during championship matches and within the training process in only 2 monitored meso cycles. The relation in the rest of them was not statistically proved. During the first competitive meso cycle, August 28 to October 15, 2006, successfulness of solving this game situation is significantly connected with the fact whether it was solved within trainings or during matches ($\chi^2 = 4,075$; $p < 0,05$). Successfulness of solving 2 on 2 game situations within trainings was significantly lower than during matches (66 percent to 57 percent).

Difference between successfulness of solving 2 on 2 game situations within trainings and during matches thus represented 11 percent. While during trainings the proportion between successful and unsuccessful solutions was 1.3 to 1, during matches it was 1.9 to 1. (Figures 1 and 2, Tables 1 and 2). The analysis in the second and third competitive meso cycles did not pointed out statistically important relations. Within trainings, the successfulness of 2 on 2 games like situations was significantly higher than during the matches. The difference was only 6 percent in both monitored periods. During trainings in the second period the proportion between successful and unsuccessful solutions was 2.3 to 1 compared 1.8 to 1 during the matches. In third meso cycle the proportion presented 2:1 ratio within the practice and 1.6:1 ratio during the games. (Figures 3, 4 and Tables 3, 4, 5, 6).

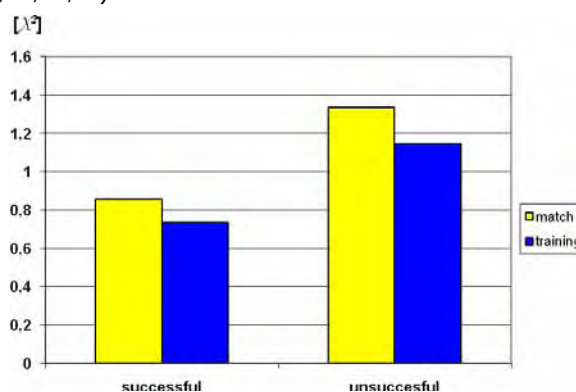


Figure 1: Share in the relation between successfulness of solving a typical 2 on 2 game situations during matches and within training sessions – 1st meso cycle

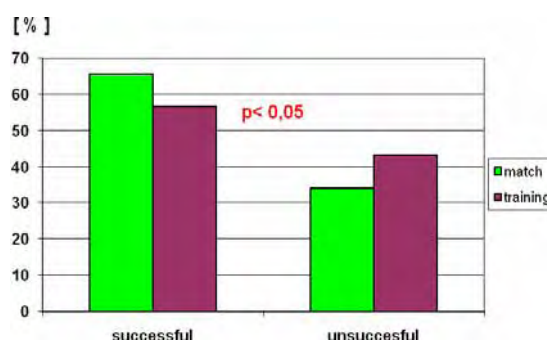


Figure 2: Difference between successfulness of solving a typical 2 on 2 game situations during matches and within training sessions – 1st meso cycle

Table 1: Frequency of occurrence of 2 on 2 GS

Frequency	Games like situations		Total
	successful	unsuccessful	
match	146	93	239
training	217	106	323
Total	363	199	562

Table 2: Share in the total χ^2

Chi	Games like situations		Total
	successful	unsuccessful	
match	0,858	1,337	2,194
training	0,735	1,146	1,881
Total	1,593	2,482	4,075

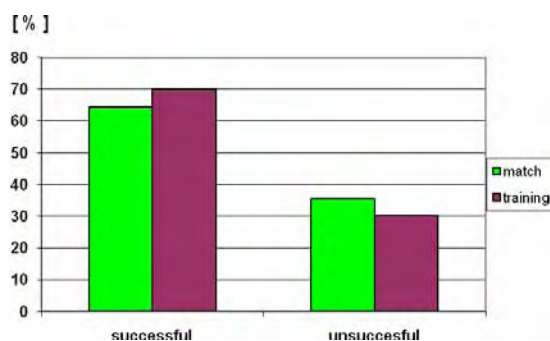
Figure 3: Difference between successfulness of solving a typical 2 on 2 game situations during matches and within training sess. – 2nd meso cycle

Table 3: Frequency of occurrence of 2 on 2 GS

Frequency	Games like situations		Total
	successful	unsuccessful	
match	134	74	208
training	205	88	293
Total	339	162	501

Table 4: Share in the total χ^2

Chi	Games like situations		Total
	successful	unsuccessful	
match	0,323	0,676	0,999
training	0,229	0,480	0,709
Total	0,552	1,156	1,708

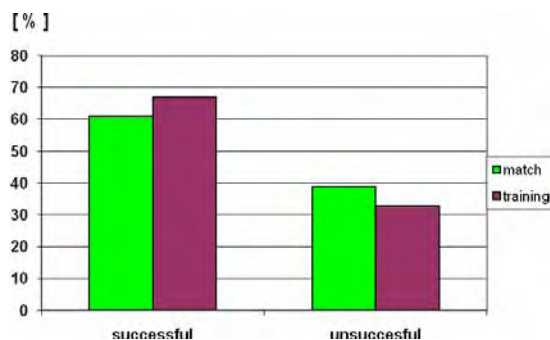
Figure 4: Difference between successfulness of solving a typical 2 on 2 game situations during matches and within training sess.–3rd meso cycle

Table 5: Frequency of occurrence of 2 on 2 GS

Frequency	Games like situations		Total
	successful	unsuccessful	
match	144	73	217
training	127	103	230
Total	271	176	447

Table 6: Share in the total χ^2

Chi	Games like situations		Total
	successful	unsuccessful	
match	0,454	0,828	1,282
training	0,336	0,613	0,949
Total	0,790	1,441	2,231

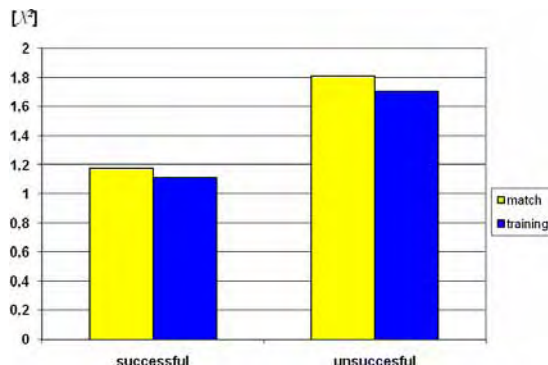
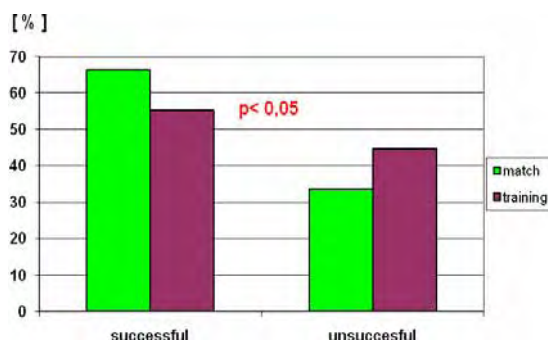
Figure 5: Share in the relation between successfulness of solving a typical 2 on 2 game situations during matches and within training sessions – 4th meso cycleFigure 6: Difference between successfulness of solving a typical 2 on 2 game situ. during matches and within training sessions – 4th meso cycle

Table 7: Frequency of occurrence of 2 on 2 GS

Frequency	Games like situations		Total
	successful	unsuccessful	
match	146	76	222
training	147	112	259
Total	293	188	481

Table 8: Share in the total χ^2

Chi	Games like situations		Total
	successful	unsuccessful	
match	1,176	1,811	2,988
training	1,110	1,709	2,819
Total	2,286	3,521	5,807

During the last competition meso cycle, February 26 to April 1, 2007, as far as in the first one we also discovered a statistically significant relation ($\chi^2 = 5,807$; $p < 0,05$). Within training sessions successfulness of solving the 2 on 2 games like situation was higher than during matches.

The difference was 11 percent. The proportion between successful and unsuccessful solutions was 1.2 to 1 within training sessions and 1.9 to 1 during match (Figures 5 and 6, Tables 7 and 8). We approached the analysis of the relation between successfulness of solving a typical 2 on 2 games like situations and the fact whether this game situation is solved during championship matches or within training sessions also from the point of view of individual micro cycles. We tried to find out whether the immediate consequence of matches and trainings within one micro cycle will bring different results than during the analysis of meso cycles. The relation between successfulness of solving the 2 on 2 game situation and the fact, whether this game situation was solved during matches or within training sessions, was statistically significant in 13 of 26 micro cycles (10 micro cycles at the level of $p < 0.05$ and 3 micro cycles at the level of $p < 0.01$). This means that in equal amount of micro cycles players achieved similar successfulness within training sessions / games.

Discussion

From the point of view of successfulness of solving 2 on 2 game situations in particular meso cycles and micro cycles we can state that there are several explanations why players did not solve the above-mentioned typical game situations during championship matches as successfully as within training sessions:

- In case of 2 on 2 game situations, the first reason can be little technical stability of game activities of individual players, which players applied during the game situations. We carried out our paper in the junior category in the team of HK 99 Ružinov, where the average age was 16.4 years. Even though players in this age category have developed game activities at quite a high level, however, under complicated conditions of matches, mainly due to psychical pressure, they are rather less stable than during training sessions.
- One of other reasons is the age of players and the related technical-tactical maturity. The observed team ranked among the youngest ones in the junior competition. This category includes two years. This team had regularly only 4 players, who played for this team also during the previous competitive period, which is in comparison with other teams (for example the team of the town of Topolčany – 2nd place in the competition), where there were regularly 12 such players, quite a big disproportion. Players, who already played one competitive period in this category, gained invaluable game experience thanks to the great number of played matches. Their experience is evident in self-confidence, which is supported by higher technical-tactical maturity.

During matches this can be seen in situations when they take responsibility for the solution of game situations, where they are less limited regarding technical as well as tactical sides, and in the given moment they choose the most effective way of solving the game situation. If a team does not have such players or their number is limited, it is reflected in successfulness of solving situations.

- Complexity of load during the training process can be one of other reasons why players in this age category do not solve game situations during championship matches as successfully as within training sessions. According to Peráček (2003), application of methodological-organizational forms of exercises in the training process is closely related to outer load of players, namely with its complexity. Under conditions of differently complicated game situations, players not only learn to analyze situation factors but they are also trained to pay less attention to technique and more to solution of tactical tasks. In our opinion, which we obtained through observation of the training, game exercises were little complex, their level of complexity did not often get close to conditions of matches.

- Another factor from the point of view of methodological-organizational forms was the fact that the coach spent little time leading preparation games 2 on 2 during trainings. Even though preparation games were included in trainings, players did not solve these situations as they would during matches. From this point of view, trainings were little consistent.

- Another reason might have been the content and proportional side of the training process. Not all game activities are equally significant for successfulness of solving game situations. Therefore it is necessary to distinguish their suitability within technical-tactical preparation and accordingly make their selection and adjust proportionality. Not only should the frequency of occurrence but also contribution to successfulness of individual or collective solution of the given game situation decide about the scope, which particular game activities are to occupy in the training process.

- One of the last reasons why players did not solve the above-mentioned typical game situations during championship matches as successfully as within training sessions could be the different quality of opponents that changed during particular monitored micro and meso cycles. Despite the fact that our team played 4 matches with every opponent (two matches at home and two matches away), successfulness of solution of individual game situations in matches varied.

Conclusion

In rationalization of the training process:

- Proportionality of particular typical game situations within training sessions should be derived from the frequency of occurrence of these game situations in championship matches. For the junior category we basically recommend 1 on 1 game like situation (45 percent), 2 on 1 game situation (35 percent), 2 on 2 and 1 on 2 games like situations (10 percent).
- While improving offensive game activities in typical 2 on 2 games like situation, all drills and preparation games should be applied under conditions similar to matches.

While evaluating game performance (successfulness of solving typical game situations):

- Solution evaluation of game situations with a 2-point scale system (successful – unsuccessful) can be used in various levels of players'

performance and also for different age categories (pupils, juniors, seniors).

- While evaluating successfulness of solving game situations, our recording sheet (match – training) should be used.
- We recommend carrying out evaluation of the game performance (successfulness of solving game situations) not only during matches but also in select micro cycles within training sessions in order to obtain fast and return information.
- We recommend interpreting obtained results individually for each evaluated typical game situation during matches but also within training sessions.
- From the point of view of evaluation of successfulness of game situations in the training process and during championship matches it turned out that it was appropriate to evaluate individual micro and macro cycles of the monitored period.

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RELACIJE RJEŠENJA U IGRI 2 NA 2 ZA VRIJEME UTAKMICE I UNUTAR TRENAŽNIH SESIJA KOD U-18 KATEGORIJE HOKEJAŠA

Abstract

Svrha ovog članka je analiza postoji li značajna relacija u rješavanju tipičnih situacija 2 na 2 poput onih u igri i unutar trenažnih sesija. Istraživanje je provedeno s ekipom hokejaša na ledu (HL 99 Ružinov – Bratislava), članom slovačke U-18 hokejaške ekstra lige. Uspješnost rješavanja situaciji u igri je evaluirana analizom 60 utakmica za vrijeme regularne sezone korištenjem 2-point mjerne skale (uspješno ili neuspješno rješenje). Relacije između uspješnih i neuspješnih rješenja su analizirane χ^2 -testom. Relacija je određena korištenjem 4 jednaka razdoblja (26 jednotjednih sesija) kroz regularnu sezonu. Temeljem ovih rezultata pokazatelji sugeriraju postojanje značajne relacije ($p < 0.05$) između situacija igre 2 na 2 i činjenice jesu li uslijedila rješenja na utakmici ili unutar trenažne sesije.

Ključne riječi: sportske igre, hokej na ledu, situacijska igra, trening

EXAMPLES OF DRILLS USED IN TRAINING PROCESS

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MOTION SENSOR OUTPUTS OF CHILDREN AND ADOLESCENTS WALKING AND RUNNING TO THREE TREADMILL SPEEDS

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Abstract

The study examined the motion sensor outputs of Singaporean children and adolescents of both sexes to walking and running on a motorized treadmill (Quinton Series 90) under controlled laboratory conditions. 58 youths of normal body mass (N=58, age: 13.2±3.0 y; height: 1.53±0.02 m; body mass: 45.5±14.2 kg; BMI: 18.8± 3.0 kg/m²; Tanner rating: 2.5±1.3) were recruited for the study. Accelerometer (ActiGraph GT 1 M) activity (ActiCounts in counts/min) and step rate (ActiSteps in steps/min) and pedometer (Omron HJ 005-E) step rate (PedoSteps in steps/min), oxygen uptake (in ml/kg/min) and heart rate (in bpm) were obtained from 5-minutes stages of 0 % gradient of treadmill walking at 4 km/hr and running at 6 km/hr and 8 km/hr. Walking at 4 km/hr was estimated at 4.0-6.0 METs, whilst running at 6 km/hr and 8 km/hr was estimated at 6.3-8.6 and 10.0-11.4 METs, respectively. Motion sensor outputs increased significantly with treadmill speeds (76-101 % for ActiCounts; 22-24 % for ActiSteps and 18-25 % for PedoSteps, all $p < 0.01$) as did oxygen uptake (48-55 %) and heart rate (27-28 %) but there was no sex difference in activity or step rate or physiological responses ($p > 0.01$). No meaningful relationships were obtained between accelerometer activity rate and oxygen uptake or heart rate. There was acceptable agreement between accelerometer and pedometer step rate for the walking and running on the treadmill but the difference between accelerometer and pedometer step rate was smallest at a treadmill running speed of 6 km/hr. These results show that accelerometer and pedometer step rates are useful and suitable measurements of physical activity involving walking and running among Singaporean children and adolescents of normal body mass. Further investigations are necessary to fully exploit the use of accelerometer data in physical activity research among young people.

Key words: Motion sensor output, children and adolescents, treadmill walking and running

Introduction

Regular and adequate amounts of physical activity (PA) are associated with desirable health outcomes among children and adolescents while inadequate and irregular amounts of PA are associated with poor levels of physical fitness, increased likelihood of obesity and deleterious health ailments in childhood and adulthood.

Biddle et al (2004) stressed the importance of a better understanding between PA and health in youth, while Strong et al (2005) presented persuasive evidence of the links between PA and short and long term health and behavioural outcomes in youth. Therefore when PA is the target of assessment, either as an intervention or as an outcome variable of choice for research, an accurate and reliable assessment of PA is paramount. Advances in technology make electromechanical motion body sensors, in particular accelerometers and pedometers, popular among researchers when assessing PA among youths. Both are lightweight and are unobstructive and are usually worn at the hip or waist.

Their use as PA assessment tools and data interpretation in young people are reviewed elsewhere (Rowlands et al, 2007; Rowlands 2007; Kavanagh & Menz 2008). One disadvantage of both the pedometer and the accelerometer is that they do not provide any information about the type of physical activity or the context or social setting that the physical activity occurred (Ward et al 2005). Another disadvantage of pedometers is that the step count accumulated provides no information about the intensity of the physical activity aggregated. Despite these limitations, the amount of research generated by accelerometer and pedometer devices continues to multiply (Tudor-Locke et al 2002; Rowlands, 2007). The time-sampling and data storage capability of most accelerometers are useful for documenting movement characteristics over researcher-determined time periods. The periods of varying intensity- low, moderate and vigorous can be categorised based on the rate of activity counts accumulated. The latest version of the uniaxial ActiGraph (GT1M) accelerometer has a memory size of 1 Mb and can collect data at 1 s epochs for nearly six days.

It has the capacity to use epochs ranging from 1 to 15s to objectively assess the temporal pattern of children's activity over days at a time. The accelerometer monitors human motion (frequency and intensity over a user-specified time epoch duration. The acceleration signal is digitised, and the magnitude is summed over the epoch duration. At the end of each epoch, the summed value or activity count is stored in memory, and the integrator is reset. The relatively high cost of each unit (about S\$ 450) additional software and hardware for calibration, distillation and analysis of data limit its use to smaller-scale studies. The relatively lower cost of pedometers (about S\$ 25) coupled with the ease of its use and increasing volume of pedometer-derived reported PA data in the research literature, make pedometers an attractive and objective alternative to accelerometers, for garnering PA data in youths, especially in large-scale population based studies.

It is prudent to heed the view of Tudor-Locke et al (2002) that as pedometers are consumer items, they are likely to evolve, and regardless of the brand preferred, it is important that researchers report the validity of the pedometer chosen. The Omron Model HJ-005 pedometer is reasonably-priced and is commercially available. The validity and reliability of Omron HJ-005-E were previously established in a group of 34 boys and girls aged 8 and 10 years. Inter-class correlation coefficients *R* between pedometer step counts and the GT1M ActiGraph accelerometer counts were 0.850, 0.829 and 0.685 (all $P < 0.05$), respectively, under 4km/h, 6km/h and 8km/h controlled-speed conditions, in the field. Intra-class correlation coefficients between two units of the Omron HJ-005-E pedometer worn on the left and right hip under the same speed-controlled conditions were 0.918, 0.812, and 0.876, respectively (Wang Ye, 2008). Researchers, in an attempt to put biological meaning to accelerometer counts related accelerometer-derived activity counts with energy expenditure at various intensities from sedentary to vigorous (e.g. Trost et al 2002; Rowlands 2004) and the publication of numerous count thresholds from different models of accelerometers, highlights the lack of agreement about the interpretation of accelerometer outputs and the many published thresholds have compounded the issue and make across studies comparisons of data problematic (Rowlands 2007). The advice provided by Tudor-Locke et al (2002) that accelerometer-derived activity counts should not be equated to energy expenditure since the two are conceptually dissimilar, provides encouragement for researchers to focus on relating accelerometer outputs to other physiological parameters (e.g. heart-rate, or oxygen uptake) and mechanical outputs (e.g. step counts).

These data are useful for the comparison of physical activity when using the ActiGraph GM 1 M accelerometer and the Omron HJ-005-E electronic pedometer, as they are conducted in standardized controlled laboratory environment. There are limited data from accelerometer and pedometer in relation to physiological parameters in children and adolescent of both sexes in response to different treadmill speeds in the same study. These data are important as they provide a biological basis of understanding accelerometer and pedometer-derived data from different exercise intensities under laboratory conditions in a sample of Asian children and adolescent participants. Moreover, there are scant data on Asian young people in this regard and as greater research attention is focused on young people in Asia, ethnic and race relevant data are useful for comparison. In apparently the only published study on an Asian sample, Louie et al (1999) examined the validity of heart rate, pedometry (Digiwalker DW-200, Yamax) and accelerometry (WAM Model 7164 and TriTrac 3D Model T303) for estimating the energy cost of physical activity (treadmill walking at 4 and 6 km/hr; treadmill running at 8 and 10 km/hr; playing catch, playing catch, and sitting and crayoning) in a sample of 21 Hong Kong Chinese boys aged 8-10 years. Their results showed that the WAM accelerometer and the hip pedometer accounted for similar variances in submaximal allometrically scaled ($\text{ml/kg BM}^{0.75}/\text{min}$) oxygen uptake (73.8% for the WAM versus 73.4% for the Digiwalker). Limitations of the cited study are that no data on Chinese girls are available, the age span of the boys was rather narrow and the models of accelerometer and pedometer are different and no longer commercially available. Hence the purpose of the present study is to examine the outputs of motion sensors and physiological responses to three treadmill speeds in a larger cohort Singaporean children and adolescents of both sexes and in commercially available accelerometer and pedometer.

Methods and Procedures

Participants

A convenience sample of 58 healthy male and female children and adolescents, segregated into three cohorts, Cohort 1: aged 11 years ($N=20$), Cohort 2: aged 14 years ($N=20$) and Cohort 3: 17 years ($N=18$) participated in the study. The sample size of the present study is substantially larger and consisted participants of both sexes than previously published research of similar but not identical nature on motion sensors that involved young people (e.g. Louie et al 1999). The research procedures were reviewed and approved by the Institutional Review Board for Ethical Clearance at Nanyang Technological University, Singapore.

Written informed consent and assent forms were obtained from the parents and participants. As step counts in children are affected by body mass index (Duncan et al 2006), all participants recruited for study were of normal body mass index. Participants wore comfortable exercise attire- shorts, a T-shirt and sports shoes for the laboratory-based test. All participants were habituated to the laboratory test environment, the motion sensors and were familiarized to walking (at 4 km/hr) and running (6 km/hr and 8 km/hr) on the motorized treadmill. The characteristics of the participants are presented in Table 1.

Instruments

Uniaxial ActiGraph accelerometer

The ActiGraph accelerometer (GT1M, Fort Walton Beach, FL, USA) was used in the present study. The ActiGraph is sensitive to movement along the vertical axis and can be programmed to record data in epochs of between 1 s and 5 minute or, when in raw data mode, at a rate of 30 Hz. The ActiGraph was checked for calibration using the manufacturer-recommended hardware and software, and calibrated if necessary. The pedometer function of the ActiGraph that allows for the simultaneous collection of step counts per minute (ActiSteps) was also used. The sampling period or epoch of the ActiGraph in the present study was set at 5s and the accelerometer output expressed as activity counts per 1 min (ActiCounts). The accelerometer was also synchronized to the investigator's timing device. Rowlands (2007) recommends that when assessing physical activity in children, epoch durations of less than 10 seconds are recommended.

Uniaxial pedometer

The Omron Step Counter HJ-005-E (Omron Healthcare Co., Ltd., Japan) was also used in the present study and registers the number of steps taken during physical activity over a period of time. Omron pedometer products use glass-enclosed magnetic reed proximity switch for their function. The step counter has a 5-digit LCD display (up to 99 999). The pedometers were checked using a shake (Vincent et al 2002) and brief walking test (Tudor-Locke and Myers 2001). If the step count error exceeded $\pm 5\%$ in either the shake or walking test, the pedometer was not used in the study. All pedometers passed the shake and walking test in the present study. Reliability research by Crouter et al (2003), albeit with adults using the Omron HJ-105-E at 54, 67, 80, 94, and 107 m/min treadmill speeds for 5-minute stages showed that the Omron HJ-105 displayed a high degree of reliability between devices attached at the right and left sides (ICC > 0.83, $p < 0.05$ for a treadmill speed of 80m/min).

In the laboratory, correlations between pedometer step counts and oxygen uptake during treadmill exercise ranged from $r = 0.62$ to 0.93 ($P < 0.05$) (Eston et al 1998; Louie et al, 1999). In the present study, the pedometer readings were reset to zero for each testing phase. The total number of steps was recorded at the end of each 5-minute treadmill stage. Pictures of the ActiGraph GT 1 M and the Omron Step Counter are depicted in Figure 1 (a & b).



Figure 1a: Motion sensors: ActiGraph GT 1 M accelerometer



Figure 1b: Motion sensors: Omron HJ 005-E pedometer

Procedure

Anthropometric measurements

Stature and body mass of participants were measured. Standing height was measured to the nearest 0.1 centimetre using a rigid stadiometer and body mass was measured to the nearest 0.1 kg using a balance scale. Body mass index (BMI) was calculated as body mass in kilograms divided by height in meters squared (kg/m^2). Exercise testing on the treadmill was conducted in a controlled laboratory environment (ambient temperature $22 \pm 2^\circ \text{C}$) and relative humidity $60 \pm 5\%$). A qualified female nurse examined the sexual maturity status of the participants using the pubic hair criteria of Tanner (1962).

Motion sensor placements

Prior to testing, the ActiGraph and Omron motion sensors were worn concurrently (clipped onto the waistband of the shorts) on the right and left hips, respectively, adhering to the manufacturers' recommendations (e.g. for best results, keep the unit aligned to the crease line of the trousers). Research informs that accelerometer placements at the right or left side of the hip did not significantly affect the data (i.e. total activity counts/min and time spent at different intensity levels) obtained from 16, seven-year-old boys and girls, worn over 4 days, and monitored over the waking hours (Nilsson et al 2002). Similarly, studies show that left or right placements of pedometers generated step counts that were not significantly different from each other (Basset et al 1996; Crouter et al 2003). Additionally, Vincent and Pangrazi (2002) reported that wearing motion sensors like the pedometer among young people aged between 8 and 12 years, who were well-habituated to the pedometers (i.e. after allowing for 10 minutes of uninhibited exploration of the device), produced no significant reactivity. Reactivity is explained as a significant reaction to wearing the device compared to not wearing the device. The present group of participants was well-habituated to wearing both the accelerometer and the pedometer.

Treadmill speed

Before the start of the exercise testing, the activity monitors were reset and synchronized to an external time piece. Following a 2- to 3-minute familiarization period with the motor-driven treadmill (Quinton Series 90, Quinton Instrument Company, USA) at a steady pace equivalent to a 2.5km/hr walking pace, participants performed three continuous 5-minute exercise bouts which consisted of (a) walking at 4km/hr, (b) jogging or running at 6km/hr, and (c) running at 8km/hr. A similar but not identical protocol of 4-minute stages at five different treadmill speeds (walk at 4 and 6 km/hr; run at 8 and 10 km/hr) was successfully completed by 8 to 10-year-old Chinese boys (Louie et al 1999). These exercise bouts were performed at 0 % gradient since previous studies show that vertical axis accelerometers to be generally non-responsive to gradient changes (Haskell et al 1993; Melanson & Freedson 1995). Verbal encouragement was given to the participants through the tests to maintain a steady walking or running pace for each of the five minute stages.

Indirect calorimetry and heart rate monitoring

The Cosmed K4b₂ (Cosmed, Italy), a widely used portable telemetry device, was used to measure the rates of oxygen uptake ($\dot{V}O_2$), carbon dioxide production ($\dot{V}CO_2$) and pulmonary ventilation ($\dot{V}_E$).

The validity and reliability of the Cosmed K4b₂ system were previously established (Pinnington et al 2001; Duffield et al 2004). Prior to each test session, the Cosmed transmitter was turned on and warmed-up for at least 30 minutes. Calibration of the Cosmed system was conducted in accordance to the recommended procedures set by the manufacturer. The portable unit was fixed onto the subject by an anatomic harness and powered by a rechargeable battery that also was attached to the same harness. Expired gas was collected via an attached face mask that covered both the nose and mouth. The face mask was secured by a mesh headcap with adjustable straps.

Subjects breathed through the facemask whilst seated for approximately 3 to 5 minutes to allow the stabilisation of respiratory variables, HR and familiarisation with the Cosmed equipment. The heart rate (HR) telemetry device of the Cosmed K4b₂ system was used for the recording of baseline and exercise HR. The telemetry device comprised a double electrode transmitter chest belt (Sports Tester PE 3000) and a HR receiver probe connected to the portable unit of the Cosmed K4b₂ system. The transmitter was positioned on the chest, anterior to the xiphisternal joint, and strapped to the subject via an elastic belt. Heart rate signals were picked up by the receiver probe that was attached on the left side of the thorax approximately 5 cm superior to the left nipple and a Polar wrist monitor. The Polar wrist monitor was secured on the treadmill in close proximity to the subject to ensure transmission of heart rate signals.

Physiological measurements

Baseline physiological measurements (HR and $\dot{V}O_2$) were obtained 1 minute prior to the start of each test, and throughout the three, 5-minute treadmill tests at 4-, 6- and 8 km/hr. All analysis of cardio-respiratory variables (HR and $\dot{V}O_2$) were performed on the steady state variables obtained during the last two minutes of each 5-minute exercise stage at 4 km/hr, 6 km/hr and 8 km/hr, respectively. Both accelerometer and pedometer were immediately removed at the end of the test session and the data in the ActiGraph GT 1 M accelerometer (ActiCounts/min and ActiSteps/min) were downloaded using manufacturer recommended hardware and software, and together with the Omron HJ-005-E pedometer (PedoSteps/min) were entered into a personal computer for statistical analysis.

Statistical analysis

All data were analysed using SPSS (Statistical Package for the Social Sciences for Windows Version 16.0). Descriptive statistics (means $\pm$ sd) were calculated for all output measures.

Sex differences in accelerometer and pedometer data sets and physiological responses to the treadmill speeds were explored using one-way analysis of variance (OW-ANOVA). Paired-sample t-tests were used to analyse motion sensor outputs (step rate) and physiological responses in response to the three treadmill speeds. Pearson product-moment correlations were computed between ActiCounts, ActiSteps, PedomSteps and treadmill speeds, physiological variables (HR, $\dot{V}O_2$) to determine significant relationships among the variables. Agreement between ActiSteps and PedomSteps were examined using the method described by Bland and Altman (1986) and the difference between ActiSteps and PedomSteps was tested by a paired-sample t-test. An alpha level of 0.05 was used for all statistical tests, however where stated, the alpha level was reduced to 0.01 to account for multiple tests of significance.

Results

The descriptive characteristics, motion sensor responses and physiological responses of the 58 youths to walking and running at three treadmill speeds are summarized in Table 1. OW-ANOVA on accelerometer, pedometer and physiological responses to the three treadmill speeds revealed no sex differences ($p > 0.01$). Hence the male and female data in each cohort were pooled. All participants were within the normal weight-for-height range according to charts furnished by the School Health Services of the Ministry of Health (2002), and within the normal healthy range for BMI ($17 < \text{BMI} < 24.9$) based on international classifications (Cole et al 2000).

Preliminary data analyses of accelerometer (ActiCounts/min; ActiSteps/min) pedometer (PedomSteps/min) data and key physiological variables (i.e. oxygen uptake and HR) showed that for all cases, that was homogeneity of variance (Levene statistic > 0.01).

Paired-sample t-tests, with corrections for multiple comparisons (adjusted alpha = 0.01) revealed that for all 3 cohorts, accelerometer counts (ActiCounts/min), accelerometer steps (ActiSteps/min) increased significantly (all $p < 0.01$) from treadmill speed from 4 to 6 km/hr and from 6 to 8 km/hr.

Table 2 shows the correlation matrix between motion sensor output (ActiCounts/min, ActiSteps/min and PedomSteps/min) and oxygen uptake in ml/kg/min at 4, 6 and 8 km/hr for all 58 participants. The highest shared variance (51.8%) was between PedomStep rate at 4 km/hr and $\dot{V}O_2$ (ml/kg/min) at 4 km/hr.

Table 1: Physical characteristics, accelerometer, pedometer outputs and physiological responses in relation to the three treadmill speeds

Cohort 1 (Pooled data of male and female participants) (N=19; age: 9.7 ± 0.7 y; height: 1.34 ± 0.07 m; body mass: 30.7 ± 7.1 kg; BMI: 16.9 ± 2.5 kg/m ²)				
Treadmill speed	0 km/hr	4 km/hr	6 km/hr	8 km/hr
ActiCounts (Counts/min)	-	2055 $\pm$ 500	3557 $\pm$ 967 ^a	5628 $\pm$ 994 ^b
ActiSteps (Steps/min)	-	123 $\pm$ 11	146 $\pm$ 10 ^a	177 $\pm$ 10 ^b
PedomSteps (Steps/min)	-	128 $\pm$ 9	150 $\pm$ 12 ^a	182 $\pm$ 14 ^b
Oxygen uptake (ml/kg/min)	13 $\pm$ 2	21 $\pm$ 3	30 $\pm$ 5 ^a	40 $\pm$ 4 ^b
Heart rate (bpm)	102 $\pm$ 12	114 $\pm$ 12	149 $\pm$ 15 ^a	178 $\pm$ 31 ^b
Cohort 2 (Pooled data of male and female participants) (N=20; age: 13.4 ± 0.3 y; height: 1.61 ± 0.08 m; body mass: 49.9 ± 9.7 kg; BMI: 19.2 ± 3.1 kg/m ²)				
ActiCounts (Counts/min)	-	1916 $\pm$ 548	4203 $\pm$ 828 ^a	7410 $\pm$ 1023 ^b
ActiSteps (Steps/min)	-	104 $\pm$ 15	135 $\pm$ 10 ^a	163 $\pm$ 7 ^b
PedomSteps (Steps/min)	-	111 $\pm$ 10	135 $\pm$ 14 ^a	165 $\pm$ 8 ^b
Oxygen uptake (ml/kg/min)	10 $\pm$ 2	15 $\pm$ 2	24 $\pm$ 4 ^a	35 $\pm$ 4 ^b
Heart rate (bpm)	99 $\pm$ 11	106 $\pm$ 12	131 $\pm$ 15 ^a	158 $\pm$ 37 ^b
Cohort 3 (Pooled data of male and female participants) (N=18; age: 16.8 ± 1.0 y; height: 1.66 ± 0.09 m; body mass: 57.0 ± 9.8 kg; BMI: 20.5 ± 2.5 kg/m ²)				
ActiCounts (Counts/min)	-	2049 $\pm$ 548	4167 $\pm$ 840 ^a	7278 $\pm$ 1222 ^b
ActiSteps (Steps/min)	-	103 $\pm$ 14	127 $\pm$ 5 ^a	160 $\pm$ 9 ^b
PedomSteps (Steps/min)	-	110 $\pm$ 8	127 $\pm$ 7 ^a	161 $\pm$ 9 ^b
Oxygen uptake (ml/kg/min)	9 $\pm$ 2	14 $\pm$ 2	22 $\pm$ 3 ^a	35 $\pm$ 3 ^b
Heart rate (bpm)	93 $\pm$ 11	101 $\pm$ 23	120 $\pm$ 16 ^a	160 $\pm$ 14 ^b

^a Significantly different from 4 km/hr ($p < 0.01$)

^b Significantly different from 6 km/hr ($p < 0.01$)

Table 2: Correlation matrix of motion sensor output rates (ActiCounts/min, ActiSteps/min, PedomSteps/min) and oxygen uptake in ml/kg/min walking and running at three different treadmill speeds (N=58, age: 13.2 ± 3.0 y; height: 1.53 ± 0.02 m; body mass: 45.5 ± 14.2 kg; BMI: 18.8 ± 3.0 kg/m²; Tanner rating: 2.5 ± 1.3)

Motion sensor output	$\dot{V}O_2$ (ml/kg/min) at 4 km/hr	$\dot{V}O_2$ (ml/kg/min) at 6 km/hr	$\dot{V}O_2$ (ml/kg/min) at 8 km/hr
ActiCounts (counts/min)	-0.03	-0.28	-0.18
ActiSteps (steps/min)	*0.65	*0.69	*0.36
PedomSteps (steps/min)	*0.72	*0.65	*0.38

* $P < 0.01$

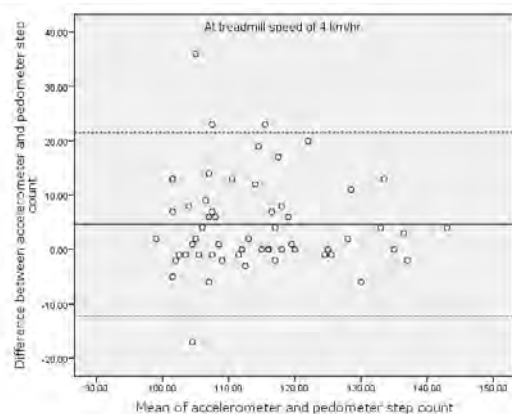


Figure 2a

Bland-Altman plot depicting error scores (ActiStep rate minus Pedometer rate) against the mean step rate of the two motion sensors ($\text{ActiSteps} + \text{PedometerSteps} / 2$) at a treadmill speed of 4 km/hr. The solid line represents the mean error while the dashed lines represent the 95 % limits of agreement. For the treadmill speed of 4 km/hr, the mean difference is 4.6 ± 8.7 steps/min.

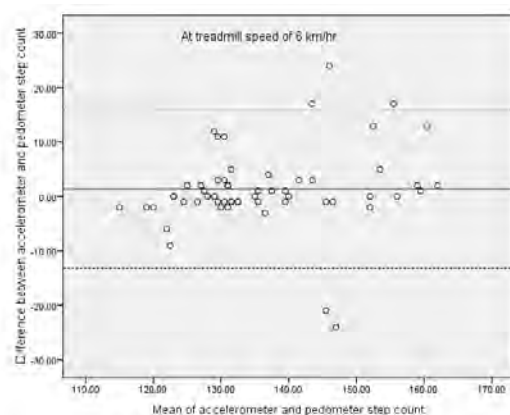


Figure 2b

Bland-Altman plot depicting error scores (ActiStep rate minus Pedometer rate) against the mean step rate of the two motion sensors ($\text{ActiSteps} + \text{PedometerSteps} / 2$) at a treadmill speed of 6 km/hr. The solid line represents the mean error while the dashed lines represent the 95 % limits of agreement. For a treadmill speed of 6 km/hr, the mean difference is 1.3 ± 7.4 steps/min.

Figure 2 shows the mean error and the 95 % limits of agreement for the motion sensors in relation to the three treadmill speeds. The differences in step count rate between the ActiGraph GT 1 M accelerometer and the Omron HJ 005-E pedometer was lowest at a treadmill speed of 6 km/hr than at 4 km/hr or at 8 km/hr. However, results of paired sample t-tests revealed that for the three treadmill speeds, the step rate at each speed, recorded by the Omron HJ-005-E pedometer was significantly greater than that recorded by the ActiGraph GT 1 M accelerometer (t-ratios= -4.08 (4 km/hr); -20.62 (6 km/hr) and -3.42 (8 km/hr), all $p < 0.01$).

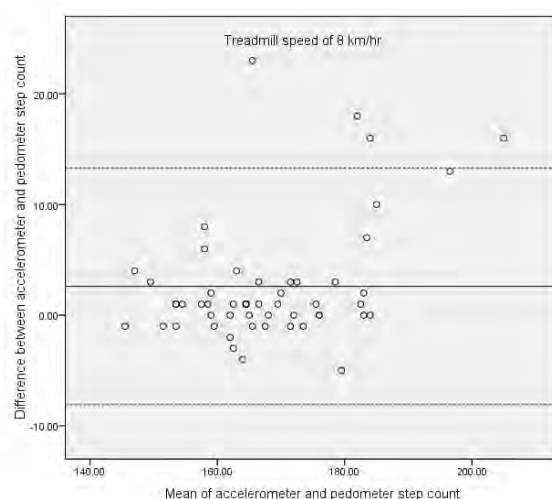


Figure 2c

Bland-Altman plot depicting error scores (ActiStep rate minus Pedometer rate) against the mean step rate of the two motion sensors ($\text{ActiSteps} + \text{PedometerSteps} / 2$) at a treadmill speed of 8 km/hr. The solid line represents the mean error while the dashed lines represent the 95 % limits of agreement. For a treadmill speed of 8 km/hr, the mean difference is 2.6 ± 5.5 steps/min.

Discussion

Relevance and importance of the present study

An objective use of body motion sensors to examine physical activity among young people is important as concerns about the prevalence of young people in the Far East who are overweight and overfat gathers momentum.

Though research on accelerometer and pedometer use in the last decade has increased significantly (Tudor Locke et al, 2002; Rowlands et al, 2007), improvements in motion sensor technology mean that research on physical activity among youth must keep pace as new electronic models of motion sensors such as the ActiGraph GT 1 M and Omron HJ 005-E become commercially available while older versions of accelerometers and pedometers become obsolete or are discontinued. To the authors' knowledge, there are apparently no information on the ActiGraph GT 1 M accelerometer and Omron HJ 005-E pedometer output data and physiological responses of male and female Asian samples of normal body mass to walking and running on a motorized treadmill under laboratory conditions.

These data are useful as more research become focused on the nexus between physical activity and health (Biddle et al, 2004; Strong et al, 2005) among Singaporean and East Asian youths.

Motion sensor outputs in relation to physiological responses

Preliminary analysis revealed no sex difference in motion sensor outputs and oxygen uptake and heart-rate response (all $p > 0.01$) to walking and running on the treadmill at 4 km/hr and 6 and 8 km/hr. No equivalent study is available for comparison and the present result provides evidence of no sex difference in accelerometer count rate, step rates garnered by the ActiGraph GT 1 M and Omron HJ 005-E, body mass-accounted oxygen uptake and heart-rate in response to walking (4 km/hr) and running (6 and 8 km/hr) on a motorized treadmill in large cohort of normal-weight children and adolescents. In terms of physiological responses to walking and running on the treadmill, this translated to, for subject cohort 1 (6.0, 8.6 and 11.4 METs), for subject cohort 2 (4.3, 6.9 and 10 METs) and for subject cohort 3 (4.0, 6.3 and 10 METs), respectively, assuming that 3.5 ml/kg/min equals 1 MET in young people (Armstrong & Welsman, 1997). Data from Table 1 show that motion sensor rates (ActiCounts/min, ActiSteps/min, PedometerSteps/min) increased significantly from 4 km/hr to 6 km/hr and to 8 km/hr, as did, oxygen uptake (ml/kg/min) and heart rate (bpm). However, the percentage increase for each of the variables, with treadmill speed was not identical. For example, from 4 km/hr (walking) to 6 to 8 km/hr (running) the increases in ActiCounts/min were 101 and 76 %, respectively. This compared to changes in ActiStep and PedometerStep rates of 22 and 24 %, and 18 and 25 %, accordingly. For the same treadmill speed change, the respective changes in oxygen uptake (ml/kg/min) and heart rate (bpm) were 55 and 48 %, and 27 and 28%, respectively.

In comparison, a study on 21 Chinese boys aged 8-10 years, using different accelerometers (TriTrac R3D and WAM 7164) and a different pedometer (Yamax Digiwalker DW 200) than the present study, deductions from the tabular data provided by Louie et al (1999) showed that TriTrac activity rate (counts/min) increased 73 and 12 % ; WAM activity rate (counts/min) increased 80 and 100%; and Yamx step count (steps/min) increased 19 and 26 % for a change in treadmill speed from 4 to 6 km/hr and from 6 to 8 km/hr. For the same treadmill speed change, the corresponding physiological change in oxygen uptake (ml/kg^{0.75}/min) was an increase of 50 and 48 %, and for heart rate (bpm), it was an increase of 16 and 25 %. These results demonstrate that whilst the physiological responses to changes in treadmill speed among children are somewhat similar in magnitude, the resultant motion sensor changes are markedly dissimilar. This, coupled with dissimilar subject cohorts, make comparisons across studies difficult.

Hence researchers must be cautious in applying results of other studies to their own without first verifying that the cited data are applicable and valid to the existing study. A unique feature of the present study is that it is apparently the first to compare accelerometer-derived step count with that derived from an electronic pedometer under controlled laboratory conditions in the same cohort of subjects. Data in Table 1 showed that for treadmill speeds of 4, 6 and 8 km/hr, the step rate derived from the electronic pedometer was significantly greater (all $p < 0.01$) than the step rate derived from the accelerometer (positive bias in pedometer step rate). However, Figure 2 shows that difference in step rate between the accelerometer and the pedometer was smallest at a treadmill jogging speed of 6 km/hr. As motion sensors (step count or step rate) are used to detect physical activity that are commonly associated with walking, jogging and running, the present result affirmed the assertions of some researchers that motion sensors are more sensitive at different speeds and accelerations of motion in children (Brage et al 2003). An unexpected result of the present study was the lack of significant associations ($r = -0.3$ to -0.02 , $p > 0.01$) between the accelerometer activity counts and oxygen uptake at the three treadmill speeds (see Table 2).

This contrasted with results reported by Louie et al (1999) where correlations between TriTrac and WAM accelerometer counts/min and heart rate ranged between 0.79 and 0.93 ($p < 0.01$). The reason for this lack of correlation is not readily apparent but the use of a different accelerometer model and the frequency-filtering of the accelerometer that captures movements of a certain frequency range (Rowlands et al, 2007) cannot be ruled out. According to them, signals from the accelerometer are weighted according to the frequency of movement, with frequencies higher or lower than 0.75 Hertz subjected to decreasing weighting. However, the frequency of walking and running of the subjects in the present study was not determined. This represents an area for further research in subsequent studies. However, the correlations between step rates derived from the motion sensors to the three treadmill speeds are in general agreement with those reported by Louie et al (1999). For example the cited authors reported a significant correlation of 0.77 between scaled oxygen uptake and step rate assessed by the Yamax Digiwalker pedometer. This compares with significant correlations of 0.56 and 0.60 ($p < 0.05$) between oxygen uptake (ml/kg/min) and ActiGraph GT 1 M accelerometer step rate and the Omron HJ 005-E pedometer. These results suggest that step rate is a useful means of assessing physical activity among children and adolescents, especially during walking and running between the speeds of 4 and 8 km/hr.

Conclusions

Data from the present study are from a sizeable subject cohort of children and adolescents of both sexes and provide much needed reference information derived from controlled laboratory conditions as physical activity research attention among Singaporean children and adolescents gathers momentum. Walking at 4 km/hr elicited between 4 and 6.0 METs whilst running at 6 km/hr and 8 km/hr elicited 6.3-8.6 and 10.0-11.4 METs, respectively.

Motion sensor outputs of children and adolescents increase with treadmill speeds, as did heart rate and oxygen uptake, albeit the magnitude of change among the variables were not identical.

Step rate assessed by the Omron HJ 005-E pedometer was significantly higher whilst walking at 4 km/hr, and running at 6 and 8 km/hr. Agreement in step rate was highest for the ActiGraph GT 1 M and the Omron HJ 005-E at a treadmill speed of 6 km/hr for Singaporean children and adolescents. These results suggest that step rate assessed by the ActiGraph GT 1 M and Omron HJ 005-E pedometer are useful and suitable measurements of physical activity involving walking and running among Singaporean children and adolescents of normal body mass. Further investigations including data reduction procedures and post-processing of accelerometer counts are necessary make biological sense of the resultant data and to exploit these devices for physical activity research among young people.

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ODZIV SENZORA GIBANJA KOD DJECE I ADOLESCENATA ZA VRIJEME HODANJA I TRČANJA NA TRI BRZINE PO POKRETNOM SAGU

Sažetak

Ovo istraživanje bavilo se izlazom senzora za gibanje u Singapuru, djece i adolescenata oba spola za vrijeme hodanja i trčanja na motoriziranom pokretnom sagu (Quinton Series 90) u kontroliranim laboratorijskim uvjetima. Ukupno 58 mladih normalne mase tijela ($N=58$, uzrast: 13.2 ± 3.0 g.; visina: 1.53 ± 0.02 m; masa tijela: 45.5 ± 14.2 kg; BMI: 18.8 ± 3.0 kg/m²; Tanner ocjena: 2.5 ± 1.3) bilo je obuhvaćeno istraživanjem. Akcelerometarske (ActiGraph GT 1 M) aktivnosti (ActiCounts u broj/min) i step ritam (ActiSteps u step/min) i pedometer (Omron HJ 005-E) step ritam (PedoSteps in step/min), primitak kisika (u ml/kg/min) i srčani ritam (u otkuca u min) su praćeni od 5-minutnog stanja od 0 % gradijenta hodanja na pokretnom sagu brzinom od 4 km/h, te trčanja od 6 km/h i 8 km/h. Hodanje od 4 km/h je procijenjeno na 4.0-6.0 METs, dok je trčanje od 6 km/h i 8 km/h procijenjeno na 6.3-8.6 i 10.0-11.4 METs, respektivno. Izlaz senzora gibanja značajno se povećao s brzinom pokretnog sagra (76-101 % za ActiCounts; 22-24 % za ActiSteps i 18-25 % za PedoSteps, sve uz $p < 0.01$) baš kao i primitak kisika (48-55 %) i otkucaji srca (27-28 %) ali nije bilo razlika po spolu u aktivnosti step ritma ili fiziološkog odgovora ($p > 0.01$). Neznačajne relacije su dobivene između akcelerometarske aktivnosti ritma i primitka kisika ili srčanog ritma. Prihvatljivo je slaganje između akcelerometarskog i pedometerskog step ritma kod hodanja ili trčanja na pokretnom sagu, ali razlike između akcelerometarskog i pedometerskog step ritma su malene kod brzine sagra od 6 km/h. Ovi rezultati pokazuju da je akcelerometarski i pedometerski step ritam korisna i primjenjiva mjera tjelesne aktivnosti koja uključuje hodanje i trčanje među djecom i adolescentima Singapura normalne tjelesne mase. Potrebna su daljnja istraživanja za potpuno korištenje podataka akcelerometra u istraživanju tjelesne aktivnosti mladih.

Ključne riječi: izlaz senzora gibanja, djeca i adolescenti, hodanje i trčanje po pokretnom sagu

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INTERACTION BETWEEN GENETIC AND NON GENETIC POTENTIALS IN THE FUNCTION OF CREATION AND DEVELOPMENT OF SPORTSMEN INDIVIDUALITY

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Review paper

Abstract

The aim of the paper according to much research done in the field of sport genetics is to analyze interaction between genetic and non genetic potentials of anthropological characteristics of sportsmen. The potentials are in the function of creation and development of sportsmen individuality in order to make the right and on time orientation of selection of young sportsmen and to enable the most optimal modelling of characteristics and abilities of sportsmen for particular sports. Finally, all this has to be carefully planned including sportsmen trainings, methods and burden as well as controlled and analyzed concerning training process as a whole. The sample of variables consists of variables with high impact of genotype ranging from 80-98% (skeleton dimension .98, speed .95, general cognitive factor .92, coordination .87, explosive strength .85 and precision .80), with the possibility to be transformed from 2-20%, then the average impact of genotype ranging from 60-80% (mass and body volume .80, pathological conative characteristics .78, balance .75, functional abilities .70, flexibility .65 and repetitive strength .60), with their possibility to be transformed from 20 - 40% and low impact of genotype ranging from 35-60% (static strength - .60, psychological states - .55, motor knowledge - .55, attitudes and opinions - .50, specific knowledge - .40 and specific habits - 35), with their possibility to be transformed from 40- 65%. General conclusion is that even today and especially in the future management in the process of training technology in top sport will not be possible without knowledge and application of anthropological (humane) genetics in sport. It is non scientific and above all non humane act to violently subject young people to transformational processes of anthropological characteristics in some sports if they do not possess genetic potentials of their individual characteristics and abilities.

Key words: sport genetics, anthropological characteristics, genotype impact, interaction, individuality

Introduction

In modern practice, training technology and sport science it is known that detecting many relevant and dominant factors for achieving top sport results apart from contribution of genetic (limited) potentials of high importance is formation of non genetic (transforming) potentials of sportsmen. This can be explained, from the point of view of anthropological aspect, by the fact that there are no two identical subjects because each sportsman represents an individual for himself. So, in the training process it is necessary to pay attention not only to what is specific for sportsmen state which represents the consequence of transformational training process but also to what is genetically specific in limited state for each person and is impossible to change by training (Malacko & Rađo, 2004). Relation between genetic and non genetic potentials can be defined as an interaction of genetic and non genetic part of variance of each human characteristic and ability. So, the general rule that the impact on a certain anthropological characteristic will be lower if the genotype of the variance of that characteristic is higher is justified.

The same applies vice versa the impact will be higher if the genotype variance is lower. The issue of determination of the relative part of genotype variance in the whole variability of anthropological characteristics so far has not been unified. The reason for this is the different view of in-born coefficients of anthropological characteristics by various authors and countries (Mraković, 1992).

Genetic and non genetic potentials

Genetic potentials are most often represented by inborn coefficient which represents the value of the variance of each anthropological characteristic which is genetically conditioned that is the part of the variance that can not be changed. For this purpose Holtzinger's tables are used most often - inborn coefficient (H²); however there are many other authors with similar research results (Gaisl, 1981; Wolansky, 1984; Malacko, 2000). Former research done in the field of genetics in sport show that top sport results can not be achieved only by the application of modern training technology.

Moreover they depend on the genetic condition of particular anthropological characteristics and abilities of sportsmen. So, genetics takes more important place in the field of sport anthropology (Wolansky, 1971; Ifrim, 1984; Schwartz, 1984; Nikitjuk, 1986; Wolansky, 1986; Moskatova 1986; Malacko, 1995). Orientational results of former research (Malacko & Doder, 2008):

- morphol. characteristics show that skeleton dimension has the highest genetic condition ($H^2=.98$), mass and body volume have lower genetic condition ($H^2=.80-.90$), and fatty tissue has the lowest ($H^2=.50$). Research of the structure of skeleton muscles shows that motor charact. are under high genetic impact;
- functional abilities are also under genotype impact but they are not the same for each ability ($H^2=.60-.80$) and they show predominance of genetic factor in maximal oxygen consumption which is considered a proof of genetic condition of aerobic system;
- motor abilities are still in the phase of empiric research so it is very hard to accept some conclusions with certainty. However, the following opinions prevail: speed ($H^2=.90-.95$), explosive strength, coordination, balance and precision ($H^2=.80-.85$) are highly influenced by genetics, while repetitive strength, static strength and flexibility ($H^2=.50$) are less influenced which means that bigger changes are possible;
- cognitive abilities are also genetically influenced because their innate coefficient is very high ($H^2=.85-.92$), but it is considered that general cognitive factor can be developed until the age of 7 under the condition various cognitive tasks are solved;
- pathological conative characteristics show that innate coefficient is very high ($H^2=.80-.85$), and research showed that even most modern therapeutically procedures can not decrease pathological factors. Normal conative characteristics show that innate coefficient is very low ($H^2=.50$) which means that it can be developed especially at an early age;
- specific psychological states, motor knowledge, attitudes and opinions as well as specific knowledge and habits are least genetically influenced ($H^2=.35-.60$) so there is the possibility of transformation in the desired direction.

Above mentioned orientational results of research contribute to the decision to pay greater attention to non genetic potentials of anthropological characteristics when developing sportsmen individuality. Non genetic potentials of anthropological characteristics are in the interaction with genetic potentials so that transformational processes and biological adaptation can be adequately understood and high efficiency and effectiveness achieved during the training process and competing sport activities.

The aim of the paper

The aim of the paper according to much research done in the field of sport genetics is to analyze interaction between genetic and non genetic potentials of anthropological characteristics of sportsmen. The potentials are in the function of creation and development of sportsmen individuality in order to make the right and on time orientation of selection of young sportsmen and to enable the most optimal modelling of characteristics and abilities of sportsmen for particular sports. Finally, all this has to be carefully planned including sportsmen trainings, methods and burden as well as controlled and analyzed concerning training process as a whole.

Methods

The paper altogether includes 18 variables with high genotype impact: ADSK - skeleton dimension, MBRZ - speed, GKOG - general cognitive ability, MKOO - coordination, MEKS - explosive strength, MPRE - precision, lower genotype impact: AMVT - mass and body volume, PKON - pathological conative characteristics, MRAT - balance, MFSP - functional abilities, MFLE - flexibility, MRES - repetitive strength and the lowest genotype impact : MSTS - static strength, PPST - psychological states, MMZN - motor knowledge, PSTM - attitudes and opinions, SSZN - specific knowledge, SSNA - specific habits. The results have been processed and graphically presented.

Results

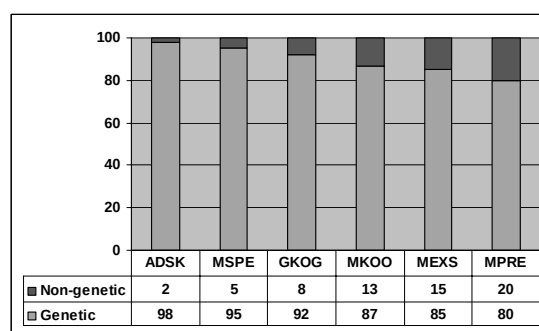


Figure 1. High genotype impact

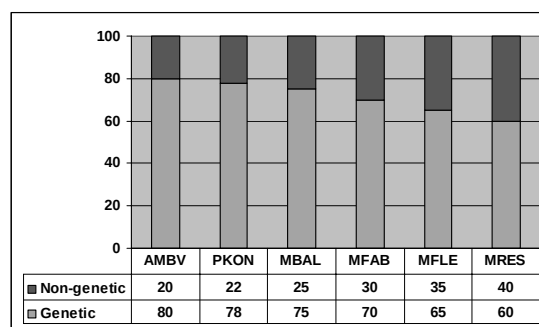


Figure 2. Lower genotype impact

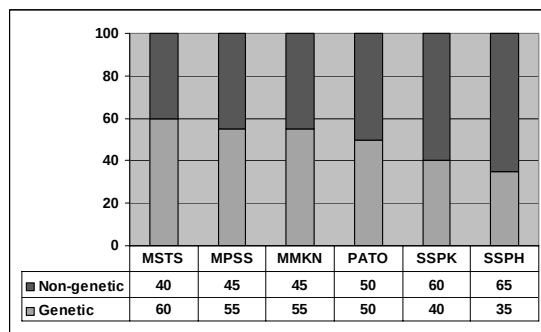


Figure 3. Lowest genotype impact

Graph 1 shows that the high genotype impact of 6 applied variables ranges from 80-98% (skeleton dimension - .98, speed - .95, general cognitive factor - .92, coordination - .87, explosive strength - .85 and precision - .80), with the possibility to be transformed from 2-20%. Lower genotype impact of 6 variables (graph 2) ranges from 60-80% (mass and body volume - .80, pathological conative characteristics - .78, balance - .75, functional abilities - .70, flexibility - .65 and repetitive strength - .60), with the possibility to be transformed from 20 - 40%. The lowest genotype impact (graph 3) ranges from 35-60% (static strength - .60, psychological states - .55, motor knowledge - .55, attitudes and opinions - .50, specific knowledge - .40 and specific habits - 35, with the possibility to be transformed from 40- 65%.

Discussion and conclusion

In recent years in top sport sportsmen selection has been intensified concerning the interaction of their anthropological characteristics, abilities and individuality. This appears as the reaction to traditional training process which was criticised and denied for many years. In traditional training process the trainer has almost the same approach to all sportsmen applying firstly programmed training which is planned in advance on the basis of trainer's personal experience, intuition and tradition, suggestions of some 'authorities' as well as some other suggested and not enough checked information and not on the basis of concrete programmed training in situational conditions.

Sportsmen individual preparation is inevitable and obligatory during all training processes throughout the year because it is creative, can be corrected, interactive and can be compared. Every trainer should practise it disregarding the kind of preparation in focus. Focus of each particular preparation during all training and competing periods depends on the type of sport, age, preparation level, competition levels and sport form achievement and it is on the trainer's creativity.

Accordingly, it is the trainer's duty to constantly 'listen' to each sportsmen organism, to notice and control the application of used training techniques, methods and burden and to take prompt and right measures so that he can create future work on the basis of feedback paying attention to the planned (expected, desired) sportsmen state in the target time.

Graph 1 shows variables of anthropological characteristics which are in the majority of sports dominant or relevant and have high genotype impact, ranging from 80-98% (skeleton dimension .98, speed .95, general cognitive factor .92, coordination .87, explosive strength .85 and precision .80), with the possibility to be transformed from 2-20%. At first sight such information might cause appropriate doubt and discourage trainers regarding any change under the impact of trainings and burden. However, due to the existence of important interactions (relations, correlations) with other characteristics and abilities in integral anthropological area partial change in concrete training activities is possible.

It practically means that trainings include creation of conditions (specific or situational motion structures improvement or development of abilities with lower or the lowest genotype impact) in order to optimally express naturally and genetically conditioned characteristics and abilities through effective motion structure of specialized sport activities. It really means that specific and/or situational motion structures (technical elements) must be adapted to innate individual speed, coordination, sportsman explosive strength developing all other dominant and relevant motor abilities which are in interaction and present in the structure of particular sport activity (specification equation) unless they are isolated redundant (deranging) motions.

Cognitive abilities represent the basis of thoughtful, conscious activity and it would be impossible to practice methodological procedures of education without them. It would be impossible to analyze sport success and failure, control and manage all other thoughtful operations in the process of training. It is supposed that there is no sport, no matter how much simple, where intelligence does not participate in specification equation. If the general device (general cognitive processor) for reception, information analysis and decision making does not function properly, it is impossible to achieve good results in such a complex situation as top sport. On the basis of former practice, experience, tradition and scientific research it has been discovered that the more complex the structure of sport activity the higher cognitive abilities and vice versa.

Reviewing graph 2 it can be seen that lower genotype impact of 6 variables ranges from 60-80% (mass and body volume .80, pathological conative characteristic .78, balance .75, functional abilities .70, flexibility .65 and repetitive strength .60), with the possibility to be transformed from 20 - 40%. In the majority of sports mass and body volume, functional abilities and conative characteristics represent anthropological segments which are important for achievement of top sport results because there is the possibility of their change. In contrast to some sports with hard tissues dominant manifested by sum of longitudinal and transversal dimension in unique skeleton dimension in the majority of other sports sportsmen have increased values in soft tissues defined by the quantity of muscular mass and subdermal fatty tissue. Concerning scientific literature it is known that muscles' volume has direct impact on the ability of muscular strength development. So, it defines the possibility of high or low efficiency of motion, mastering resistance or hurdles. In training procedures of transformation of soft tissues (muscular mass increase) it is highly necessary to pay attention to balance in order to develop active muscular mass by constant use of muscular stations and by adequate nutrition regarding the fact that big muscular mass has high energy consumption which increases total motor efficiency and effectiveness. For pathological conative characteristics (personality characteristics) it is important to emphasize that their increased intensity decreases adaptation level, in other words, if some pathological conative factor is higher, the adaptation level is lower. It is supposed that pathological conative characteristics have physiological basis and cause disturbance of personality integration which causes violation of balance between the process of irritation and inhibition. The influence of conative regulative mechanisms on success in sport activity has different intensity and it depends on the type of mechanism and kind of sport as well as on some other expected or non expected situations and conditions aiming at the most optimal sport result regarding ability, sport knowledge and sportsman form. The intensity which is lower than the expected value of conative mechanism and especially higher one decreases the potential sport success of sportsmen. Sportsmen functional abilities are mostly identified with their motor capacity which is characteristic for its longer motion and is based on the efficiency of function of regulative mechanisms which are manifested in energetic reserves (adenozin-triphosphate, creatin-phosphate, glycogen and oxygen) and functional quality of energetic potential. Some groups of muscle fibres (slow-contracting, oxidizing or red) are suitable for slow aerobic workout while the others are more suitable for non aerobic workout

(fast-contracting, glycolytic or white). It is considered that some white muscle fibres can perform as red muscle fibres as the time passes and accordingly to circumstances (for example in stamina training) but when the training process stops they return to the former state but muscle fibres have high genetic limitation.

Reviewing graph 3 it can be seen that the lowest genotype impact ranges from 35-60% (static strength - .60, psychological states - .55, motor knowledge - .55, attitudes and opinions - .50, specific knowledge - .40 and specific habits - .35, with the possibility to be transformed from 40-65%. From this group of listed variables with low genotype impact the most important is motor knowledge (learnt motion structures) based on the most modern learning theories. On the basis of such knowledge it is certain that new theories, concepts, approach and learning methods should be based on activation of, so far neglected, right cerebral hemisphere where the center for automatic-reflexive creation and task operationalization is based, as well as intuition, creativity and logical thinking with their base in individual genetic potentials. Accordingly, turning learning methods towards right cerebral hemisphere in modern conditions represents an important challenge in sport with the aim to activate unused potential of right cerebral hemisphere and in the interaction of both hemispheres enable motion structures (situational mobility, technique, tactics) to be realized in a simpler way and more appropriately and that way make learning process faster and more efficient and effective. Presented and analyzed research results contribute to the orientation that special attention should be paid to genetic and non genetic potentials of anthropological characteristics when developing sportsmen individuality in order to adequately understand transformational processes and biological adaptation and that way achieve well-timed and valid orientation in sports selection. Then, regarding training technology characteristics and abilities' modelling of sportsmen should be done concerning particular sports and sport disciplines. Further, the diagnosis should be done and finally planning and programming of trainings, methods and burden as well as control and analysis of the effects of total training process. All above stated and analyzed results in the fact that even today and especially in the future the management of training technology in top sport will be impossible without the knowledge of anthropological (humane) genetics in sport and its application. It is non scientific and above all non humane act to violently subject young people to transformational processes of anthropological characteristics in some sports if they do not possess genetic potentials of their individual characteristics and abilities.

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INTERAKCIJA GENETSKIH I NEGENETSKIH POTENCIJALA U FUNKCIJI KREIRANJA I RAZVOJA INDIVIDUALNOSTI SPORTAŠA

Sažetak

Cilj rada je da se na osnovu većeg broja istraživanja u prostoru sportske genetike izvrši analiza interakcije genetskih i negenetskih potencijala antropoloških karakteristika, koji su u funkciji kreiranja individualnosti sportista, radi pravovremene i pravovaljane orijentacija prilikom selekcije, a s druge strane, optimalno modeliranje značajki za pojedine sportove, sprovedo njihovo dijagnosticiranje, planiranje i programiranje, , kao i analiza efekata trenažnog procesa. Razmatrane su varijable s visokim utjecajem genotipa, u rasponu 80-98% i mogućnosti transformacije 2-20%, zatim srednji uticaj genotipa u rasponu od 60-80% i mogućnosti transformacije u rasponu 20-40% i mali utjecaj genotipa u rasponu od 35-60% i mogućnosti transformacije u rasponu 40-65%. Generalni zaključak je, da već danas, a pogotovu u budućnosti, upravljanje u procesu trenažne tehnologije u vrhunskom sportu neće biti moguće bez poznavanja i primjene antropološke (humane) genetike u sportu. Neznanstveno je i nestručno (i nehumano), nad mladim ljudima sprovoditi transformacione procese u pojedinim sportovima i sportskim disciplinama, ako oni za njihove individualne osobine, sposobnosti i karakteristike ne posjeduju odgovarajuće genetske potencijale.

Key words: genetika u sportu, antropološke karakteristike, utjecaj genotipa, interakcija, individualnost

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ACCURACY OF VISUAL FEEDBACK CONTROL OF BODY POSITION DURING TASK-ORIENTED SENSORIMOTOR EXERCISE IN VARIOUS POPULATIONS

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Original scientific paper

Abstract

The study compares the accuracy of visual feedback control of COP movement in antero-posterior and medio-lateral direction during task-oriented sensorimotor exercise in various populations. Individuals of different age and performance level (groups of healthy young adults – students of technical university, older women, and elite dancers), athletes of various specializations (competitors of snowboarding, windsurfing, cycling, rowing, canoeing, karate, and PE students), and athletes after lower limb injury (ankle, knee) volunteered to participate in the study. Subjects were provided by feedback on COM displacement on a computer screen while standing on dynamometric platform. Their task was to trace, by shifting COM, a curve flowing either in vertical or horizontal direction. The test consisted of three 30-seconds trials randomly performing in each direction. The deviation of instant COP position from the curve was recorded at 100 Hz by means of the system FiTRO Sway Check. Results showed that mean COP distance from horizontally and vertically flowing curves was significantly ($p \leq 0.01$) lower in dancers (11.8 ± 2.3 mm and 10.1 ± 2.2 mm, respectively) than in students (14.8 ± 1.9 mm and 13.7 ± 2.0 mm, respectively) and older women (16.4 ± 2.6 mm and 14.5 ± 2.7 mm, respectively). On the other hand, there were no significant differences in the COP distance from both curves in competitors of snowboarding and windsurfing (20.7 ± 2.2 mm and 20.1 ± 2.2 mm, respectively), karate (20.8 ± 2.7 mm and 20.3 ± 2.7 mm, respectively), PE students (21.5 ± 3.0 mm and 20.6 ± 2.6 mm, respectively), cyclists (22.6 ± 3.0 mm and 21.3 ± 2.7 mm, respectively), and rowers (23.0 ± 2.8 mm and 22.5 ± 2.2 mm, respectively). As in previous groups, there were no significant differences in mean COP distance from horizontally and vertically flowing curve in athletes after lower limb injury while performing the task on both legs (28.7 ± 2.5 mm and 27.0 ± 2.1 mm, respectively) and on non-injured leg (42.6 ± 4.6 mm and 33.3 ± 4.2 mm, respectively). However, its values were significantly ($p \leq 0.05$) higher in antero-posterior than in medio-lateral direction while standing on injured leg (50.8 ± 5.0 mm and 33.6 ± 4.5 mm, respectively). It may be concluded that the task-oriented test based on visual feedback control of body position can be applied for an evaluation of sensorimotor performance in subjects of different age and expertise, as well as in individuals after lower limb injury.

Key words: athletes, individuals after lower limb injury, older people, sensorimotor parameters, task-oriented sensorimotor exercise, visual feedback control of body position

Introduction

For many years balance has been evaluated under static conditions. However, using this method no significant differences in sway variables were found even in individuals with impaired coordination. For instance, patients with Parkinson's disease demonstrated similar or even reduced sway of COP in comparison with healthy control subjects when tested in upright stance on stable support surface (Horak et al., 1992; Schieppati et al., 1994; Smithson et al., 1998). On the other hand, when the postural demands were increased (one-legged stance or compensation of stance perturbations) the patients showed significant deficits in their balance control. Lower sensitivity of static posturography is a consequence of multiple sensory inputs (visual, proprioceptive, and vestibular) involved in postural control.

Such a system can compensate smaller impairment of the system in such a way that under normal conditions (quiet stance) no deficits in postural stability may be apparent. Under dynamic conditions (stance on unstable surface), the control mechanisms is taxed to a substantially higher extent so that individual differences can be revealed. However, though in current practice various posturography systems are available, most of them have shortcomings. First, some of the platforms, even the largest and fastest motions producing, are insufficient to destabilize subject beyond its stability limits. Though being very suitable for elderly and patients with deteriorated coordination, in highly skilled athletes does not cause serious balance impairment. Second, many of them produce only unidirectional movements, usually in antero-posterior plane.

Furthermore, in some cases the learning effect has been observed using tilted platforms since relatively high predictability of the subjects to upcoming perturbations. To avoid these drawbacks one should use more sophisticated methods closer to functional balance. Promising seems to be task-oriented sensorimotor tests performing on either stable or unstable platform equipped with PC system for feedback monitoring of COM movement (Hamar, 2008).

Advantage of the system is that there are variety of task settings like „Hit the target“ or „Trace the curve“ by horizontal shifting of COM. In the first case, subjects have to hit the target randomly appearing in one of the corners of the screen by horizontal shifting of COM in appropriate direction. The test consists of 2 sets of 20 responses while better results is taken for the evaluation. Time, distance, and velocity of COP trajectory between stimulus appearance and its hit by visually-guided COM movement on the screen are registered by means of the system FITRO Sway Check based on dynamometric platform (www.fitronic.sk). In the second, subjects are provided by feedback on COM displacement on a computer screen while standing on dynamometric platform. Their task is to trace, by shifting COM, a curve flowing either in horizontal or vertical direction. The test consists of 3 sets of 30-seconds randomly performing in antero-posterior and medio-lateral direction. The deviation of instant COP position from the curve is recorded at 100 Hz by means of the system FITRO Sway Check (www.fitronic.sk). Analysis of repeated measures showed measurement error of 8.8 % for visually-guided COM target-matching task and 7.0 % for visually-guided COM tracking task, which is within the range comparable to common motor tests.

Test-retest correlation coefficient between repeated measurements in different days was 0.81 for visually-guided COM target-matching task and 0.83 for visually-guided COM tracking task, which signify good reliability. Also the testing protocols were standardized by analysing of sensorimotor parameters under various conditions, e.g. using different velocity and positioning of the curve tracking by a visually-guided COM. In order to provide a meaningful description of an accuracy of visual feedback control of body position during COM tracking task, however, the presented system have to have also an appropriate level of sensitivity and specificity. Therefore the aim of the study was to compare the accuracy of visual feedback control of COP movement in antero-posterior and medio-lateral direction during task-oriented sensorimotor exercise in various populations.

Methods

Subjects

Various groups of subjects volunteered to participate in the study. First, individuals of different age and performance level: groups of healthy young adults – students of technical university ($n = 20$, age 20.9 ± 1.5 y, height 180.2 ± 7.0 cm, and weight 77.6 ± 12.3), older women ($n = 20$, age 54.0 ± 4.5 y, height 162.7 ± 6.1 cm, and weight 69.1 ± 15.0), and elite dancers ($n = 20$, age 21.0 ± 2.6 y, height 172.8 ± 11.6 cm, and weight 65.9 ± 12.4). Second, athletes of various specializations: competitors of snowboarding and windsurfing ($n = 10$, age 23.9 ± 3.1 y, height 174.0 ± 7.4 cm, and weight 70.5 ± 11.2), cycling ($n = 5$, age 24.4 ± 3.2 y, height 182.6 ± 6.5 cm, and weight 76.2 ± 11.5), rowing and canoeing ($n = 13$, age 23.3 ± 7.6 y, height 180.3 ± 8.5 cm, and weight 77.7 ± 14.8), karate ($n = 10$, age 23.2 ± 2.2 y, height 172.2 ± 7.2 cm, and weight 65.1 ± 7.8), and PE students ($n = 26$, age 22.7 ± 2.4 y, height 179.9 ± 7.9 cm, and weight 76.7 ± 10.2 kg). Third, athletes after lower limb injury ($n = 13$, age 19.6 ± 2.6 y, height 179.8 ± 8.6 cm, and weight 67.6 ± 5.1 kg). All of them were informed on the procedures and on the main purpose of the study. The procedures presented were in accordance with the ethical standards on human experimentation.

Study setting



Figure 1a. Task execution: trace a curve flowing either in vertical or horizontal direction by visually-guided COM movement on the screen while standing on dynamometric platform

Subjects were provided by feedback on COM displacement on a computer screen while standing on dynamometric platform. Their task was to trace, by shifting COM, a curve flowing either in vertical or horizontal direction (Figure 1). The test consisted of three 30-seconds trials randomly performing in each direction. The deviation of instant COP position from the curve was recorded at 100 Hz by means of the system FiTRO Sway Check developed in our department by Hamar (2007-09).

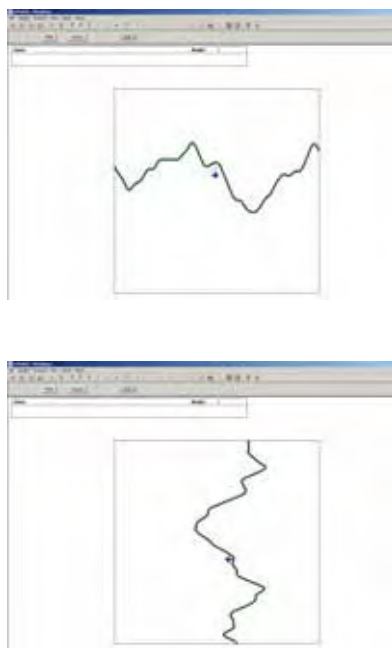


Figure 1b Task execution: trace a curve flowing either in vertical or horizontal direction by visually-guided COM movement on the screen while standing on dynamometric platform

Statistical analysis

Ordinary statistical methods including average and standard deviation were used. A paired t-test was employed to determine the statistical significance of differences in mean COP distance from both horizontally and vertically flowing curves between examined groups, $p < 0.05$ was considered significant.

Results

Results showed that mean COP distance from both horizontally and vertically flowing curves was significantly ($p \leq 0.01$) lower in dancers (11.8 ± 2.3 mm and 10.1 ± 2.2 mm, respectively) than in students (14.8 ± 1.9 mm and 13.7 ± 2.0 mm, respectively) and older women (16.4 ± 2.6 mm and 14.5 ± 2.7 mm, respectively) (Figure 2). On the other hand, there were no significant differences in the COP distance from horizontally and vertically flowing curves in competitors of snowboarding and windsurfing (20.7 ± 2.2 mm and 20.1 ± 2.2 mm, respectively).

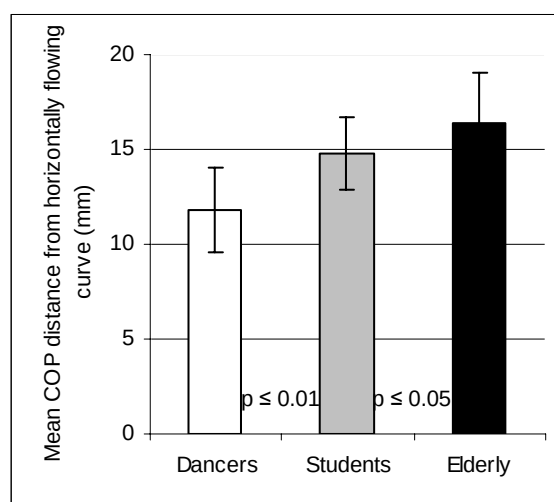


Figure 2a. Mean COP distance from horizontally flowing curves in dancers, students, and older women

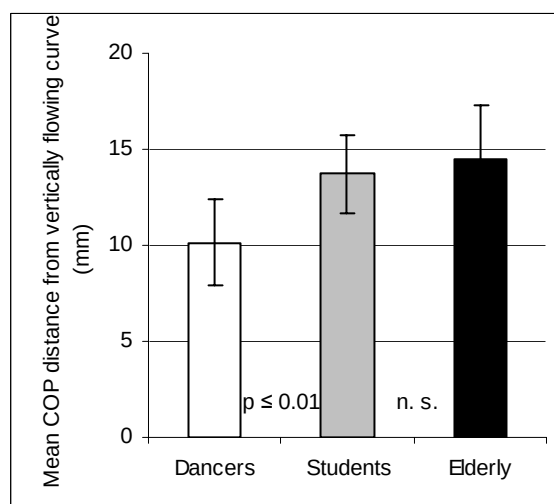


Figure 2b. Mean COP distance from vertically flowing curves in dancers, students, and older women

The same situation in karate (20.8 ± 2.7 mm and 20.3 ± 2.7 mm, respectively), PE students (21.5 ± 3.0 mm and 20.6 ± 2.6 mm, respectively), cyclists (22.6 ± 3.0 mm and 21.3 ± 2.7 mm, respectively), and rowers (23.0 ± 2.8 mm and 22.5 ± 2.2 mm, respectively) (Figure 3). As in previous groups, there were no significant differences in mean COP distance from horizontally and vertically flowing curve in athletes after lower limb injury while performing the task on both legs (28.7 ± 2.5 mm and 27.0 ± 2.1 mm, respectively) and on non-injured leg (42.6 ± 4.6 mm and 33.3 ± 4.2 mm, respectively). However, its values were significantly ($p \leq 0.05$) higher in antero-posterior (A-P) than in medio-lateral (M-L) direction while standing on injured leg (50.8 ± 5.0 mm and 33.6 ± 4.5 mm, respectively) (Figure 4).

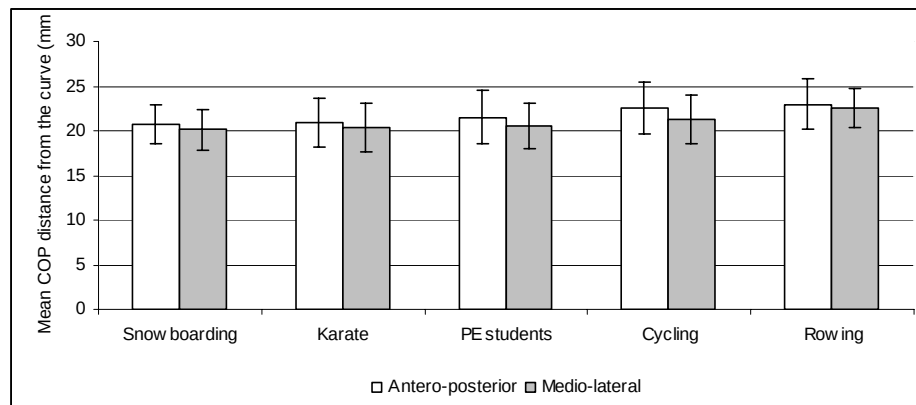


Figure 3. Mean COP distance from horizontally and vertically flowing curves in competitors of snowboarding and windsurfing, karate, cycling, rowing, and PE students

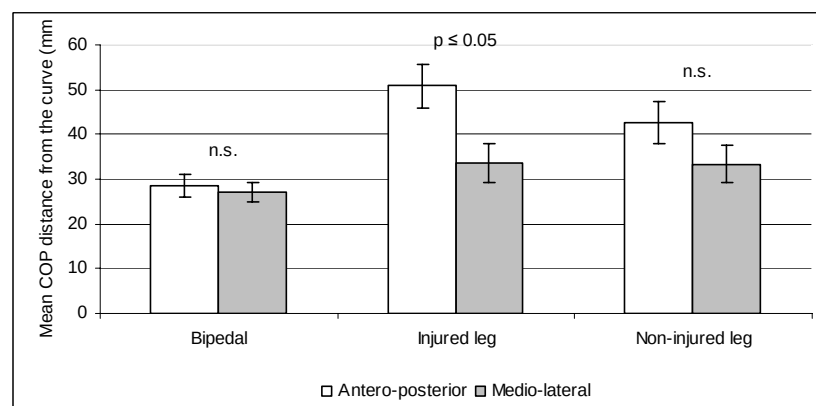


Figure 4. Mean COP distance from horizontally and vertically flowing curves while performing the test on both legs, injured and non-injured leg

Discussion and conclusion

Our previous results showed no significant differences in parameters of balance registered during quiet standing on dynamometric platform between dancers, students and older women. On the other hand, mean COP distance from both horizontally and vertically flowing curves was significantly lower in dancers than in students and older women. These findings indicate that for some athletes, untrained subjects and elderly people, the task-oriented tests based on visual feedback control of body position might represents more sensitive and therefore more appropriate testing method allowing discrimination of individuals of different age and performance level than evaluation of postural stability under static conditions. Since there are contradictory findings on relationship between proprioceptive acuity and motor skill level, we were also interested whether highly-skilled athletes of snowboarding and windsurfing would have more precise perception of COM position and its regulation in A-P and M-L direction during visually-guided COM tracking task than cyclists and rowers.

A comparison of the accuracy of visual feedback control of COP movement in both directions in athletes of different specializations showed only slightly lower values in competitors of snowboarding, windsurfing, and karate as compared to cyclists and rowers. For these athletes the regulation of COM movement based on visual feedback of its position on a computer screen likely does not represent a typical form of body control. Therefore, in order to obtain sensorimotor parameters relevant to most free-style sports, the specific test close to the one used during training or competition should be preferred. For these highly-skilled athletes, dynamic posturography seems to be more sensitive method reflecting their sport-specific adaptation (Zemková et al., 2005). However, the visually-guided COM tracking task might be an appropriate alternative for individuals after lower limb injury, namely in an early phase of rehabilitation when effusion and pain in a joint can make it exquisitely sensitive to movement when the joint is moved in a way that is perceived as possibly aggravating that injury.

Indeed, our results showed that mean COP distance from the curve was significantly higher in antero-posterior than in medio-lateral direction while performing the test on injured leg, whereas its values did not differ significantly between both directions during standing on non-injured leg and on both legs. In addition, these differences were more pronounced on ankle than knee injured leg. As regulation of body position in A-P direction is provided predominantly by ankle strategy, an increase in threshold of perception of ankle movement due to injury may be assumed. From physiology it is known that this effect may be ascribed to mainly a decreased sensitivity of receptors around the joint. It may be assumed that resulting partial reduction of afferent impulses leading to deterioration in proprioceptive feedback control of balance after injury very probably contributed to less precise perception of COM position.

And regulation its movement in antero-posterior direction, as well. Task-oriented test based on visual feedback control of body position can be applied for an evaluation of sensorimotor performance in subjects of different age and expertise (e.g., dancers), as well as in individuals after lower limb injury. However, experience showed that for some athletes (e.g., competitors in snowboarding and windsurfing) the regulation of COM movement based on visual feedback of its position on a computer screen likely does not represent a typical form of body control.

Therefore, in order to obtain sensorimotor parameters relevant to most free-style sports, the specific test close to the one used during training or competition should be preferred. A visually-guided COM tracking task does not seem to be an appropriate alternative.

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PRECIZNOST VIZUALNE KONTROLE POZICIJE TIJELA POVRAATNOM VEZOM ZA VRIJEME 'TASK'-USMJERENE SENZOMOTORNE VJEŽBE KOD RAZLIČITIH POPULACIJA

Sažetak

Istraživanje uspoređuje preciznost vizualne povratne veze COP gibanja u antero-posteriornom i medio-lateralnom pravcu za vrijeme 'task'-usmjerene senzomotorne vježbe kod različitih populacija. Pojedinci različitog uzrasta i razine sposobnosti (grupe zdravih mladih ljudi – studenti tehničkog univerziteta, starije žene, i elitni plesači), sportaši različitih specijalizacija (takmičari u snowboardu, windsurfingu, biciklizmu, veslanju, kanuu, karateu, kao i studenti tjelesnog odgoja), te sportaši nakon povrede donjih zglobova (skočni zglob, koljeno) dobrovoljno su sudjelovali u istraživanju. Subjektima je omogućena povratna veza na COM premještanju putem računalnog monitora dok su stajali na dinamometrijskoj platformi. Zadatak im je bio da prate, pomicanjem COM-a, tok krivulje bilo u okomitom ili vodoravnom pravcu. Test se sastojao od tri 30-sekundna pokušaja slučajno izvedena u svakom pravcu. Odstupanja trenutne COP pozicije od krivulje su snimana na 100 Hz uz pomoć sistema FITRO Sway Check. Rezultati su pokazali da je prosječna COP udaljenost od vodoravnog i okomitog toka krivulje značajno ($p \leq 0.01$) niža kod plesača (11.8 ± 2.3 mm i 10.1 ± 2.2 mm, respektivno) nego kod studenata (14.8 ± 1.9 mm i 13.7 ± 2.0 mm, respektivno) i starijih žena (16.4 ± 2.6 mm i 14.5 ± 2.7 mm, respektivno). S druge strane, nije bilo značajnih razlika u COP udaljenosti obiju krivulja kod takmičara u snowboardu i windsurfingu (20.7 ± 2.2 mm i 20.1 ± 2.2 mm, respektivno), karateu (20.8 ± 2.7 mm i 20.3 ± 2.7 mm, respektivno), studenata (21.5 ± 3.0 mm i 20.6 ± 2.6 mm, respektivno), biciklista (22.6 ± 3.0 mm i 21.3 ± 2.7 mm, respektivno), i veslača (23.0 ± 2.8 mm i 22.5 ± 2.2 mm, respektivno). Kao i u prethodnim grupama, nije bilo značajnih razlika u prosječnoj COP udaljenosti od vodoravnog i okomitog toka krivulje kod sportaša koji su imali povrede donjih zglobova u izvođenju testa s obje noge (28.7 ± 2.5 mm i 27.0 ± 2.1 mm, respektivno) i na nepovrijeđenoj nozi (42.6 ± 4.6 mm i 33.3 ± 4.2 mm, respektivno). Međutim, te vrijednosti s ubile značajno ($p \leq 0.05$) više u antero-posteriornom nego u medio-lateralnom pravcu za vrijeme stajanja na povrijeđenoj nozi (50.8 ± 5.0 mm i 33.6 ± 4.5 mm, respektivno). Može se zaključiti da 'task'-usmjereni test temeljen na vizualnoj povratnoj vezi kontrole tjelesne pozicije može biti primjenjen za evaluaciju senzomotorne sposobnosti kod subjekata različitih uzrasta i vještine, baš kao i kod pojedinaca nakon povrede zglobova donjih ekstremiteta.

Ključne riječi: sportaši, pojedinci nakon povrede donjih zglobova, starije osobe, senzomotorni parametri, task-usmjereno senzomotorno vježbanje, vizualna feedback kontrola tjelesne pozicije

MANAGEMENT OF DEVELOPMENT PHASES IN SPORT

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Review paper

Abstract

The purpose of this paper was to establish general idea in sports management and that is a global management of development phases in sport. That is real possibility because of complexity in modern sport and because of enormous amount of information that circulate in sport activity in general. The paper provides a conceptual discussion of the issue of development phases of sportsman progress surrounded with several different, but closely connected, professions and specialists. It is obvious that training in old-fashion sense includes a trainer, sportsman, and some kind of management that ensure material conditions and similar resources. Contemporary, and especially future sport, is unsustainable in such relations, because such way of organizing is not natural any more. It was defined a new model of sport development phases surrounded with management of new level and new incorporation. It is to be expected that practical implications of that model will be applied in future times as some kind of paradigmatic frame for successfulness sport organization guiding. Value of this conception is probably defined in long-term evaluation of sports organizing and evaluation positioned in measurable results on sports fields.

Key words: sport, management, new model, development

Introduction

Each athlete during their long and complex training in sport that leads toward top result goes through a long and serious road characterized with transformations that lead him to top model. This is a process whose duration can generally register in the range of as much as 15-20 years of systematic work (Bilić, 2007; Bonacin, Bilić & Bonacin, 2008; Trninić, Jelaska & Papić, 2009). To illustrate this let's assume that in certain sport such specialized training starts with primary selection at age of 8 and ends with top result at age of 24 which means 16 years long process. Certainly we can assume that he will maintain top result for some time after 24 years of age (at least 4 to 6 years).

Table 1. Tasks and fundamental purpose

Task	Scope	Duration
Definition of game model	Where to?	Minimum 12 yrs
Strategic objectives	What?	4-8 yrs
Tactical objectives	Why?	One season
Operational objectives	How?	Conducting
Evaluation of accomplished	How much?	Evaluation

This process can be described with simple overview that presents the way of approach to such serious task since monitoring, through selection and directing toward accomplishment of imagined model. During this process each of necessary levels has to answer one simple question (Table 1). In accordance with basic anthropological laws and anthropological-kinesiology objectives, it is obvious that physical exercise affects almost all anthropological segments of a man, depending on the type of activity, duration, etc., and some more and some less, some short-term, some long-term etc. Using exercise, movement, activity, sport, competition, man gives that activity particular and specific individual attributes (Matveyev, 1980; Bonacin, 2006; Trninić, Jelaska & Papić, 2009).

So we can say that a man transfers his actual abilities into that activity (e.g. in sport) precisely as much as he possess energetic, information and other specific individual attributes so he could express himself as a unit in certain activity (Adizes, 1996). At the same time, training is changing his attributes, skills, dimensions, characteristics, so we can say that through exercise, competing etc. motion activities accordingly to specific admission abilities of individual transfer into its complex (Zatsiorsky, 1995; Malacko & Rađo, 2004; Bonacin, 2006; Bilić & Bonacin, 2007). This bilateral advent on relation man-activity, we will call **transfer**, where the transfer is determined by certain parameters that can subsume the effects on the model, but the effects are equally manifest in man, just the same as in the activities. A man makes activity "human" and activity "activates" a man (Bonacin, Bilić & Bonacin, 2008). These two activities are inextricably linked and can not be considered separately.

Training, motor dimensions and achievement

Transfer that carries out on the mentioned relation man-activity is possible since a man changes under influence of transformational process which is generally his main anthropological attribute (Matveyev, 1980; Malacko & Rađo, 2004; Bonacin, Bilić & Bonacin, 2008). These changes may or may not be permanent to remember and then transferred to the following generations. Specifically, individual changes in one case, even if it's so important, if in a long term starts losing its importance or stops existing, it will not be remembered and passed on to the following generations especially in context of thousands or one hundred thousand years.

When a man was at a lower level of knowledge, certain information, actions, resources and events in his surroundings were more important to him, since he possessed a sufficient strength and knowledge to be able to subsume everything under control and make impact (Kirkpatrick & Kirkpatrick, 2006). Generalization, as one of the most important things for a man was decisive and obviously grew (Bilić, 2007; Bonacin, Da., 2008b). In this way, a man (just like any other entity) slowly perceived the rules and some events were not unfamiliar any more. This was a process of centuries. Learning, we will not locate only into nervous system segment, since that would be a big anthropological mistake, since it is familiar that other segment and sets are also to be learned. Ability of skeletal apparatus to withstand stress, force to form a lever due to the effect that muscle and connective tissue can move is also specific study, even though "the bones" didn't go to school to learn that but their "professor" was every day life, which was in ancient times hard, cruel and uncompromising as well as situational oriented. Among such information the selection is conducted according to importance, and ensures identification of significant unlike insignificant that shouldn't be memorized at all (Bonacin, Blažević & Carev, 2003). This perfect model (human being), certainly, uses knowledge not only to conduct identification, but based on the knowledge actively engages in his environment which makes him extremely developed advent. Of course, such attributes also possess each entity as well, so we can say that beavers are the creators of their dams, ants and bees of their habitats, but a man is for now unsurpassed in the world we know. Learning is not only a man's characteristic, and also in man its not only attribute of Central Nervous System as often misinterpreted. Everyone learns and all learn but not about everything and not equally and not effectively. Changes we talk about and described transfer are visible in locomotor circuit, biomechanical, functional, cardiovascular, psychological, sociological etc, and what interest us in kinesiology are changes and transfer (learning) in motor circuit (Bonacin, Bilić & Bonacin, Da., 2008a).

This term considers all the levels of movement control that enable successful realization of targeted movement tasks. This definition includes dominant nervous system, even though study can not be incorporated exclusively into that anthropological set, but this one is very interesting since concrete learning of motor tasks depend on its function, well maintained movement programs and finally application of memorized movement structure in concrete tasks, e.g. in sport. If there is really a need for movement (in a daily life) or if we deliberately want to learn (e.g. sport) then the existing ideomotor program is insufficient for objective realization of that movement since it's not provided with the parameters that include adequate affect on body segments, extremities, mass, forces necessary to produce with structure acting, time-space relations etc. That is why we have to learn such motion systematically (Bonacin, Bilić & Bonacin, Da., 2008).

Learning is focused in three principal directions:

1. **Reduction optimization** of redundant and unnecessary program material and thereby increase efficiency of the concrete structure of the default motion by optimizing the program in order to approach the motion toward „ideal“ and „cleaned up“ from inefficient movement that can be set from ideomotor program or even much later;
2. **Adding optimization** of necessary nonexistent program material and thereby increase efficiency of the concrete structure of the default motion by optimizing the program in order to approach the motion toward „ideal“ and „fulfill“ with efficient movements they may be missing since ideomotor program or for a long time later;
3. **Incorporating information about the physical parameters** in order to perform a motion efficiently in real terms with functions of other circuits (morphological, functional,...) and thus increase the efficiency of the concrete structure of the default motion in order to approach the motion toward „ideal“ at a much higher energy level (Bonacin, Bilić & Bonacin, Da., 2008).

Competition and score

Competition as a term requires establishing which of at least two entities in some activity is more successful. Such establishment, in order to declare one entity more successful obviously requires clear and certain measure which can be verified with later testing. That measure is named sports result. **Sports result** is a final indicator in some competition and final indicator of capabilities of one or more competitors which are trying to win. Evidently, sports result doesn't have to be constant value or indicator of success. This attribute of sport result makes competition virtually interesting, since in many situations it is not certain which entity will win or have differently defined result of a competition. Even more, some rules in a certain sport disciplines are sometimes formulated to increase uncertainty to lower possible monopoly on the result of extremely good athletes/teams since this would greatly reduce the lure of competition (Sindik & Vidak, 2009). In the context we already discussed the result is primarily a proof of victory. If the result of some test is unresolved (tie) then competition continues to the victory or the test has to be repeated. There are situations where it appears that the result is acceptable, but only then when cumulative number is accepted as a result, egg cup matches at home and away that „sum“ in a way, or league system where the results and points are recorded) or if technical means do not provide sufficient accuracy (same time in the race = two same positioning). However, those are rare situations and in the finish it is always streaming toward victory as a proof of superiority over the opponent. There is no acceptable unresolved result in any important final competition. Although many victories can be deprecated, sport result is from generic point of view in anthropological sense the fairest thing there is. It doesn't mean the conditions of athletes training are fair and equal it doesn't mean the opponents had the same conditions.

Meaning, for training (means, experts, technique, technology, illicit funds, width of the core sports base selection,...), it doesn't mean that in different environments, same achievements is equally valued, it doesn't mean media are equally prone to athletes from different cultural environments, it doesn't mean that the opponents had the same treatment of a judge,..., but achieved result is achieved and it has to be accepted. **In sport wins the best always and the result proves the one is better.** What this „better“ means, from minor interest after achieved result. Defeated can complain, can draw lessons and progress, can withdraw from further involvement in the activity, but this is all irrelevant in the relations where winner is the winner and defeated is defeated. Through this, sports result can be defined in different ways but all can be reduced to three basic:

1. Achieving **explicit** result with no direct confrontation with the opponent, usually expressed in some physical units or points
2. Achieving results with **measuring**, which requires existence of direct opponent in order to achieve result and,
3. Achieving **estimated** result based on the expert assessment which includes subjective evaluation of achievement according to performance rating. Evidently, maximized usefulness of achieving pre-set goal is what modern man wants and he will seek to continue wanting it. But a man always wanted more, what is maximally possible to get, according to the stage he was on and the available resources. Science and technology helped him with that but decision-making and optimizing of the current was always happening.

Management in sport

Development of knowledge thought from science, even from ancient times, was heading in the only direction possible. That direction was characterized by attempts to understand, explain and eventually control all what was available for a man, everything that surrounds him (Bonacin, 2006; Bonacin, Da., 2008b). Quantity and quality of knowledge grew in proportion to the time, space and climate conditions, as well as anthropological characteristics of a man, his ability of making various tools and weapons, his ability to do the work, to adapt to the environment or to change it according himself (using tools and weapons). New discoveries that he gained, he integrated into already existing knowledge circuits, practically directing them and maximally using them in concrete, clear and usually limited (Katić i Bonacin, 2001) thus building new models and forming new objectives. To us interesting area – sport, developed parallel to this, because according to some resources, the beginning of sport goes back in pre-history when the first human communities acknowledged connection between skills of handling the tools of work and work results (Radan, 1977). Logically thinking, we can conclude that at that time children (same as today) were mimicking working moves of adults and such through playing prepared for their role in a community.

Discovery of spear, ax, bow and arrow required practicing especially because these items were used as tools for food gathering and weapons for defending and attacking. The ones who were running, jumping, throwing, swimming and shooting had an advantage and as such they were separated from the others, which was their intention (General encyclopedia, 1967; Encyclopedia of physical education, 1977). All this time they were competing through play and work. If there was no chance to express it in hunting and wars, they organized special manifestations as religious ceremonies, weddings, funerals etc (Radan, 1977). Certainly, through time, this gained different adequate forms and ways of conduction and greater importance proved by the oldest diggings in Crete (General encyclopedia, 1967; Radan, 1977). Thinking in that direction and studying available saved historical remaining, we can observe how man since its beginnings used new discoveries and optimized the way of living making optimal decisions in order to make his life easier and maximize usefulness on the stage of his current development. Obviously whatever he did he couldn't do alone, he had to optimize his life joining in communities with other people which is visible from the traces of hearth with burning bones. It is obvious he had to organize in community with many members who are performing different work. Then those were packs and tribes, but using imagination we can say those are today's organizations and their associations. But their function is the same – accomplishing certain goal. Survival, acknowledgment,... In a long term, every new discovery led toward community benefit that was the reason for optimization. Knowledge was shared; new discoveries were applied into practice. Cooperation during that times, and language development, which is today development of computer technology, enabled further progress. A man was optimizing resources he had. Precisely from this areas date the oldest information about organization (work) from the time of Babylonian ruler (1792 do 1686 B.C.) capable administrator and military commander responsible for the creation of Codex Hammurabi in which, among other things we see the organizational structure of their society divided into free people, clients and slaves (General encyclopedia, 1967). The division of labour increase hierarchy relations that have to be determined by the rules which lead to the beginning of constitution and the state as organization all the way to present time way of living. During that road humanity passed through a few revolutions; tool and weapon development revolution, revolution of personal food sources, organization of social community constitution, machine development, information system and artificial intelligence development and moral revolution that still takes place (Bilić & Bonacin, 2007). From all above mentioned, aware of today, we can conclude that everything we are makes us to optimize what we have and go on. This brings us to a conclusion that optimization is possible in two ways: spontaneous or stochastic that conducts naturally as a combination of many random conditions or deliberate i.e. directed.

Action with purpose

It is logical to conclude that management, even originated as a spontaneous need to manage available resources, became deliberate and directed way of existing resource optimization in the moment when it grew into one of the most important functions and tools of today's way of living (Malacko & Rađo, 2006; Bonacin, Da., 2008; Bonacin, Da., 2009). To discuss about problem of sport organization optimization is easier, understandable and seeks optimal, if in the simplest way we describe domain in which sport organization acts and if we induce the terms that are its integral part. General environment creates general climate where organization functions and it consist of economical, technological and politically-legal dimension while business environment consist of competition, buyers, suppliers regulators and strategic partners. Environment where sports organization is functioning in sociological sense we call the society. The term of society was explained in many ways by many society theoreticians so there are a several definitions, but common parameters are relatively easy to isolate: the society is abstract complex of relations between individuals or relation system made by mutually dependent parts and which is capable of self reproduction. It is adapting according to environment, it is integrated (has normative classification). It also has hierarchy of goals and the ways of their accomplishment and maintains certain dominant cultural model of values where he maintains social living as mutual permeation of culture, people and social (Fanuko et al., 1995).

Society and activity

In the most general sense (lat. Societas) indicates the form of connections between people, the ones who are voluntarily connected in common objectives. Structure (lat. structura) presents how some unit is compound from its elements (parts, members, details) (General encyclopedia, 1967). We can conclude that social structure is an arranger set of society elements and their relations and the purpose of its existence would be to direct, regulate and limits acting of people in society. Elements of social structure are: social status (position of the individual in social structure, achieved and ascribed, everyone has more then one position), social status (particularly valued social position and ranking), social role (culturally and socially defines rights and responsibilities related to certain social status), social group (permanently established specific relations in a group with its own rules and structure), social organization (groups of people connected with formalized relations of subordination, superiority and cooperation in carrying out common tasks and achieving common objective) and social institution (system of norms, values, social position and role, and organized activities, which allows members of society to achieve vital social goals). In such way we can close a set of knowledge required for understanding the position of sport.

However, social inequality exists i.e. idea that people are not the same, and it occurs for different reasons and can be found in all spheres of human life. There are man and women, rich and poor, intellectuals and uneducated. Depending on some natural characteristics and by what they do, we distinguish them. The division of functions and work means different positions and roles, but does not suggest ranking immediately. These are hierarchically arranged groups of people and the inequality is composed of different availability of material wealth, prestige and power. Within the organization, it's a part of formal social system (Fanuko et al., 1995; Bonacin & Bonacin, 2008).

Hierarchy is taking place in the organization in such a way that the position on a particular level is responsible for the execution of his work holder position in the next, higher rank. Sports management as a principle means superiority and subordination relationship, i.e. the relationship between managers and employees. It is based on the sub ordinance of lower levels to the higher. Viewed from another aspect hierarchy is the relation between members of a social group who have more authority and members of the group who have less power. In this relation the first are superior and second are inferior (Bonacin & Bonacin, 2007). From the third aspect, hierarchy is business connecting in a social group after these jobs are passed over for better accomplishment of group objectives (Drucker, 1987). All these aspects assume a hierarchy of tasks as a way of transferring or issuing orders from the highest to the lowest level in the organization. The process of creating a hierarchy of the company is called a scalar process or chain of command, for example, military (Bahtijarević-Šiber & Sikavica, 2001).

In most of social groups and organizations specific relations operate:

- 1) **communication** is giving and receiving information, and communication system consist of the source, (originates), coder (conversion), communication channel (transfer), decoder (transform), reception (understanding), and hash (interference) that are usually on the communication channel (Bonacin, 2008);
- 2) **manipulation** is a procedure or series of procedures of subordinating individual, public and media to a certain type of interest with assistance of force, power, interests and discourses i.e. handling objects of interest like objects;
- 3) **the power** the ability of a person or group to persuade others to behave the way they usually wouldn't There are three basic sources of power: physical strength, economic wealth and spiritual abilities;
- 4) **coercion** is the use of power by one entity to another, and is really guiding behavior of another subject in the way of representing an application of evil, we differ physical, economic and spiritual
- 5) **power** is more than a naked power and coercion. It is a compulsion that is legitimate and based on formal and customary legal norms, and sometimes the customs.

Organization and sport achievements

Relations in society and organization are regulated through norms (customary, moral and legal) whose main function is to forcefully influence members of society to behave in an adequate way. In recent years society as an entity, with all its segments, is pervaded by a specific process - globalization, which aims at comprehensiveness of the world, expanding the borders, free movement of people, goods. All this makes society noisily and complicated place for a living. Companies and organization has to design its organizational structure so this can overcome the degree of uncertainty it is facing in its environment. Two main factors of uncertainty are complexity and dynamics.

Complexity is determined by the number of surrounding components that affect the functioning of the company and affect the degree of delegation of authority for the complex environment of the higher degree of decentralization of decision-making, etc. **The level of dynamics** is determined by the rate and predictability of its changes. Environment of sport organization acting, viewed from the aspect of management is viewed through dynamic dimension (as stable or dynamic environment) and through dimension of complexity (simple or complex environment). Depending on the condition of environment Burns and Stalker 1961. (according to Šunje, 2002) we distinguish two opposite types of organizations: **organic**, applicable in a dynamic environment (cross-functional teams, cross-hierarchical teams, free flow of information, a wide span of control, decentralization, low formalization) and **mechanical** type of organization is applicable in a stable environment (high specialization, rigid forming of departments, a clear chain of command, a narrow span of control, centralization, high formalization) (Šunje, 2002). In the modern world sport is a very important factor that made the impact on overall development. People are involved in sport for thousands of years and do everything in their power to achieve a result they want and expect (Bonacin, 2006). Looking at the anthropological or kinesiological aspect, the sport, according to its genetic character, is systematic human activity which dominates the expression of specific skills and knowledge of the realization of the motion which is directed towards the achievement of competitive sports results (Bonacin, 2006). From all the above, you can clearly see the importance of sport as an environment in which the sport organization operates, not forgetting that the sports organizations is just one way of structuring the sports segments. Sports organizations together form sports associations, which make national sports federations and these in turn make international sports federations. Therefore, the quality of the sports organization actually has a wider significance than it seems. Various experts have also looked different to the concept and meaning of organizations, each from its slot and each of their points of view, so that there are many theoretical directions in the development of the organization.

For this reason, it would be easiest to access from chronological point of dividing them into:

1. Traditional: classical and neoclassical theory or theories of interpersonal relations, which put into focus the organizational structure and behavior of people and covering the time from study's beginning of the organization to 50's of 20th Century.

2. Modern: modern (quantitative methods, organization behavior, system theory, situational theory, TQM) and postmodern (organization engagement, mismanagement, neo Marxist criticism neo romantic) that are freer and more liberal, caused by movements in the global economy

Basic structure factors

The basic factors of organizational structure are: environment organizations (external and internal), technology (craft, routine, engineering, technology neutral and production - individual and low-volume, mass and high volume, and the process), strategy (a plan to achieve goals), the style of leadership, division of labor (translation of the tasks and activities of the holders of execution in the form of parsing the entire task and the synthesis and allocation of tasks) organizational culture, age and size. According Adizes (1996), organizations have life cycles that pass certain stages - creation, development and aging. The main aspect of the organizational structure is a span of control is the number of employees who are directly subordinate to one manager (Bahtijarević-Šiber i Sikavica, 2001). According to some considerations may be a number of levels of management. Basic dimensions of organizational structure are:

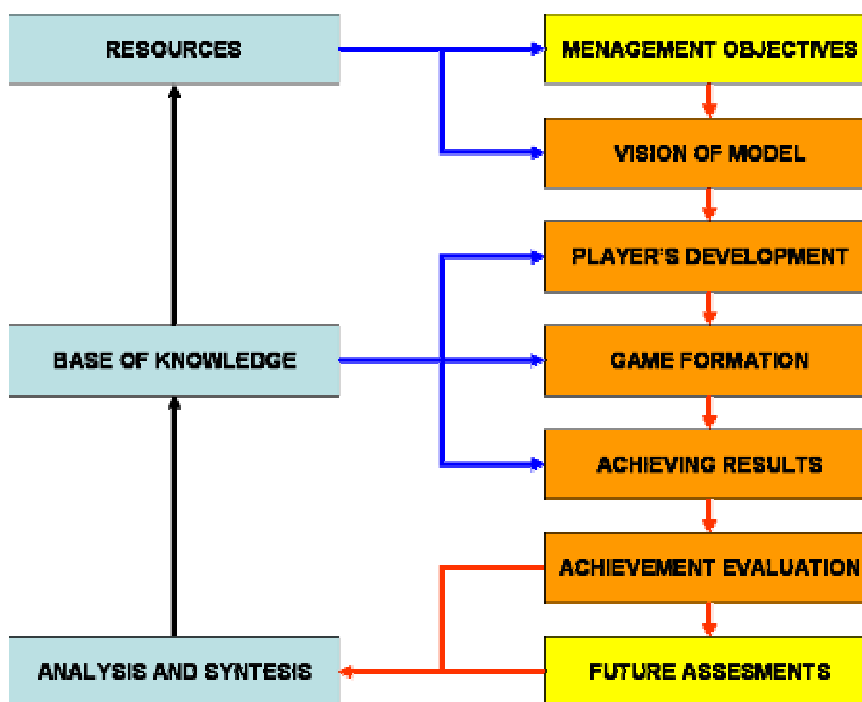
- Specialization is the result of division of labor and primarily applies to humans, but in terms of the distribution of activity represents a heterogeneous group of tasks on homogeneous partial tasks;
- Coordination is the process of harmonization and integration of individual and group efforts and activities for the successful implementation of tasks. There are horizontal and vertical coordination;
- Configuration is a form of organization, a schedule of parts of entity, in this case, the organization and providing visibility and control of events;
- Decentralization is a process of transferring authority to lower levels of hierarchy and its dispersion within the same level (autocratic, oligarchic, polycentric autocracy and democracy);
- Centralization is a process of the reallocation of government that deals with decision-making within the organizational structure;
- Departmentalization is the process of grouping of activities and tasks for the purpose of guidance and control and comes from English word denoting particular department or area of operations in which the branch manager is authorized to ensure the performance of tasks envisaged;
- formalization is the final step in the process of organizational structure and the degree of prescription-level standards, roles, procedures, rules and procedures that determine the functioning of the organization .

Development phases in sport

Practicing motions, as it was already mentioned maintains with setting of forms, in other words at learning of movements. However, the same was already mentioned, that even when the forms are "ideally" set, exercise as a way of maintaining and increasing the energy capacity of learned movements, presents certain learning, but it is noticeable in other segments of the body. Question raised at this point is: How to "force" the organism, such as muscles to increase energy reserves, such as in mitochondrion, but later that same motion could be made at a higher energy level? We saw in the previous text that the body adapts to the applied stimuli, and that generally increases energy and other capacity. What is fundamental and inherent to training (and any training is essentially training, regardless of whether the intensity and volume of recreational, educational, sports or otherwise), is the indebtedness in accordance with the desired threshold (...liminal, supraliminal,...). Exercise exhausts to some extent energy capacity. The body must ensure to make it up. Moreover, in principle, the bigger the task was the higher expectation is for the higher level of super compensation i.e. achieving higher levels of a series of such options after the programmed loading after the time needed for primary recovery. Motor practice, therefore, is nothing but a process of bringing motor function in an optimal program position (engrams) for the goals set, which then attempts to bring the maximum (sport), or another lower (education, recreation) desired energy level.

To some stimulus or set of stimuli (task, movement) could serve as the initiator of the transfer, first it should be learned well i.e. to create a adequate program form that is stable and saved in the early levels and generally in areas of sensory cortex. Only after that, in some situations and in parallel with the finalization of learning, these trends can be used to increase capacity, regardless of whether it is a lower or higher level of energy requirements as defined in any real terms. Rules of the exercise in kinesiology, of course, are subject to the familiar rules of exercise as well as in any other human activity, and also the learning the rules of any other material. That rules we can assort as didactic principles (e.g. Bjelica & Bilić, 2008). New but well known (and improved) models of some sports discipline are not created overnight and their quality sometimes requires the whole life experience and knowledge of trainers and some other experts = vision. Usually in the practice there are two approaches and some of their combinations. The most common, but certainly not the best approach starts from the information available to players based on which the coach assort combination of activities – **pragmatic**. Such models are short-term and often a life confutes them but the are often reality because of pressure for result achievement. Today, more and more abandoned and replaced with much better approach, in which profession defines the model and then carries out the actions to ensure their credibility – **planned models**.

Graph 1. Stages of development in sport



Obviously such set of acting has to respond to the question: Where to? i.e. in which direction will the activity of the club be targeted. Strategic goals are

set of planned activities that precisely set general parameters and models whose realization gives a great change to achieve the desired objective.

Set of such activities is set in advance and has to respond to a question What? i.e. what is to be achieved and with which global conditions. This is the hardest part of the job in kinesiology and unconditionally it requires good knowledge of anthropological characteristics of the engaged. Here we talk about **the longest effects** in sport which might last for 16 years with the final goal of accomplishing result in senior age. Unlike them, tactical goals are of narrower scope and usually include programming of smaller tasks in sport domain, regardless of the age of athletes. On this level there are all scientific and professional knowledge necessary for plan realization, i.e. sport machinery strategy. All this tasks and actions are **medium-term** character and need to insert into long-term in blocks of several years (usually as one Olympic cycle not shorter even we have examples with two cycles). All programming procedures that are conducted in medium-term, have to adequately fit into long-term. "The lowest" level is, certainly, operational characterized as a short-term actions with the immediate implementation of training operator and in its inherent components integrate concrete transformational forms, methodical and didactic procedures, from small planning (three months, monthly, weekly) to implementing of specific individual training units, since here it is respond to the question : How? As described above, all preconditions for bringing athletes in the **top sports form** i.e. situation where is possible to achieve top sport result. Such **evaluation** is always parametrically set and can not be shaped into a set of "nicely lined sentences" but has to include series of values and indicators possible to quantify and demonstrate their quantitative and structural objectivity. Evidently here the question to respond to is: How much? i.e. how big is the result achieved, why, under what conditions and with what loading and other necessary conditions. Evaluation ensures authenticity and value of permanent acknowledgments.

In this way it is easy to recognize key activities necessary for objective and authentic achieving of sports result. Today's kinesiology and sport science have passed a long road since ad hoc and prosaic stochastic solution, over pragmatic-empiric actions

to scientifically established creative acting that we call planning and programming of transformational processes. All founded sports machinery of today present complex multilevel managing systems where segmented thematic glorification of certain actions eliminates systematically and gives priority to knowledge, integrity of acknowledgments and development. In terms of concrete actions we can conclude that these are mutually intertwined constant actions we can simply entitle as:

1. Definition of game model,
2. Crating players for models,
3. Creating game as sport assumption,
4. Crating results, and
5. Achievement evaluation.

Neglecting any of these developing segments certainly leads to failures, loss of time and resources, possible injuries and athlete's sickness, which in finish disables achieving top sports result. In a few following lines, each of this integral segments will be explained as a systematic preconditions for top result accomplishment.

Conclusion

It is evident that managers acting in general almost completely depend on the level of intellectual knowledge and higher levels of educational competencies, while business tasks in operative part require dominant specific professional-technical competencies. Sports machinery (players of all ages) was positioned composite i.e. with expressed level of both competencies that can not be isolated or separately be observed. Not through sport nor biological maturing this interaction does not lose its strength, since in the beginning (pioneers) have to learn a lot, seniors can act on the level of solving complex sports tasks, and energetic engagement in each case is expressed (training). Through such approach we could also identify high degree of agreement with man's general development, because if the ontogenesis is short recapitulation of phylogenesis, then we can say that "sportogenesis" is recapitulation of ontogenesis with clear signs of the importance of sport and operational control segment of current and future sports activity (Bonacin Da., 2008).

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UPRAVLJANJE RAZVOJNIM FAZAMA U SPORTU

Sažetak

Svrha ovog članka bila je da utemelji opću zamisao u sportskom menadžmentu a ta je globalno upravljanje razvojnim fazama u sportu. To predstavlja realnu mogućnost zbog složenosti modernog sporta i zbog ogromne količine informacija koja cirkulira općenito u sportu. Članak nudi konceptualnu raspravu o pitanju razvoja sportaša sa više različitih, iako blisko povezanih, profesija i specijalista. Očito je da trening na staromodni način uključuje trenera, sportaše, kao i neku vrstu menadžmenta koji osigurava materijalne uvjete i slične resurse. Današnji, a posebno budući sport je neodrživ u takvim relacijama, jer takav vid organiziranja više nije prirodan. Definiran je novi model faza sportskog razvoja zaokružen menadžmentom nove razine i novog utjelovljenja. Za očekivati je da će praktične implikacije tog modela biti primjenjene u budućnosti kao neka vrsta paradigmatškog okvira za uspješnost vođenja sportskih organizacija. Vrijednost ove koncepcije je vjerojatno definirana u dugoročnoj evaluaciji sportskog organiziranja i evaluaciji pozicioniranoj u mjerljivim rezultatima na sportskom polju.

Ključne riječi: sport, menadžment, novi model, razvoj

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ANALYSIS OF INNOVATIVE MODEL OF FUNCTIONAL ROLES AND LEVELS OF SPORTS MANAGEMENT ORGANISATION

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Abstract

In this work we analyzed phenomenon of team sport organizations such as football, basketball, volleyball and handball. We also analyzed basic organizational configurations of innovative character and its projected model of management pyramidal structure (top, middle and basic level). Phenomenon of management adjustment to transition conditions has opened the issue of innovative model creation within sports organizations management structures of team sports that are made of relatively and conditionally independent subsystems. This opens completely new approach in a modern innovative management projecting model in a way that team sports organizations in their operational core mandatory include managers of all levels, but they keep management functions that determine its pyramidal structure. In all of this, as one separate management structure subsystem closely related with consultant position, presents the right to dispose of property used by sports organizations.

Key words: analysis, structure, management, titular of right to property disposal

Introduction

Considering methodological approach of organizing and building (formal) organizational structure (Čičić, 1996; Bartoluci, 1997; Šunje, 2002a), we projected a model of sports organizations sustainable development management for team sports such as football, volleyball, basketball and handball based on a sample of 63 sports organizations existing in Sarajevo Canton and compete on a cantonal and international level. Analysis was conducted for 2003/04 season. All entities within analyzed sample according to organizational form selection belong to a basic type of professional organization that in its structure includes five basic parts (Drucker, 1987; Drucker, 2002; Drucker, 2005) - (figure 1). The research relates to the structural forms of sports organizations projected model (Hurvicz, 1973; Hernandez, 2002; Jones & George, 1998). That is a model of organizational configuration of professional type of innovative character (further referred to as a professional sports organization/club of innovative character) in a terms of organizational functions with less pronounced hierarchical structure of work management (Luhmann, 1968; Mašala 2002; Mašala, 2008). Sport clubs are usually organized as professional sports basic organizational configurations (Wehrich & Koontz, 1998; Mintzberg, 1989; Šunje, 2002a; Tomić, 2001). The main organizational part of sports organization is operational core containing professional staff (coach, assistant coach, athlete/players, specialists etc.).

For a sports organization to achieve set goals, besides athletes, coach and managers it has to contain trained staff that will perform all necessary activities to ensure conditions and support for sports (business) process realization (techno staff and support staff), (Figure 1). Strategic top of sports organization is made of top managers who are usually successful business people that give their input to sports organization development (Malacko & Rađo, 2006). Mostly they are directed towards "abroad" where they connect to important groups of interest follow complex environment and maintain strategic management activities (Sleight, 1989; Joshua et al., 1997; Irwin et al., 2002). Athletes mostly perform fewer tasks which leads us to a conclusion that jobs are highly horizontally specialized. Sport club's organizational structure is quite shallow; sport clubs are very heterogenic, according to their size, achieved results, purpose of existence and set goals. (Mintzberg, 1991; Šunje, 2002c; Malacko & Rađo, 2004).

Model

For model understanding we have to emphasize its basic difference according to classical model of professional organizational structure (figure 1). Unlike the previous model, this team sports model with innovative character in terms of organizational and functional in its operational core includes managers of all levels.

This is how such professional sports organizations introduce rational approach to internal organization and democratic management adjusting their managers and organizational structure to their autochthon needs (Rosemary, 1985; Šunje, 2002; Mašala, 2008; Bonacin, Da., 2008). In such cases it usually leads to unification of managers and organizational functions with less pronounced typo specific hierarchical management structure (Scheme 2) which meets the requirements of cost-effective operation and club's business (Mašala, 2008). This type of business and sports philosophy of analyzed sports organizations reflects the needs of modern sports industry to define titular of right to property disposal, in other words, to determine property structure within organization in order to achieve high performance of business and sports success.

Problem and goal

Problem of the research is non-existence of coexistent manager's function model of team sports organizations such as football, basketball, volleyball and handball, so with this research we offered possible innovative model of management organizational structure of team sports. The aim of the research is comparative analysis of basic type professional organization model regarding offered model of professional sports organization of innovative character. (Figure 2).

Methods

The sample of respondents for this research was defined as a cluster of 62 analyzed sport clubs of team sports such as football, basketball, volleyball and handball in competing 2003/04 season in Sarajevo Canton, previously determine to have high level of marketing and entrepreneur potential (Mašala, 2002). Variables regarding which we conducted procedure of statistical verification and estimation are as follows: sport's organization president (PREDS), sport's organization (DIRE), sport's organization consultant (KONS), sport's organization general assistant (GSEK), sport's organization sports director (SPDIR), marketing director and PR of sport's organization, team manager – scout A (MENG), Head of Professional staff dep. (SSTAB1), coach A (TRENA), coach B (TRENB), coach C (TRENC), youth dep. team leader (TLOP), school of sport's team leader (TLSS), head of facility maintenance dep. (SEFOO), titular of property disposal (TPRVLAS). Even the structure of management can be observed equally in variable domain and entity domain, for determining correlations of initial parameters for operational action needs, in this research, analysis in variable domain, was of particular interest. To determine structure of management in analyzed sample we applied Factor analysis/method of main components with rotation in varimax position (Bonacin, 2004; Rađo & Wolf, 2002).

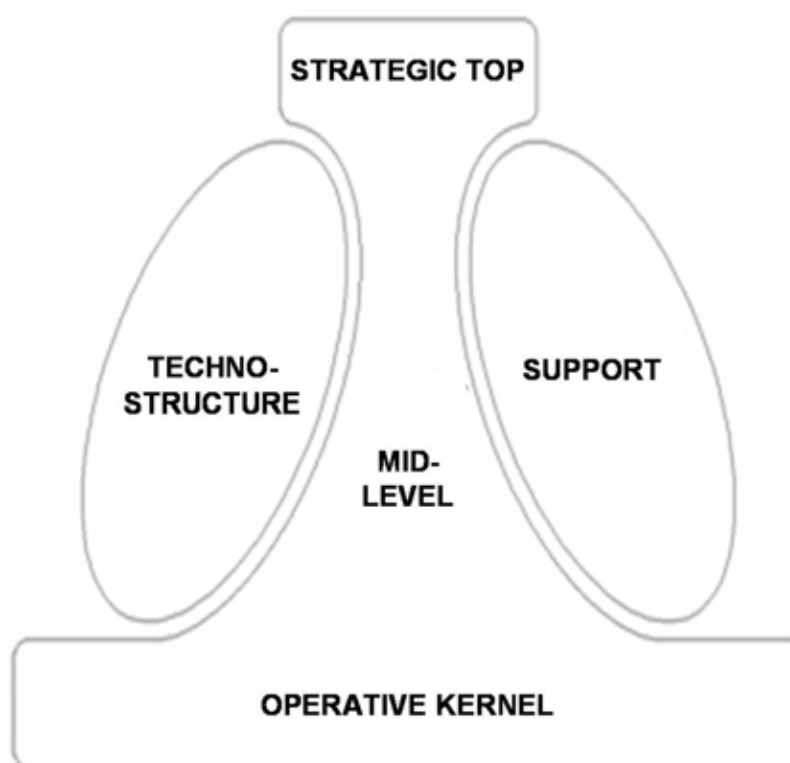


Figure 1. Basic structure of professional organization (Šunje, 2002 b)

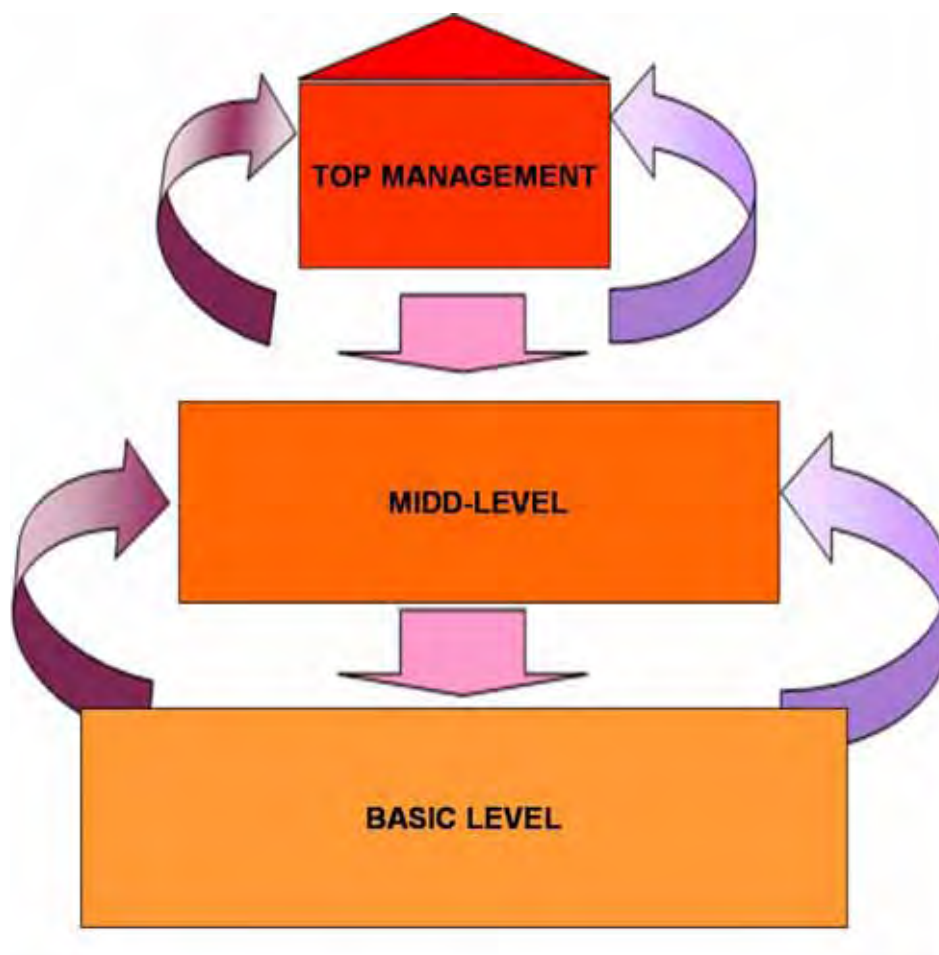


Figure 2. Organization model (Mašala, 2008)



Figure 3. Levels of management (Mašala, 2008)

Results and discussion

According to statistical procedure of Factor analysis/method we determined latent management structure and significant projection of analyzed variables on separated dimensions of management structure. Factor analysis/method of main components was conducted in accordance with the objectives. The basic was determining projection of basic, middle and top management of analyzed sports organizations on factors, but also determining titular of property disposal and its position regarding structure of basic, middle and top management of analyzed sports organizations. First methodological procedure related to value overview of individual manifest variable communality, which reflects proportion of one manifest variable common variance with other manifest variables (Table 1).

Table 1. Variables communality

Variable	h^2
PREDS	,729
DIRE	,387
KONS	,720
GSEK	,696
SPDIR	,948
DMPTP	,692
MENG	,948
SSTAB1	,586
TRENA	,681
TRENB	,577
TRENC	,423
TLOP	,689
TLSS	,681
SEFOO	,718
TPRVLAS	,716

In table we presented results of analysis regarding which we can determine that the biggest communality values have variable as follows: Sport's director (SPDIR), team manager – scout A (MENG), president (PREDS), consultant (KONS), head of facility maintenance (SEFOO), titular of right to property disposal (TPRVLAS), as well as remaining variables according to the size of the results as follows. Because of large heterogeneity, projection of variable coach C (TRENC) on separated main components results with the lowest communality values. Observing the table we conclude that communality variable results sport's director and MENG have equally high values but also mostly pronounced so these two variables are carriers of a whole set of information about presented problem. This means that in analyzed variable system those variables were mostly incorporated while e.g. DIRE does not belong to the system enough, since the unknown part of variable variance equals even 0.61.

This actually means that the source of a president and consultant variation is located deeply within the system of sport's organization, while Director isn't but this variable is affected by many other factors outside the organization system. The following methodological procedure referred to determination of variable relations on a higher level, in other words, mechanisms where sets of variables (factors) are being constituted in accordance with Guttman – Keiser's criteria (higher and equal 1.00) table 2.

Table 2. Totally variance of main components

Component	Initial Eigenvalues		
	Total	%	Cumulative %
1	3,62	24,12	24,12
2	2,03	13,54	37,66
3	1,76	11,71	49,37
4	1,58	10,54	59,91
5	1,21	8,03	67,95
6	0,96	6,38	74,32

According to criteria of accepting main components of characteristically root higher than 1, five significant main components of management structure was isolated with 67,946% of totally described variance, out of which 24% belongs to the first, 13,5% to second, 11,7% to third, 10,5% to the fourth and 8% to the fifth totally described variance. In table 3 we presented initial description of manifest variables according to isolated main components with projection values higher or equal to 0.50 for visibility

Tabela 3. Varimax solution with expressed variable projections

	1	2	3	4	5
SPDIR	,952				
MENG	,952				
PREDS		,839			
SSTAB1		,709			
TRENB		,688			
DIRE		,533			
TRENC		,514			
SEFOO			,805		
DMPTP			,771		
GSEK			,716		
TLOP			,618		
TLSS				,804	
TRENA				,753	
TPRVLAS					,765
KONS					,656

With first varimax factor, two variables significantly correlate; sport's director (SPDIR) and sport's organization – scout A (MENG). This factor can be identified as **foundation of sport management profession** because precisely this type of managers within manager's hierarchic structure is responsible for resource provision.

Especially the ones referred to players and professional staff according which it is possible to create sports success in such type of sport's organizations. With second varimax factor following variables significantly correlate; sport's organization president (PREDS), head of professional staff (SSTAB1), coach B (TRENB), sport's organization director (DIRE) and coach C (TRENC).

This manager's structure is directly responsible for **final sports and business success**. Activity of these managers is directed directly toward production process, in other words offering services to primarily satisfy sports consumers, sponsors and sports public (sports entertainment). With the third varimax factor following variables significantly correlate; head of facility (SEFOO), director of marketing and public relations (DMPTP), general assistant (GESEK) and youth dep. team leader (TLOP). Special emphasis we gave to connection between head of facility maintenance and marketing director that directly participate in promotion and sales of sport's products/services on the market, promoting the potential and the mission of sport's organization. There is internal and external communication in the existing conditions of sport's infrastructure and available facilities. The strength of system support reflects in connection between functions of sport's organization general assistant and youth dep. team leader, whose primary functions relate to creation of environment for achieving successful business and sports results through professional work with young talents.

With the forth factor following variables significantly correlate; sport's school team leader (TLSS) and coach A (TRENA) that indicates at **synergic effect of managerial functions within operational core** regarding system potential realization of young players since their early age all the way to entering club's first (A team). Grouping of these variables on the forth primarily component reflects the need for system connecting of basic level management, which is absolutely natural since this type of managers possess knowledge required for youngest category, but also the skills necessary for their sport's progress and promotion to a first team. With the fifth factor following variables significantly correlate; titular of the right to property disposal (TPRVLAS) and consultant (KONS) which evidently have their functional connection as well; **setting and objectifying goals of sport's organization**. This means the owner, while choosing his goals (within sports activity), has a need to receive information beyond the immediate circle of associates. Such information is available only through consultant services this type of managers offers on the market.

With the results of factor analysis we confirmed the basic premise of innovative character model in the sense that team sport's organizations in their operational core mandatory include managers of all levels, while the fifth and second factor are determined by top level functions and the first varimax factor maintains basic managers function of sport's profession contained within the middle management level. At the end the third and fourth level are determined by basic managers functions of operational core which are directly responsible for sport's product/services quality on the market in other words for sports and business success.

Conclusion

Management structure of analyzed sports organizations according to different levels of management (basic, middle and top management) is characterized by specific projection related to structure settings of projected management model of sustainable development sports organizations. Sport's organization management structure consist of relatively and conditionally independent subsystems that are presented through rooted main components around which are gathered certain manifest variables of management structure according which we confirm the main premises of a model with innovative character. That would be that team sport's organizations in their operational core mandatory include managers of all levels while factors five and two determine top level functions, while the first varimax factor maintains basic managers functions of sport's profession contained within middle level of management. At the end the third and the forth factor determine basic managers functions of operational core that is directly responsible for sport's organization positioning on the market. Synergy that is presented with relation of subsystem within management structure reflects new quality that is confirmed by effects of business and sports success of sport's organization. Analyzing obtained results, and according to the level of variable correlation on the main components and the way of their grouping we can conclude the following: Majority of the right to property disposal used by sports organizations presents special management element closely associated with the position and a job of a consultant and together they made one separated subsystem of manager's structure. Results of conducted analysis indicate that with elements of subsystem of isolated main component manager's structure we can influence general business development of sports organizations which is determined by individuality and invariant of management as a way of organizing business processes that are used for internal restructuring and influences creation of the external environment.

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ANALIZA INOVATIVNOG MODELA FUNKCIONALNIH ULOGA I RAZINA MENADŽMENTA SPORTSKIH ORGANIZACIJA

Sažetak

U ovom radu posebno je analiziran fenomen profesionalne sportske organizacije timskih sportova nogometa, košarke, odbojke i rukometa. Također i bazične organizacijske konfiguracije inovativnog karaktera i njen projektirani model piramidalne strukture menadžmenta (top, srednji i osnovni nivo). Fenomen prilagođavanja menadžmenta autohtonim tranzicijskim uvjetima otvorio je pitanje kreiranja inovativnog modela unutar struktura menadžmenta sportskih organizacija timskih sportova za koje se u ovom istraživanju može konstatirati da se sastoji iz relativno i uvjetno nezavisnih podsistema. To otvara jedan potpuno novi pristup u suvremenom inovativnom projektiranju modela menadžmenta na način da sportske organizacije timskih sportova u svoje operacionalno jezgro obavezno uključuju menadžere svih razina, s tim da pri tome zadržavaju funkcije menadžmenta koje determiniraju njegovu piramidalnu strukturu. U svemu tome kao jedan zaseban podsistem menadžmentske strukture koji je usko povezan sa pozicijom i poslom konzultanta predstavlja pravo raspolaganja vlasništvom nad imovinom koju koriste sportske organizacije.

Ključne riječi: analiza, struktura, menadžment, titular prava raspolaganja vlasništvom

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DIFFERENCES OF MORPHOLOGICAL CHARACTERISTICS OF FOOTBALL PLAYERS AGED 10 YEARS OLD

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Abstract

During the last century it is observed that there is a lot of changes in the field of growth and development new generation familiar as acceleration of growth and development. The main goal of this research represents the derivation some knowledge about the difference of some morphological characteristics between two generation children of the same aged in a football school. The sample involves 43 male children aged ten years old who were tested in 1997 and 52 male children who were tested in 2007. The variables involve 12 anthropometrical measures which define longitudinal and transversal measures of skeleton, volume and mass of the body and under skin fat. The data is arranged by t-test.

Key Words: *morphological characteristics, acceleration, male children*

Introduction

During the previous and this century it was noticeable a general tendency of changes in the growth and development of new generations. Because of that, following of morphological characteristics of children is the subject in more scientific disciplines. In physical education as well as in sport as its integral part, morphological characteristics and their knowing are important for a correct selection and an application of physical exercises, as well as a correct determination of load in a training process. A biological phenomenon of an indicator value increase of a somatic development and previous physiological maturing of children and youth is known as acceleration or a secondary trend of growth and development.

This appearance is being registered independently from a geographical location, climate and ethnic belonging, in urban as well as in rural environment and it demands all classes (Čeleš, Hadžikadunić, Hadžikadunić and Kozić, 2007). Nowadays, children are higher and heavier and they mature earlier than the children of the same chronological old age few generations before (Đuragić, Popović, Jevtić and Nikolić 199), (Kalajdžić, Nićin and Todorović 1996), (Radovanović 2000). Because of that, the aim of this paper was to establish if in a period of 10 years there were some changes in variables relevant for the estimation of a physical development of boys, attendants of the school of football in Novi Sad.

Methods

The sample of respondents enclosed 45 boys' attendants of the school of football enrolled in 1997 at the age of 10 and 45 boys enrolled in 2007 of the same old age.

In compliance with the set aim of work it was chosen a sample of twelve anthropometric variables, which were measured according to the International biologic programme (IBP).

For the estimation of a longitudinal dimensionality of a skeleton: body height (HEIGHT), leg length (LLENGTH), foot length (FLENGTH), for the estimation of a transversal dimensionality of a skeleton: pelvis width (PELWID), shoulder width (SHOWID), knee diameter (KNEEDIA), for the estimation of mass and body volume: body mass (MASS), overhock size (OVESI) and forehock (FORSI).

For the estimation of subcutaneous fatty tissue: abdomen skin fold (ABSFO), overhock skin fold (OVSFO), forehock skin fold (FOSFO). Anthropological measures were taken according to the method which is recommended by IBP. For all the variables there were calculated basic descriptive parameters, the difference between means, and the importance of differences of averages was calculated by t-test.

Results

Table 1. Basic statistical indicators

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
TELVIS	Equal variances assumed	1,355	,247	-2,659	93	,009	-4,019	1,512	-7,021	-1,018
	Equal variances not assumed			-2,662	90,022	,009	-4,019	1,510	-7,019	-1,019
DUZNOG	Equal variances assumed	,441	,508	-3,101	93	,003	-3,496	1,127	-5,734	-1,257
	Equal variances not assumed			-3,095	89,067	,003	-3,496	1,129	-5,740	-1,252
DUZSTO	Equal variances assumed	,815	,369	,259	93	,796	7,576E-02	,293	-,505	,657
	Equal variances not assumed			,255	83,584	,799	7,576E-02	,297	-,514	,666
SIRKAR	Equal variances assumed	3,066	,083	-3,231	93	,002	-1,355	,419	-2,188	-,522
	Equal variances not assumed			-3,338	90,683	,001	-1,355	,406	-2,161	-,549
SIRRAM	Equal variances assumed	,469	,495	-1,836	93	,069	-,762	,415	-1,585	6,197E-02
	Equal variances not assumed			-1,868	92,992	,065	-,762	,408	-1,571	4,784E-02
DIJKOL	Equal variances assumed	9,395	,003	-6,788	93	,000	-,868	,128	-1,122	-,614
	Equal variances not assumed			-7,103	85,304	,000	-,868	,122	-1,111	-,625
TELMAS	Equal variances assumed	1,512	,222	-2,954	93	,004	-3,95	1,34	-6,61	-1,30
	Equal variances not assumed			-3,036	92,067	,003	-3,95	1,30	-6,54	-1,37
OBNAKD	Equal variances assumed	2,110	,150	-5,708	93	,000	-3,87	,68	-5,21	-2,52
	Equal variances not assumed			-5,856	92,416	,000	-3,87	,66	-5,18	-2,56
OBPODK	Equal variances assumed	1,035	,312	-4,955	93	,000	-2,63	,53	-3,69	-1,58
	Equal variances not assumed			-5,012	92,516	,000	-2,63	,52	-3,67	-1,59
KONTRB	Equal variances assumed	2,658	,106	-2,376	93	,020	-1,447	,609	-2,657	-,238
	Equal variances not assumed			-2,423	92,977	,017	-1,447	,597	-2,634	-,261
KONNAK	Equal variances assumed	1,930	,168	-1,511	93	,134	-2,144	1,419	-4,962	,674
	Equal variances not assumed			-1,629	65,229	,108	-2,144	1,316	-4,772	,484
KONPOD	Equal variances assumed	1,252	,266	-,969	93	,335	-,713	,736	-2,174	,748
	Equal variances not assumed			-,986	92,999	,327	-,713	,723	-2,148	,722

The first table includes the data about the basic descriptive parameters for analyzing variables and group entities. It is presented by a number of participants in every sample (N), means of both samples (Mean), standard deviation of both samples (Std. Deviation) and standard error means (Std. Error Mean). The second table includes all data related to procedure of t-test for independent samples. The first row includes the data based on the hypothesis of equal variance, and the second row includes the data based on the hypothesis of non-equal variance. The first two columns present the results of Levene's Test

for Equability of Variances), its value (F), and significance (Sig.).

The following columns present the results of testing equality of means in both groups: the value of t-test (t), the degree of freedom (df), the significance of two-tail testing the means (Sig. 2-tailed), the mean difference (Mean Difference), the standard error difference (Std. Error Difference), the higher and lower interval level of the difference with 95% confidence (95% Confidence Interval of the Difference – Lower, upper). The data were arranged by t-test. A conclusion was drawn that the participants of football school aged 10 years old who are tested

in 2007 showed higher means in all morphological characteristics, except one variable, i.e. length of the foot.

In addition to this, it was also concluded that these two generations had significant difference in eight morphological characteristics: physical height, length of leg, width of pelvis, diameter of knee, physical size, volume of upper leg, volume of lower leg and skinfold of stomach. However, it is also concluded that these two generations didn't have significant difference in four morphological characteristics: length of foot, width of shoulders, skinfold of upper leg and skinfold of lower leg.

Conclusion

After testing difference of means two generations of participants in football school 10 years of age, who were tested in 1997 and in 2007, it seemed to have been the acceleration of growth. This object of this was enlarging the value of anthropometric variables which defined the volume of skeleton. The physical size was increased because of significant growth of length of legs, volume of upper leg and volume of lower leg, and it was also partly affected by the significant growth of skinfold of stomach. There is a question, which variable has the biggest effect to the growth of physical size but it is going to be a subject of some further research.

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Table 2. T-test

Group Statistics					
GRUPA	N	Mean	Std. Deviation	Std. Error	Mean
TELVIS 1997	43	140,700	7,291	1,112	
2007	52	144,719	7,368	1,022	
DUZNOG 1997	43	79,926	5,523	,842	
2007	52	83,421	5,425	,752	
DUZSTO 1997	43	22,349	1,530	,233	
2007	52	22,273	1,321	,183	
SIRKAR 1997	43	23,705	1,623	,248	
2007	52	25,060	2,319	,322	
SIRRAM 1997	43	32,300	1,805	,275	
2007	52	33,062	2,167	,301	
DIJKOL 1997	43	8,442	,440	,715E-02	
2007	52	9,310	,736	,102	
TELMAS 1997	43	33,05	5,41	,83	
2007	52	37,00	7,27	1,01	
OBNAKD 1997	43	32,88	2,78	,42	
2007	52	36,75	3,65	,51	
OBPODK 1997	43	28,47	2,40	,37	
2007	52	31,10	2,71	,38	
KONTRB 1997	43	5,737	2,609	,398	
2007	52	7,185	3,212	,445	
KONNAK 1997	43	11,423	3,075	,469	
2007	52	13,567	8,869	1,230	
KONPOD 1997	43	11,437	3,190	,487	
2007	52	12,150	3,854	,534	

RAZLIKE MORFOLOŠKIH ZNAČAJKI NOGOMETAŠA UZRASTA 10 GODINA

Sažetak

Kroz prošlo stoljeće primjećene su mnoge promjene u rastu i razvoju novih generacija poznate kao "akceleracija rasta i razvoja". Glavni cilj ovog istraživanja predstavlja dobivanje nekih spoznaja o razlikama morfoloških značajki između dviju generacija djece istog uzrasta u nogometnoj školi. Uzorak obuhvaća 43 dječaka od 10 godina koji su testirani 1997 i 52 dječaka testirana 2007.g Varijable su uključivale 12 morfoloških mjera kopje definiraju longitudinalnu i transverzalnu dimenzionalnost skeleta, volumen i masu tijela te potkožni nabor. Podaci su obrađeni t-testom.

Ključne riječi: morfološke značajke, akceleracija, dječaci

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UNCERTAINTY COEFFICIENT AS A METHOD FOR OPTIMIZATION OF THE COMPETITION SYSTEM IN TABLE-TENNIS LEAGUES IN "SOKAZ"

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Abstract

The Association of Recreational Table-Tennis Players in Zagreb (SOKAZ) attracts many table-tennis fans in Zagreb and its periphery. In spite of nominally recreational aims in these table-tennis leagues, there are many indicators to believe that SOKAZ gathers both recreational players as well as former elite table-tennis players. Among various methods of table-tennis team performance quality analysis, on the basis of the team's results in competition, the uncertainty coefficient of match outcome could to a large extent explain the uncertainty of competition. Thus, the main goal of this research was to attempt to determine possible correlation between the competitive level in SOKAZ leagues and the uncertainty coefficient in the championships for these leagues and, furthermore, on the basis of the correlation established eventually to adjust the competition system by attempting to raise the level of uncertainty in competition. This research has provided the data analysis of all the matches played in all SOKAZ leagues, during championships from autumn 2003 until autumn 2006. The research has ascertained that during all seven championship leagues the uncertainty of the matches showed a constant statistical decrease with the ordinal number of the league. On the basis of these results corrections in the competition system of SOKAZ leagues have been proposed by dichotomization of "better" and "weaker" leagues (with faster acceleration for the teams in "weaker" leagues), as same as some proposals for future researches.

Keywords: SOKAZ, table-tennis, system, competition, uncertainty coefficient

Introduction

There are two terms that usually occur in literature, important in sport economy, as same as in stimulating motivation for athletes in some sport contest and for sport attendants, too: "competitive balance" and "outcome of uncertainty". But the "competitive balance" and "outcome of uncertainty" are not the same phenomenon. Those terms are closely linked, but the "competitive balance" studies impact of alternative point systems on the competitive balance in professional sport leagues. The "outcome of uncertainty" means an effort that competition as a whole, doesn't have a predetermined winner at the outset of competition (Halicioglu, 2006). The most measures of the competitive balance are based on the dispersion of wins, i.e. on the winning percentage. The competitive balance could be measured by comparing "the actual performance" of a league to the performance that would have occurred if the league had the maximum degree of competitive balance in the sense that all teams were equal in playing strengths. The less the deviation of actual league performance from that of the ideal league is, the greater is the degree of competitive balance (Noll 1988, and Scully, 1989, all from Berri et al., 2005).

Summarizing previous findings and different theoretic approaches, there are no data found in individual sports, or co-active sports. Both concepts (outcome of uncertainty and competitive balance) are much more used in team sports, or in team competitions in individual sports. The most probable explanation is very simple: profit. Specifically, the concepts of competitive balance and uncertainty coefficient are interesting primarily from the aspect of sports economics. Namely, greater uncertainty of a sport game or sports competition as a whole means higher interest of viewers. A growing number of viewers mean greater financial profit. However, there are no data connected with the table tennis contest. But using measures of competitive balance and contest uncertainty, we can find more stimulating competition systems, even for the table tennis. The Association of Recreational Table-Tennis Players in Zagreb (SOKAZ) has been gathering many table-tennis fans in Zagreb and its periphery, but also from some more distant towns (Stubica, Zabok, Novska, etc.), for almost 60 years. Presently, SOKAZ includes 1200 sportsmen and sportswomen, distributed in 20 male leagues (12 teams in average) and one women's league with 12 teams.

Although the nominal goal of competition in table-tennis leagues is identical to those of sports recreation, there are a series of indicators to believe that SOKAZ attracts not only recreational players, but also sportsmen who, according to their previous sports achievements, could be classified as elite table-tennis players. Namely, although a large number of former "active" players competes in weaker SOKAZ leagues as well (e.g. in 11th, 12th and weaker), several top ranked SOKAZ leagues include the best players according to match results, who are often members of the most successful Croatian teams (1st and 2nd Croatian league), or top teams in neighbouring countries (Slovenia and Bosnia and Herzegovina), as same as in Austria or Germany. From the above it is to be concluded that both from the standpoint of recreational goals of SOKAZ and from the standpoint of "motivation of top sportsmen" the uncertainty coefficient is a very important factor that can motivate players participating in SOKAZ leagues. The recreational players can be motivated to persevere (to avoid boredom), and thus to reach the goals of keeping themselves healthy or socializing. The sportsmen can be motivated to keep the high level of achievements in sports, to advance in their table-tennis performance. Consequently, higher uncertainty coefficient in single or team matches could hypothetically motivate the players and the teams to find more pleasure in their performance, but also to keep the level of motivation that could bring progress or keep the achieved performance quality in table-tennis championships. Table-tennis is a complex poly-structural kinesiological activity.

Except for the technique area, i.e. motor abilities, table-tennis is demanding as far as information (tactical) knowledge is concerned, as well as relevant conative properties necessary for a successful result in competition (Grujić, 1975, Hudetz, 1984, 2000). Within the numerous relevant characteristics of a successful table tennis-player, the high quality selection process is extremely important. However, even after the successful selection process it is necessary to continue with systematic improvement of the player's performance. The main question raised by experts aiming at improvement of performance of the sportsmen or teams in various sports is how to assess the quality of game (Brčić, Viskić-Štalec, & Jaklinović-Fressl, 1997). From the sports aspect, both for individual players and teams, the main and most useful indicator of game quality are the score, both individual and team, obtained at a particular competition event. The hypothesis has therefore been made that results in table-tennis competition could also be the measure of a player's successfulness.

Nevertheless, if the aim is to use the scores from table-tennis matches in order to maintain the uncertainty in competition, it is important to pay due attention to maintenance of the level of uncertainty of match results within respective SOKAZ leagues. Among the various means of quality analysis of the game of table-tennis teams, the uncertainty coefficient (Bućo, 2007) could be the best. Thus, the main goal of this research was to attempt to determine possible correlation between the competitive level in SOKAZ leagues and the uncertainty coefficient in the championships for these leagues and, furthermore, on the basis of the correlation established eventually to adjust the competition system by attempting to raise the level of uncertainty in competition. Within the literature available no previous research directly connected by content to the goal set in table-tennis was found. From the research goals following problems have been made: finding correlation between the competitive level in SOKAZ leagues and the uncertainty coefficient in the championships as a whole (1); finding correlation between the competitive level in SOKAZ and the uncertainty coefficient in team matches (2); finding differences between the uncertainty coefficients in "better" and "weaker" leagues.

Methods

The data was collected by examination of results of the individuals and teams in SOKAZ leagues competition from official records from the matches (Bućo, 2006).

Entities

All data from all matches played in championships in all SOKAZ leagues, from autumn 2003 until autumn 2006, was analyzed. Each team played approximately 11 matches per championship. In each championship approximately 11 rounds were played following the "round robin" principle, each team having played 66 matches per championship in the average. For each hypothesis we have different sample of entities. For each hypothesis in the research we had three different samples of entities.

Samples

First sample: "Respondents" in the research (Hypothesis 1) were all SOKAZ leagues, i.e. in 7 championships. Analyzed the number of respondents (leagues) was: 17 leagues in autumn 2003, 18 leagues in all championships from spring 2004 to autumn 2005, 20 leagues in championships in spring 2006 and autumn 2006. For all matches played in separate championships, for each SOKAZ league respectively, the uncertainty coefficient was calculated.

Second sample: In the second part of the research (Hypothesis 2) the "respondents" were all teams in all SOKAZ leagues, but only in spring (N1=233) and autumn 2006 (N2=241)¹ championships. The uncertainty coefficients were calculated for all matches played in all leagues during these two championships, for all the participating teams. Third sample: *Third sample*: The third part of the research (Hypothesis 3) included all SOKAZ leagues as "respondents", but only during spring and autumn 2006 (both N=20)² championships. The uncertainty coefficients for all matches played in all leagues during those two championships were calculated.

Variables

The dependent variable in the research is the uncertainty coefficient. Here is the "logics". One of the means of measuring uncertainty in a league (or uncertainty of an individual team match performance) is to follow the score. For example, the larger the number of matches won by the defeated team, the higher the uncertainty coefficient. For the championship and the chosen league (team) an average number of matches played by the defeated team in the chosen league or team (in case of a team it is irrelevant whether it won or lost the match) can be calculated.

The simplest "version" of uncertainty coefficient is the one that offers the same coefficients for matches with the same score. Consequently, the matches with the score 10:0 or 0:10 were given the coefficient 0, those which scores 9:1 and 1:9 the coefficient 1, scores 8:2 and 2:8 the coefficient 2, scores 7:3 and 3:7 the coefficient 3, scores 6:4 and 4:6 the coefficient 4, and the score 5:5 the coefficient 5. The total coefficients for all championship matches divided by the number of matches gives an average coefficient (shown within the results given). In this research we used the simplest "version" of uncertainty coefficient, with the exponent 1. So, in our research, formulae given could be transformed into:

$$CU_{team} = \frac{loss^{1.round} + loss^{2.round} + \dots + loss^{last.round}}{N_{rounds}}$$

$$CU_{league} = \frac{\sum loss}{N_{team.games}}$$

¹ This choice was made because a similar number of teams participated in these championships, and the number of leagues was identical.

² This choice was made because a similar number of teams participated in these championships, and the number of leagues was identical.

Legend:

"loss" – symbol for the number of individual matches won by the defeated team

CU_{team} - team uncertainty coefficient

CU_{league} - league uncertainty coefficient

N_{rounds} – number of rounds

$N_{team.games}$ – number of team games in league championship

The independent variables are: ranking of the SOKAZ league (first to twentieth), affiliation of the team to a particular SOKAZ league.

Data Analysis

All the methods of analysis and result presentation used were found within the *Statistica 5.0* package. Uncertainty coefficients for the leagues and teams were calculated, as same as the average results and standard deviations (with the relative variability coefficients) for the uncertainty coefficients in all leagues during seven seasons (championships). Spearman correlation coefficients were calculated between the uncertainty coefficients and ordinary number of the SOKAZ league, i.e. between the uncertainty coefficients value and ordinary number of the SOKAZ league in which a team is positioned. Mann U Whitney test was made between the uncertainty coefficients in leagues with "more" (1-10. league) and "less" (11-20 league) quality in SOKAZ (in all championships from spring 2003. to autumn 2006).

Results and Discussion

The "logic" base of the uncertainty coefficient is very simple. It depends on very low and limited range of possible results in SOKAZ table tennis team games competition (10:0, 9:1, 8:2, 7:3, 6:4 and 5:5). Thus, we can say that uncertainty coefficient is a limited measure, in general. It can be applied only in the competitions with a limited number of possible results of the team matches. Utilitarian value of the uncertainty coefficient could definitely be contained in the possibility, on the basis of principally varying "attractiveness" of the matches (which is practically manifested in a higher number of matches with more balanced results), and on behalf of the public and the players, to modify the competition system, i.e. uncertainty of the matches. This research aimed at achieving this too. Table 1 contains correlation coefficients between the uncertainty coefficient value and ordinary number of SOKAZ league in championships from autumn 2003 until autumn 2006. It is obvious from the results that the correlations are generally negative and statistically significant. All correlation coefficients have similar values (they do not vary to a larger extent). They are significant, negative and medium-sized, in range from -.31 (autumn 2006) to -.59 (spring 2005).

Table 1. Spearman correlation coefficients between the uncertainty coefficient value and ordinary number of SOKAZ league in championships (autumn 2003 - autumn 2006).

League Championship	Correlation Coefficient (Spearman)	Probability of Importance
autumn 2003	- .58	< .01
spring 2004	- .47	< .05
autumn 2004	- .58	< .01
spring 2005	- .59	< .01
autumn 2005	- .54	< .05
spring 2006	- .56	< .05
autumn 2006	- .31	< .10

In championships for "weaker" (11th-20th) SOKAZ leagues, uncertainty coefficient values tend to be generally lower than for the "better" (1st-10th league) SOKAZ leagues. Table 2 contains important data about comparisons of the average uncertainty coefficient values for the all championship seasons in 1st - 10th leagues, with the same values in 11th - 20th leagues. As we can see by the inspection of the values in the Table 2, average values of the uncertainty coefficients varied in the rank from 2.44 (18th league) to 3.33 (6th league). Standard deviations of the uncertainty coefficients varied in the rank from .11 (2nd league) to .49 (18th league). Relative variability coefficients varied from 19.91 % (18th league) to 3.18 % (2nd league).

Table 2. The uncertainty coefficient values and Mann U Whitney test between the uncertainty coefficients in leagues with "more" (1-10. league) and "less" (11-20 league) quality in SOKAZ (all championships from spring 2003. to autumn 2006.)

N ₀ league	autumn 2003	spring 2004	autumn 2004	spring 2005	autumn 2005	spring 2006	autumn 2006	M	σ	Relative variability
1.	3.41	3.14	2.91	2.85	2.86	2.80	2.85	2.97	.22	7.46
2.	3.20	3.23	3.49	3.21	3.33	3.30	3.38	3.31	.11	3.18
3.	2.80	2.88	3.17	3.38	3.26	3.27	2.85	3.09	.24	7.68
4.	3.39	3.15	3.06	3.06	3.39	3.05	3.06	3.17	.16	4.96
5.	2.77	3.21	3.12	3.27	3.33	3.47	3.14	3.19	.22	6.88
6.	3.41	3.56	3.46	3.14	3.39	3.23	2.85	3.33	.16	4.90
7.	2.91	3.61	2.83	3.33	3.50	3.36	3.15	3.24	.29	9.01
8.	2.73	3.40	3.12	3.20	3.39	3.24	3.14	3.17	.23	7.09
9.	3.46	3.09	3.32	3.30	3.61	3.00	3.42	3.31	.21	6.39
10.	3.08	2.99	3.35	3.21	2.89	2.96	3.36	3.12	.19	6.08
11.	3.17	2.97	3.09	2.94	2.89	3.49	2.76	3.04	.24	7.79
12.	3.29	3.20	2.56	3.24	3.18	2.92	3.20	3.08	.26	8.42
13.	2.83	3.38	3.32	3.36	3.00	2.77	3.21	3.12	.26	8.20
14.	2.79	3.14	2.92	2.92	2.99	2.95	3.11	2.97	.12	4.04
15.	2.29	3.26	3.02	2.89	3.38	3.03	3.08	2.99	.35	11.70
16.	2.87	2.61	2.82	2.24	2.99	3.02	3.11	2.81	.30	10.63
17.	2.02	2.74	2.47	2.06	2.73	2.65	3.08	2.54	.38	15.15
18.	-	2.56	1.68	2.68	2.01	2.83	2.88	2.44	.49	19.91
19.	-	-	-	-	-	2.96	2.66	2.81	.21	7.55
20.	-	-	-	-	-	2.69	2.59	2.64	.07	2.68
M _{stronger}	3.12	3.23	3.18	3.20	3.30	3.17	3.15	3.19	0.20	6.36
M _{weaker}	2.75	2.98	2.74	2.79	2.90	2.93	2.97	2.85	0.27	9.61
Difference	0.36	0.24	0.45	0.40	0.40	0.24	0.18	0.35	-0.07	-3.24
U	49	43.5	33.5	18	14.5	20.5	28	Mann U Whitney test values		
Z	0.08	0.49	1.25	1.96	2.27	2.23	1.67			
p	>.20	>.20	>.20	<.05	<.02	<.05	<.10			

Legend:

N₀ league = ordinary number of the league

M_{stronger} = average uncertainty coefficient value for the championship season in 1-10. leagues (as same as for M, σ, relative variability)

M_{weaker} = average uncertainty coefficient value for the championship season in 11-20. leagues (as same as for M, σ, relative variability)

Difference = the difference between M_{stronger} and M_{weaker} (as same as for M, σ, relative variability)

M = average (arithmetical mean) of the uncertainty coefficient value for the whole specific league

σ = standard deviation of the uncertainty coefficient value for the whole specific league

U, Z = values of the Mann U Whitney Test

p = probability of importance

Relative variability (coefficient) = calculated with the Formula: $\frac{\sigma}{M} * 100$

All differences in arithmetical means between "weaker" and "stronger" leagues tended to direction of higher uncertainty coefficient values for "stronger" leagues. The results of the Mann U Whitney test showed that these differences (between "weaker" and "stronger" leagues) are statistically significant for the championships in spring 2005, autumn 2005 and spring 2006. Finally, the indicators of the lower uncertainty (standard deviations and relative variability coefficient values) showed that those indicators are higher in "weaker" leagues in SOKAZ. Therefore, the uncertainty in SOKAZ leagues competition drops with the ordinary number of leagues. Consequently, in the "better" leagues (with smaller ordinary number) the uncertainty is higher, while in the "weaker" leagues the uncertainty of matches is significantly lower. All indicators in the Table 2 show the same fact: that the uncertainty coefficients during all championships are in average higher values in "stronger" leagues, while the deviations and variability between those coefficients are higher in "weaker" leagues. In "stronger" leagues championships have more uncertain games, than in "weaker" leagues. We can assume that the reasons for this trend are motivational in nature: maybe some "ambitious" new teams are too strong for their opponents in "weaker" leagues, while some teams loose their ambition and play "just recreative". When the analysis comprises teams in all the leagues, and not only the league as a whole (in this case results from only two seasons were analyzed with the same number of leagues, 20 each, and equal number of teams), both correlations are negative and statistically significant. Both correlation coefficients between the uncertainty coefficients value and ordinary number of the SOKAZ league in which a team is positioned have relatively similar values ($\rho_{\text{spring2006}} = -.25$; $p < .01$; ($\rho_{\text{autumn2006}} = -.13$; $p < .05$). They are significant, negative and low-sized. In championships for "weaker" (11th-20th) SOKAZ leagues, uncertainty coefficient values tend to be generally lower than for the "better" (1st-10th league) SOKAZ leagues. The uncertainty of a particular team's performance in SOKAZ leagues declines with the ordinary number of leagues. The uncertainty coefficient in the "better" (1st-10th league) and "weaker" (11th-20th) SOKAZ leagues in championships in autumn 2006 ($M_{1-10\text{th}}=3.12$; $M_{11-20\text{th}}=2.97$) and spring 2006 ($M_{1-10\text{th}}=3.17$; $M_{11-20\text{th}}=2.37$) are both (or very close to) statistically significantly different ($t_{\text{spring2006}}=2.41$; $p < .01$; $t_{\text{autumn2006}}=1.52$; $p < .07$). In championships for the "weaker" (11th-20th) SOKAZ leagues, uncertainty coefficient values are statistically significantly lower than for the "better" (1st-10th league) SOKAZ leagues. We register difference in correlation values between different league uncertainty coefficients and the ordinary number of league during seasons.

It could be explained by specific variations in uncertainty inside the same leagues. Par example, the competition in some league can be quite certain during one season (with one or two "dominant" and one or two "weak" teams), while during the other season the competition becomes in the same league becomes uncertain (when "weak" teams were relegated and the dominant teams promoted). Teams that have replaced promoted and relegated teams can have same competitive quality as the average team league in which they are now. The difference in correlation values between league and team uncertainty coefficients are probably not only the consequence of number of entities in different samples. It is possible that inter-league uncertainty is realistically higher than intra-league uncertainty, which could reflect in lower correlation values between the team uncertainty coefficients and ordinary number of the SOKAZ league in which a team is positioned. The number of teams in some (especially in "weaker") leagues is equal, and their competition with each other is uncertain. That partial uncertainty could be the reason why we are able to try to make different acceleration and deceleration systems for teams in the "weaker" and "better" SOKAZ leagues. These results mean that sport competition in "weaker" SOKAZ leagues has less uncertainty in general. Motivation of players that are playing in teams in the "weaker" leagues probably differs from the motivation of players in teams in the "better" leagues. Some teams in the "weaker" leagues are probably much more ambitious (they want to be accelerated), while the other teams play more for recreation. In the "better" leagues, most of the teams could have the similar motivation, playing more competitively and with more ambition. On the basis of data presented here, it can be estimated that for the purpose of increasing the uncertainty coefficient (and consequently the motivation for competing) in SOKAZ leagues, it would be suitable to form different competition systems for the "better" and "weaker" SOKAZ leagues. Instead of the existing system of "acceleration", by which the top positioned team at the end of the championships in all leagues (except the first and the second one) advances by two leagues, and the second and third team by one league (the team at the very bottom of the league "falls" by two leagues, while the penultimate and third team from the bottom "fall" by one league) different systems of acceleration of teams in the "better" and "weaker" SOKAZ leagues could be suggested. Thus, while the existing system could continue to be applied in the "better" leagues, the "weaker" leagues could consider the possibility of introducing alternative systems. For example, teams from 11th up to 20th league could advance.

That could be provided under the following system: top team advances by three leagues, second team advances by two leagues, third and fourth positioned team by one league. A similar method could be used to "decelerate" the lowest ranked teams. However, it could be possible to think of other systems of "acceleration" and "deceleration" for the purpose of increasing the uncertainty coefficient in competition, and after that check the effects by application of uncertainty coefficient after the championship. However, we have to be careful with application of the proposals for these "acceleration" and "deceleration" systems, based only on the uncertainty coefficient. This measure has to be compared with other formulae for calculating competitive balance. For example, we can compare the results obtained by using formulae made by Palomino & Rigotti (2000) or Fort & Quirk (1995).

On the other hand, it is not sufficient to analyze the uncertainty coefficient within leagues, because it doesn't incorporate any information about uncertainty coefficient if two teams from different leagues compete against each other. It would be much better to analyze the results of the teams that accelerated to better leagues. For instance, it is common that the team that won

(say) 16th league and progressed to 14th league was superior in this league, and next season progressed to 13th or even 12th league. Then, the analysis of the performance of this team in 13th or 12th should be performed. One could see the impact of the presence of this team in 14th or 13th league on the uncertainty coefficients. In other words, a certain longitudinal study has to be performed, to validate the uncertainty coefficient measure. It would be useful to use the uncertainty coefficient in other research work (perhaps in some other sports as well) on a multiple number of respondents in various competition ranks.

Conclusions

The correlation coefficients between the competitive level in SOKAZ leagues and the uncertainty coefficient in all the leagues as a whole (as same as for all teams in all the leagues) in analyzed championships were mostly negative and significant. Following these results, we can propose different "acceleration" and "deceleration" systems in inter-league competition. However, we should make caution at decision-making only on the basis of coefficient of uncertainty, since it previously should be validated in comparative studies.

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KOEFICIJENT NEIZVJESNOSTI KAO SREDSTVO ZA OPTIMALIZACIJU SUSTAVA NATJECANJA U STOLNOTENISKIM "SOKAZ" LIGAMA

Sažetak

Udruga stolnotenisača rekreativaca Zagreba (SOKAZ) privlači mnoge ljubitelje stalnog tenisa u Zagrebu i okruženju. Nasuprot mnogim nominalnim rekreacijskim ciljevima u stolnoteniskim ligama SOKAZ-a, postoje brojni pokazatelji da su igrači u SOKAZ-u i rekreativci i bivši vrhunski sportaši. Među različitim metodama analize kvalitete sportske uspješnosti stolnoteniske momčadi, izabrali smo koeficijent neizvjesnosti natjecanja. Osnovni cilj istraživanja bio je pokušati utvrditi povezanost između razine ligaškog natjecanja i koeficijenta neizvjesnosti ligaških mečeva, te na temelju utvrđene povezanosti (eventualno) korigirati sustav natjecanja u smislu povećanja izjednačenosti natjecanja. U ovom istraživanju analizirani su podaci svih mečeva koji su se igrali u svim ligama SOKAZ-a, tijekom prvenstava od jeseni 2003. do jeseni 2006. Rezultati istraživanja su pokazali da u odnosu na koeficijente neizvjesnosti, izjednačenost natjecanja u ligama SOKAZ-a opada s rednim brojem lige kojoj momčad pripada. Na temelju dobivenih rezultata, mogle bi se predložiti korekcije natjecateljskog sustava na temelju dihotomizacije "boljih" i "slabijih" liga, u smislu brže akceleracije uspješnijih momčadi u ligama s manje uspješnim momčadima, uz segusetije za buduća istraživanja.

Ključne riječi: SOKAZ, stolni tenis, sustav, natjecanje, koeficijent neizvjesnosti

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GLOBAL NONLINEAR MODEL FOR EFFICACY EVALUATION IN TEAM SPORTS

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Preliminary scientific communication

Abstract

There is probably no efficiency model within team sports games that represents kinesiological reality in whole. This is so because in sport kinesiology or sports science it is impossible to explicitly form theories and models without fault, since they are tested on a limited assembly of instances. This is particularly true for theories and models applying to the situational approach because the experts are aware of the fact that kinesiological theories and models constantly modify based on the feedback generated in the process of scientific-exploratory work. The linear model, which is dominantly present in explaining the factors of sports efficacy, does not explain the interaction between inner and outer factors of competition efficacy. The reason is that it doesn't describe the bothways' effect of mentioned variables, but shows an assembly of known and unknown factors that influence the team or athlete efficacy, that is, it shows a pondered sum of their influences. Unlike the linear, the suggested nonlinear model enables a more appropriate insight and understanding of multiple influences of inner and outer efficacy factors in sports. The goal is to use the basis of the suggested nonlinear model to construct an exact, expert-scientific interaction approach that would enable an appropriate efficacy formula in team sports games based on which appropriate diagnostics, selection and development of potential top-level athletes and/or teams could be conducted.

Keywords: sport, teams, efficacy, nonlinear model

Introduction

From a historical genesis point of view, regarding kinesiology of sport or sports science, already in the last century '60-es Konstantin Momirović (1966, 1969, 1972), as a protagonist of the newly founded quantitatively exclusive science of kinesiology, was the first to point to the necessity of introducing simplified linear models in explaining efficacy factors in sport. He also claimed that the linear model shows an assembly of known and unknown factors that affect athlete or team efficacy, that is, that it shows a pondered sum of their influences.

Therefore, the mentioned educational pattern doesn't exclude multiple reciprocal connections between the variables, nor does it specify the effect of internal and external variables applicable to sports efficacy. Such a simplified linear combination of anthropological factors had neglected the influence of external factors onto athlete's performance and sports accomplishment. However, Momirović (1966) thought even back then, that such a pattern of comprehension of sport factor structure doesn't meet the criteria of "hard" science, especially regarding poly-structural and complex sports activities, (Matvejev, 1977, 1981, 1999) because they have far more complex demands on an individual player than do monostructural cyclical and acyclical sports activities.

Quite expectedly, the monostuctural sports activities (cyclical and acyclical) are simple motor activities, whose success formula is made up of a relatively minor number of relevant dimensions. However, complex sports activities, as are the team sports games and the poly-structural ones (martial arts) are determined by a large number of inner and outer influences in multiple interactions. Team sports games are of multi-causal nature and as such cannot be reduced simply to athlete's potential and/or his actual quality and team structure (athlete selection). Therefore, athlete's performance and competition efficacy are based on multi-causal mechanisms, where the basic idea is that internal and external variables are in a reciprocal deterministic relationship (Philips and Orton, 1983). For this reason the explorations in sports science must be unconditionally interdisciplinary (Trninić et al, 2008). Athletes in team sports games are indirect carriers of sports activity and competition results in the context of the tactics model and coach's leadership behaviour. This is why it is mandatory in the efficacy model for team sports games to include, besides internal factors like athlete's potential (basic and specific anthropological dimensions), team structure, adequacy of the tactics model, coach's athlete and team leadership, organization system, expert policy and sports institution logistics,

emotional and functional inter-athlete relations (cooperation quality) relations within the club, interplay level, "internal chemistry" of the team (Silva and Stevens, 2002) and micro social conditions in the team, as well as external determinants: quality of the opposing coach, quality and readiness of the opponents (individual players and/or team), objective factors: wider environment, judging criteria, spectators, competition conditions, conditions when organizing the sport preparation process, as well as specifics of the particular sport, unknown factors and certain dimension and measurement importance assessment errors.

Ways of evaluating and predicting efficacy in sport

Horga (1993), states that there are two basic ways to evaluate and predict sports efficacy. The first refers to a comparison of athletes of different actual quality in features for which we are trying to establish how much they attribute to efficacy predictions. This presuming that the more and the less successful will differ from each other in these relevant features for the explored sports activity. This differentiation of the more and the less successful athletes within the same sport refers to the level of development of relevant anthropological features, and to the structure of the characteristics of the whole assembly of the athlete efficacy features. The second basic way to evaluate and predict sports efficacy consists of connecting efficacy in sport to an assembly of athlete's relevant features. Accordingly, it is assumed that the features that have a high relative influence onto efficacy will show connectivity with some of the measures of competition efficacy. Horga (1993) states that this way of analyzing demands defining criteria of efficacy in sport. He additionally states that defining efficacy in sport is a complex issue, because not in every sport can the results be objectively determined (for example: artistic gymnastics, rhythmic gymnastics, water jumping and figure skating). This enlightens the fact that determining features of efficacy in sport isn't a simple issue. Horga (1993) directs that it is impossible to solve this problem instantly in general for all sports, but separately for each sporting activity, and that before any attempt to determine the formula of sports efficacy specification, it is crucial to define several basic parameters: the way to determine efficacy in sport, potential predictors (athlete features) of sports efficacy, and the sports efficacy of the participants, that is, the quality of the sport group getting tested. Therefore, it is necessary to answer two basic questions. One refers to the level of development of particular anthropological features that would show relevant for the investigated sport.

The other one refers to the specific features that might be of relevance for that one sport exclusively, not any other sport. This is important because sports differentiate based on different demands that this activity makes on the athlete's potential. In the process, each activity enforces development of a specific structure of athlete's features. From the scientific-investigatory blueprint point of view, it is most appropriate to define all relevant anthropologic features based on top-level athletes in the chosen sport. It is assumed, of course, that successful athletes possess relevant feature, and/or that combination of developed features ideal for the particular sport. In example, Morgan (1979) states that physiological or psychological data can never on its own be an appropriate predictor of efficacy. Accordingly, only when an athlete is investigated as a complex psychobiological system is it possible to approach the ideal level of prediction. Likewise, Deshaies et al (1979) state that sports behaviour should be examined in the light of interaction of numerous physiological, as well as psychological variables, and that such an approach is more appropriate than solely physiological or psychological predictive models of sports efficacy.

Determining an efficacy model in sports for team sports games

Because of the complexity, that is, the impotence to set a mathematic model that would completely describe the factors that affect sports efficacy and their mutual influence, a solution emerged in expert systems. A reason for application of expert systems in the field of kinesiology can be explained by their gratification of the principles of simplicity and coverage. It is also important to mention that modularity and possibility of expansion of expert systems have encouraged an array of new scientific researches which enabled further progress of sports science (Dežman, 1988, 1992, 1995; Jošt et al, 1992; Dežman and Leskošek, 1993; Filipčić, 1996; Dežman and Erčulj, 1995; Dežman et al, 2001a, 2001b; Trninić et al, 2002a, 2002b). Therefore, it is important to point out that expert systems provide acceptable solutions, but without a mathematically structured equation that would precisely define the whole model of efficacy and its behaviour in dependence of variability of internal and external parameters.

Expert systems are based on the knowledge acquired from expert people and a set of rules that are formed through their filled questionnaires, and the emulation of human contemplation is expanded further through an application of the so-called fuzzy logic (Zadeh, 1965, Siler and Buckley, 2005, Papić et al, 2009, Rogulj et al, 2009.).

New scientific blueprints directed at research of efficacy factors in complex and poly-structural sports as in complex dynamic systems marked by variant processes of integration, and functional mutual dependence of players who play different positions in a particular team sports game (Trninić, 1995; Lebed, 2006, 2007; Trninić et al, 2008). In accordance with this is also the assumption that the best player in team sports games is the one who in interaction with other co-players achieves maximal individual and team performance. This demonstrates that for team sports games it isn't all about how much a certain player can play, but how much he participates in assistance systems in all phases of the course of the game (Trninić et al, 2009). In sports practice, expert coaches believe that an appropriate determination of the efficacy equation is the basis for a rational management of the process of sports preparation, a starting point for adequate guidance, selection and specialization of a particular player for particular roles in the game (Dežman, 1988; Trninić, 1995). Jacob and Carron (1997) have come to a conclusion that the most important factors that have contributed to the status of sports teams are performance ability and roles of the players in the team, as well as competition experience. Player roles enable development of a dynamic game system of a particular team (Lebed, 2006, 2007; McGarry and Franks, 2007). The traditional approach to understanding sports factor structure was directed mainly on the assembly of athlete's abilities, traits, knowledge, skills and habits that influence sports performance and competition efficacy in an individual branch of sport. Accordingly, research was dominantly directed on the influence of anthropologic dimensions on efficiency in sports activities and vice versa. However, except for numerous internal factors, external and general social factors influence efficacy of players and of team, and are multiply interacting (Filipčić, 1996; Dežman, 1988, 1997; Trninić et al, 2008). Because of the complexity of the sports efficacy model, solving the sports factor structure is commonly just partial and therefore provides with incomplete answers to the basic question-what makes a successful player and/or team (Horga, 1993). Dežman (1992, 1995, 1997) and Erčulj (1998) state that ascertaining an efficacy model for an individual player and/or team is possible to conduct in two ways:

1. through measuring or evaluating all factors with the biggest influence on performance quality of an individual player and/or team. This approach evaluates player's potential (the level of development of relevant basic and specific anthropologic dimensions that affect player's efficacy) or his potential efficacy. The tests that measure potential efficacy must have high correlation with the criterion of situation efficacy and/or total actual player quality.

Based on acquired results in such a type of selected tests, it is possible, with the help of multiple regression analysis, to calculate beta ponders, which in different ways ponder particular tests in total points count. So it is necessary, within the theory of efficacy, to distinguish total (e.g. total potential or psychosomatic player status) and partial potential efficacy (e. g. motor area of player's psychosomatic status). In recent researches, several multi-criteria models for determining partial potential have been formed and checked (Dežman and Leskošek, 1993; Dežman, 1992; Jošt et al, 1992; Dežman and Erčulj, 1995; Dežman, 1996; Leskošek, 1996; Erčulj, 1998). Schilling (1975) says that the total of athlete's personality (individual set of behaviour, thought, and emotions that identify athlete's adjustment) is labelled by his potential abilities (fitness, muscle force, extended performance ability, quality of total nervous system function, technique and sports activity tactics adoption), readiness for accomplishment (traits of personality and motivation, emotions and athlete's intentions). He also believes that the category of potential sports accomplishment (what the athlete is capable of) and readiness for accomplishment (what the athlete wants and how much he assists), especially in complex sports activities, are in constant multiple interaction. From the methodical aspect, the manner of defining potential accomplishment and readiness for accomplishment is different from one researcher to another. This is, of course, determined mainly through technical possibilities of research performance, and specifics of demands for some sports activity.

2. through evaluation of total and partial efficacy. Total game efficacy (total athlete quality) includes all relevant factors of actual player quality, which are assessed by experts by using a certain criteria system (Trninić, 1996; Trninić et al, 1999a; Trninić, Dizdar, 2000; Trninić et al, 2000, Dežman et al, 2001a, 2001b, Trninić et al, 2002a, 2002b, Hraste et al, Trninić, 2008). Also, concerning the football game, Čorluka (2008) founded a criteria system for evaluation of total efficacy in a football game, while in water polo Hraste et al (2008) set a criteria system for evaluation of actual quality of top-level water polo players. Čorluka (2008) and Hraste (2008) have affirmed characteristics of the measurement instrument for evaluation of total efficacy in football and water polo games, and concluded that for most criteria metric characteristics (objectivity and sensitivity) are in coherence with their coefficients of relevance for a certain position. In these mentioned scientific researches, there is a defined relative contribution of individual criterion to total quality of players on particular positions in the game, and accordingly there was a suggested structure of relevant criteria for each position.

Empirical findings show evident differences in importance of individual criterion for evaluation of player quality in afore-mentioned team sports games considering the position that the player plays primarily. It is important to mention that in team sports games the efficacy of each player is evaluated by the level of achievement of set common and special tasks. Unlike total efficacy, partial efficacy obtains only those factors that are gathered by a statistic record of final actions of players in the competition (indicators of situation efficiency), also known as player efficiency (Jošt et al, 1992; Swalgin, 1994, 1998; Erčulj, 1998; Dizdar et al, 1997, Trninić et al, 1997, Trninić et al, 1999b).

The assessment of total situation efficacy should be based on valuation of players according to position and time spent in the game. So, for example, Dizdar (2002) states that with the help of 13 indicators of situation efficacy, it is possible to assess around 77% of the criterion variable "total basketball player quality", even 85% if together with the 13 indicators of situation efficacy we also include variables for assessment of player consistency in situation efficacy (evaluated by standard deviations). Such a result may be considered the threshold of prognostic validity of mentioned variables. It is important to note that the findings of this study have shown that the biggest contribution to prediction of criteria variable "total basketball player quality" was made by the variables defence jump, successful two-point shoot, free throws and assistances, while the others didn't show statistic relevance.

Therefore, single player quality can be evaluated in three ways:

- through subjective evaluation of expert coaches (Trninić, 1995, 1996; Dežman, 1988; Swalgin, 1998),
- through objective evaluation of the situation efficacy (Gréhaigne and Godbout, 1995; Swalgin, 1994, 1998; Trninić et al, 1995; Dizdar et al, 1997, Dežman, 1998)
- through combining both approaches - the model includes professional subjective assessment based on a criteria system and an objectively measurable situation effect (Trninić et al, 2000; Dežman et al, 2001a, 2001b)

Thus, a player can be evaluated by an assessment of the condition of the development of his/her anthropologic feature and/or evaluation of total game efficacy. Because of high complexity of sports games and diversity of roles of athletes in game, their potential as well as actual quality can be differently structured (Trninić et al, 2002a, 2002b). This means that athletes manage to achieve equal total evaluation of potential and/or total game efficacy in different ways.

The specific structure of factors of athlete's potential conditions also a specific structure of factors that determine game efficacy. This is why not only the final value of potential evaluation or total game efficacy are said to be relevant, but also the profile of their individual factors (Dežman et al, 2001a, 2001b). From the point of view of the expert systems model, potential efficacy of athletes encompasses all important internal and external factors that govern the efficacy in team sports games, but also a set of factors that encompasses some general social factors which can be only approximately defined. Erčulj (1998) points out the fact that expert systems are more and more adequately applied for sports efficacy research. Also states that computer-assisted expert system enables us to accept relations between individual factors of efficacy within a particular sport discipline or sports branch and a different level of development of these factors which make the basic source of information when choosing. This is particularly relevant for identifying differences between potential efficacy and actual athlete quality. Further on, Erčulj (1998) claims that the reliability and quality of a decision depends upon the quantity and quality of information (expert knowledge) possessed by an expert (most important and irreplaceable instrumentation in the development of sports expertise and science), that is, an expert group in the interdisciplinary, multidisciplinary and trans-disciplinary approach. Within the mentioned scientific study, what was also investigated was the relationship between the variables of potential efficacy (predictor variables) and the variables which helped conclude player efficacy and situation efficacy (criteria variable). This showed that all connections between the variables of potential efficacy (predictor variables) and the variables which helped conclude efficacy and situation efficacy (criteria variable) are linear. Accordingly, the hypothesis that potential efficacy of all three basic types of players in basketball (guards, wings and centres) is directly shown in their player efficacy and efficiency has been substantiated. However, this research has encompassed only some of the internal factors (morphologic and motor potential) that directly affect athlete potential, and that probably have a bigger meaning in younger age categories than in senior categories where the psychosocial status differentiates more the level of actual player and team quality. Independently, what is achieved is a high prognostic value expressed mostly in anticipating actual player efficacy and efficiency of athletes and the team. Erčulj (1998) believes that the model of potential basketball player efficacy shown in the study isn't something formal, and should be changed in accordance with knowledge databases.

As well as with results of sciences and practical knowledge of expert coaches. These are all preconditions that enable experts to improve their knowledge and cognition.

Proposition of a nonlinear efficacy factors model in sports

Malacko and Popović (2001) state that during efficacy factors analysis in sports activities, the information on how many factors F_1, F_n influence an individual activity presents the main task of researchers in the field of applied kinesiology. Further on, they point out that the generating of the hierarchy structure of anthropologic characteristic of athletes is done through application of mathematical statistics methods (factor, regression or canonical analysis), and that the most common form of the specification equation is:

$$Y = \sum_{i=1}^n a_i F_i + ex, \text{ where}$$

Y- stands for efficacy in a particular sports activity

F_i - stands for factors which sports activity efficacy depends on, $i=1, \dots, n$

a_i - stands for coefficients of influence of particular factors (contributions of efficacy), $i=1, \dots, n$

ex - stands for error factor

In accordance to the mentioned, it is assumed that by means of the system of differential equations we could more appropriately describe the high complexity of internal and external determinants of athlete's performance and competition efficacy, and their interaction in poly-structural and complex sports activities. It is relevant to note that the systems described by differential equations must as variables have objects described functionally, by continuous objects. This is a problem, since kinesiology as an applied science gets variables through measurements, as a finite discrete set of normally distributed data. In that context, it is possible to use continuous approximation.

Further more, the presented efficacy specification equation can be understood as a linear part of Taylor's series expansion of the efficacy function

$$Y = f(x_1, x_2, \dots, x_n)$$

which is obtained through solving the nonlinear system of (differential) equations that in itself integrates dynamic relations between system's variables? It is, however, possible to solve the system by a numeric scheme and get a discrete solution (Smith, 1978), and generalize it by usage of interpolation techniques into continuous (Fröberg, 1966; Kvasov, 2003; Jelaska, 2005).

In the context of multi-index notation, the Taylor's series expansion of function consisted of d variables, about d -dimensional point $a = (a_1, \dots, a_d)$ would be as follows (Bermant and Abramovich, 1975; Atkinson, 1988; Bajpai et al, 1973):

$$f(x) = \sum_{|\alpha|=0}^n \frac{1}{\alpha!} \frac{\partial^\alpha f(a)}{\partial x^\alpha} (x-a)^\alpha + \sum_{|\alpha|=n+1} R_\alpha(x) (x-a)^\alpha$$

Demonstrated as standard, upper formula can be written in following form:

$$f(x_1, x_2, \dots, x_d) = \sum_{\alpha_1=0}^{\infty} \dots \sum_{\alpha_d=0}^{\infty} \frac{(x_1-a_1)^{\alpha_1} \dots (x_d-a_d)^{\alpha_d}}{\alpha_1! \dots \alpha_d!} \left(\frac{\partial^{\alpha_1+\dots+\alpha_d} f}{\partial x_1^{\alpha_1} \dots \partial x_d^{\alpha_d}} \right) (a_1, \dots, a_d)$$

For example, if we were to say that $d=2$, meaning the function is dependant of only two variables, X and Y , then Taylor's series expansion, including quadratic terms, about the point (a, b) would be:

$$f(x, y) \approx f(a, b) + (x-a)f_x(a, b) + (y-b)f_y(a, b) + \frac{1}{2!}[(x-a)^2 f_{xx}(a, b) + 2(x-a)(y-b)f_{xy}(a, b) + (y-b)^2 f_{yy}(a, b)]$$

Where we used standard symbols for partial derivations:

$$\frac{\partial^2 f}{\partial x^2} = f_{xx}, \frac{\partial^2 f}{\partial x \partial y} = f_{xy} = f_{yx}$$

Here we can see that with a different notation:

$$f(x, y) \approx x f_x(a, b) + y f_y(a, b) + f(a, b) - a f_x(a, b) - b f_y(a, b) + \frac{1}{2!}[(x-a)^2 f_{xx}(a, b) + 2(x-a)(y-b)f_{xy}(a, b) + (y-b)^2 f_{yy}(a, b)]$$

we get the linear part separated from the nonlinear, so the first two members of the above expression would correspond with some two-factor model of efficacy

$$Y = a_1 F_1 + a_2 F_2 + ex$$

with ponders $a_1 = f_x(a, b)$ and $a_2 = f_y(a, b)$, while the rest would enter error factor ex. Quite analog to this, we read out coefficients for an efficacy model with n factors.

It is important to accentuate that Taylor's series expansion can be more compactly written down in a matrix form (Bermant and Abramovich, 1975):

$$T(x) = f(a) + (x-a)^T Df(a) + \frac{1}{2!}(x-a)^T \{D^2 f(a)\}(x-a) + \dots$$

Where $Df(a)$ is the gradient of function f calculated in point $x=a$ and $D^2 f(a)$ is Hessian matrix. It is important to note that by changing the degree of approximation, we also vary its precision. Also, a nonlinear and reciprocal functional relation of variables X and Y can be integrated into the part of Taylor polynomial that includes the exponents of variable X , and all its multiple products with variable Y .

Conclusion

From the sports kinesiology or sports science point of view, the formation of the process of sports preparation depends on an appropriate factor sport structure, since without its proper defining it is impossible to rationally manage the processes of growth of athlete's potential and/or the whole team. Modern kinesiology is theoretically directed to inter-relation and interaction of inner, outer and general social factors that determine efficacy in a sport. This is because the processes of interaction are dynamic and chaotic in a sports surrounding. Through explicit defining and construction of multiple connections amongst variables within a hypothetical nonlinear model, we enter the frames of usage of the mathematical functional symbolic instrument which generates higher order interactions. Therefore, the linear model of sports efficacy factors cannot be the appropriate pattern that depicts the complexity of sports activities of a poly-structural and variable type. On the other hand, the factors of efficacy of a particular team sports game cannot be presented as a single direction, since the processes occurring in dependence of the time variable in the system of sports preparation do not move single-dimensionally but oscillate. Therefore, the linear model is not only inappropriate, but also limited in explaining and understanding the determinants of competition efficacy, because it clearly does not explain the interaction of the inner and outer factors that determine efficacy.

These reduction patterns do not describe mutual influences of mentioned variables that refer to sports efficacy. The athlete, the team and also the sports activity is impossible to properly interpret by one-way relations or as static occurrences, but as nonlinear dynamic systems which inside carry implemented two-way paths between particular inner and outer factors of competition efficacy. In order for the factor structure of efficacy in sport to be defined and properly guide the process of sports preparation, it is important to be familiar with not only the development level of basic and sport-specific anthropologic dimensions of top-level athletes, but it is also necessary to know the coefficients of importance of criteria for particular positions in the team sports game (actual athlete quality).

However, factor structures of sports for mono-structural, poly-structural and complex sports activities shouldn't be compatible in the mathematical formal description, since the demands of each sports activity different, and also the factor combination that structures the equation of efficacy in sports. In so, the model characteristics of top-level athletes in sports activities demand prediction of development of a particular team sports game, and accordingly, an anticipation of model features of top-level athletes and teams, and an explicit analysis of actual and future model demands.

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GLOBALNI NELINEARNI MODEL ZA PROCJENU UČINKOVITOSTI U MOMČADSKIM SPORTOVIMA

Sažetak

Vjerojatno nijedan model uspješnosti unutar momčadskih sportskih igara ne predstavlja u potpunosti kineziološku realnost. To zato što u kineziologiji sporta ili sportskoj znanosti nije moguće eksplicitno formirati teorije i modele koji ne bi imali nikakvu grešku jer se testiraju na ograničenom skupu pojava. To osobito vrijedi za teorije i modele koji se odnose na situacijski pristup jer su eksperti svjesni činjenice da se kineziološke teorije i modeli neprestano modificiraju na temelju povratnih informacija generiranih u procesu znanstveno-istraživačkog rada. Linearni model koji je dominantno prisutan u objašnjavanju čimbenika uspješnosti u sportu ne objašnjava interakciju unutarnjih i vanjskih čimbenika natjecateljske uspješnosti. To stoga jer ne opisuje obostrane utjecaje navedenih varijabli već prikazuje skup poznatih i nepoznatih faktora koji utječu na uspješnost sportaša ili momčadi tj. prikazuje diferencijalno ponderiranu sumu njihovih utjecaja. Za razliku od linearnog, predloženi nelinearni model omogućava primjereniji uvid i razumijevanje višestrukih interakcija između unutarnjih i vanjskih čimbenika uspješnosti u sportu. Cilj je na predloženom nelinearnom modelu zasnovati egzaktni, znanstveno-stručni interakcijski pristup koji bi omogućio prikladnu jednadžbu uspješnosti u momčadskim sportskim igrama na temelju koje bi se provela primjerena dijagnostika, selekcija i razvoj potencijalnih vrhunskih sportaša i/ili momčadi.

Ključne riječi: sport, momčadi, učinkovitost, nelinearni model

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FUNCTIONAL ABILITY TRANSFORMATION PROCESSES OF FEMALE STUDENTS UNDER INFLUENCE OF FITNESS PROGRAM THAI-BO

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Original scientific paper

Abstract

The aim of this research is to determine the level of transformational processes in functional abilities of female students in Tuzla University under influence of fitness program Thai-Bo. The research was conducted on 64 examinees. Based on presented results that we gained through testing in the beginning and at the end of implemented fitness programs during 6 months period with a frequency 2 times a week, t-test and factor analysis under congruence model, we can conclude that fitness program Thai-Bo and functional variables applied on 64 female student produced significant quality and quantity differences.

Key words: fitness programs, Thai-Bo, quantity changes, quality changes

Introduction

Fitness training is a set of the newest and the most popular methods of training for conditional ability development based on results of applied science research. The fact is; there is a close correlation between functional abilities and health which gives as a result that those measures of functional abilities contribute health level estimation. Since the level of fitness is primarily the result of systematically implementing of physical activity (along with gene component), it is logical to accept that physical activity contribute to the protection and the improvement of health with its basically preventive, if necessary, curative and rehabilitation involvement. Due to significance of body activity and fitness correlation with health we imported the term "health fitness" (health – related fitness), which specifies certain fitness characteristic that can be positively and adversely influenced by body activity and can reflect on health status. The health fitness can be defined as ability to implement tiring daily activities with reduced risk of early development of hypokinetic diseases and conditions

Methods

Subject sample: The subjects of this research are the first year female students on their secondary Faculties of University of Tuzla. The subjects are age 19 to 21 and the research was conducted only on subjects that were healthy during this research. There were 64 participants totally. **Variables:** The sample of variables in this research included 22 functional variables. In the research we applied variables relevant for following functional transformations: VO2MAX-Astrand test to estimate maximal oxygen uptake,

SHURUN-Shuttle run 20m, Spirometry: VC, FVC, FEV1, FEV1/VC, FEV1/FVC, FMEF, FMFT, FEF, PEF and MVV IND. **Data processing methods:** Data processing for this research was performed on Faculty of physical education and sports in Tuzla with statistical program package SPSS 12.0. We applied T-test and factor analysis under congruence model in all applied variables in order to determine significant differences between two measuring and to register quantity and quality changes in final measuring.

Results and discussion

Based on results of arithmetic means in estimation of functional ability tests at the beginning and at the end of fitness program and also based on significance of changes tested with T-test for relative samples it is obvious that program Thai-Bo produced significant partial effects. With test for functional ability estimation, which are presented in this research with variables SHURUN – shuttle run 20 m, Astrand test for maximal oxygen uptake VO2MAX, and variables from spirometry, visible positive improvement of arithmetic mean value appeared in half of tested variables during final measuring. Statistically significant positive improvement of arithmetic mean values in final measuring appeared in variables: SHURUN – shuttle run 20 m (Sig. 0,00), and variables for estimating maximal oxygen uptake VO2MAX (Sig. 0,00) and other variables presented in tables on the level to Sig. 0,05. The results of T-test of half of variables for estimating functional abilities indicate statistically significant differences between initial and final measuring which means that fitness program Thai-Bo, conducted on the first group of subjects, produced significant partial effect in functional ability field.

Table 1. Statistic parameters and t-test

		Paired	Diff.	95% Confidence				
	Mean	Std. Dev.	Std.Err.of Mean	Low*	Upper	t	df	Sig. (2-tailed)
VCMJ – VCMJF	,12	,43	,05	,01	,23	2,26	63	,03
VCPROC – VCPCROCF	3,59	12,35	1,54	,51	6,68	2,33	63	,02
FVCMJ – FVCMJF	-4,50	2,20	,28	-,99	,11	-1,59	63	,12
FVCPROC – FVCPCROCF	-11,76	58,90	7,36	-26,47	2,95	-1,60	63	,12
FEV1MJ – FEV1MJF	,43	1,34	,17	,09	,76	2,56	63	,01
FEV1PROC – FEV1PROCFF	12,86	41,17	5,15	2,58	23,14	2,50	63	,02
FEV1VCMJ – FEV1VCMJF	5,36	21,48	2,68	-,01	10,72	2,00	63	,05
FEV1 VCPROC – FEV1	5,17	21,29	2,66	-,15	10,49	1,94	63	,06
FEV1FVCMJ – FEV1FVCMJF	-,95	31,10	3,89	-8,72	6,82	-,24	63	,81
FEV1FVCPROC – FEV1F	-2,06	30,55	3,82	-9,69	5,57	-,54	63	,59
FMEFMJ – FMEFMJF	13,79	24,32	3,04	7,71	19,86	4,54	63	,00
FMEFPROC – FEFPCROCF	233,45	252,36	31,54	170,41	296,48	7,40	63	,00
FMFTMJ – FMFTMJF	-,34	,38	,05	-,44	-,25	-7,33	63	,00
FMFTPROC – FMFTPCROCF	-75,39	113,20	14,15	-103,67	-47,11	-5,33	63	,00
FEFMJ – FEFMJF	,38	1,49	,19	,00	,75	2,02	63	,05
FEFPROC – FEFPCROCF	20,77	87,21	10,90	-1,02	42,55	1,91	63	,06
PEFMJ – PEFMJF	-13,15	169,02	21,13	-55,37	29,07	-,62	63	,54
PEFPROC – PEFPCROCF	-1,47	40,19	5,02	-11,51	8,57	-,29	63	,77
MWINDMJ – MWINDMJF	16,20	50,50	6,31	3,59	28,82	2,57	63	,01
MWINDPROC – MWINDPCROCF	13,42	41,26	5,16	3,11	23,73	2,60	63	,01
VO2MAX – VO2MAXF	-2,52	2,69	,34	-3,19	-1,84	-7,48	63	,00

Results of quality changes analysis through 22 tests for functional ability estimation on the sample of 64 female subjects of the first group fitness program Thai-Bo respondents were carried out with Factor analysis – Congruence method. First through Bartlett's test we tested possibility of submitting this set of functional variables to any type of factorization. Data from tables (initial and final measuring) confirm that data can be submitted to factorization. (Sig .000). Using matrix factorization of latent motor variable intercorrelation and applying Guttman-Kaiser criteria in initial measuring we obtained 7 characteristic roots that clarify totally 86,91% of common variance. Individually they clarify mutual variance for the first latent variable 42,86%, for the second 10,03%, third 9,47%, forth 7,72%, fifth 6,12, sixth 5,81% and the seventh latent variable 4,86%. Rotation was carried out by using direct Oblimin method. With method of congruence – folding factor scores of initial and final measuring, we wanted to determine is there any structural changes under influence of training operators within applied fitness program Thai-Bo. Based on isolated main component characteristic roots it is obvious there have been some structural changes in final measuring regarding to initial measuring.

In the further procedure it is necessary to determine what has changed in the structure of isolated main components. By monitoring set of matrix in initial and final measuring we can conclude that partly changes occurred in structure of isolated main components. In initial measuring the largest impact on the first main component had variables for forced expiration volume estimation FEV1MJ and FEV1PROC (0, 9 and 0, 88) and variables for Tifneau's index estimation -FEV1VCMJ and VEV1VCPCROCF. The largest impact on the forth component had variable SHURUN- shuttle run 20 m (0,68), on the sixth had variables for forced vital capacity factor estimation FVCMJ I FVCPCROCF (0,9 and 0,88), and on the seventh main component had variable for maximal oxygen uptake factor estimation VO2MAX (0,5).

Observing matrix of the structure in final measuring, the conclusion is; we isolated six main components and hyper cone narrowing appeared. Isolated latent variables significantly changed structure regarding their positions in initial state. The largest impact on the first main component kept variables for forced expiration volume estimation FEV1MJ and FEV1PROC (0, 9 and 0, 88), but with smaller coefficients.

On the third main component impact had variables for factor estimation of forced vital capacity FVCMJ I FVCPROC (0,91 i 0,89), on the forth main component impact had variables for vital capacity estimation VCMJ and VCPROC, the fifth variable SHURUN-Shuttle run 20m (0,82) and on the sixth main component the impact had variable for maximal oxygen uptake factor estimation VO2MAX (0,86). From the results it is visible that coefficients of significance of certain variables on isolated main components are higher regarding initial state. That fact points out there are significant quality changes of functional abilities under influence of fitness program Thai-Bo, applied on the first group of respondents. We can conclude that fitness program Thai-Bo, applied on the first group of respondents affected quality changes of tested functional abilities.

Table 2. Functional abilities

Paired Differences					t	df	Sig. (2-tailed)
Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
			Lower	Upper			
-6.88	4.35	0.54	-7.96	578.89	-12.65	63	.000

Table 3. Factor analysis congruence model – functional (initial)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	,67
Bartlett's Test of Approx. C hi-Square	4838,47
Sphericity df	231
Sig.	,00

Table 4. Factor analysis congruence model functional (final)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	,75
Bartlett's Test of Approx. C hi-Square	2926,28
Sphericity df	231
Sig.	,00

Table 5. Eigen values (initial)

Component	initial Eigen values		
	Total	% of Variance	Cumulative %
1	9,430	42,863	42,863
2	2,208	10,038	52,901
3	2,085	9,478	62,379
4	1,699	7,722	70,101
5	1,347	6,121	76,222
6	1,279	5,815	82,037
7	1,073	4,876	86,913

Table 6. Skew factor solution (initial)

	Component						
	1	2	3	4	5	6	7
SHURUN	,061	,051	-,122	,682	,209	,224	-,032
VCMJ	,223	,208	-,198	-,751	,071	,254	-,373
VCPROC	,202	,015	-,112	-,164	,132	,014	-,895
FVCMJ	,607	,357	-,171	-,043	,041	,006	-,061
FVC PROC	,628	,359	-,180	-,033	,081	,088	-,178
FEV1MJ	,980	,359	-,196	-,117	,134	,418	-,131
FEV1PROC	,978	,332	-,185	-,098	,150	,385	-,269
FEV1VCMJ	,983	,349	-,186	-,076	,130	,391	-,104
FEV1VCPROC	,982	,347	-,176	-,085	,126	,378	-,091
FEV1FVCMJ	,268	,983	-,130	-,065	-,068	,192	-,063
FEV1FVCPROC	,276	,983	-,125	-,071	-,068	,187	-,054
FMEFMJ	,061	-,135	,233	,014	,057	,203	,200
FMEFPROC	,779	,164	-,019	-,063	,543	,033	-,153
FMFTMJ	-,570	-,251	,196	,345	-,327	,305	,361
FMFTPROC	-,104	-,010	,284	-,076	-,681	,189	,343
FEFMJ	,627	,496	-,143	,052	,352	,729	-,194
FEFPROC	,643	,495	-,135	,045	,349	,722	-,235
PEFMJ	,108	,186	-,074	,075	-,020	,046	-,123
PEFPROC	,201	,103	-,067	,025	,010	,082	-,207
MWINDMJ	,980	,358	-,196	-,118	,132	,410	-,129
MWINDPROC	,978	,332	-,185	-,098	,150	,385	-,269
VO2MAX	,105	-,208	,275	,574	,230	-,075	,494

Table 7. Factor correlations (initial)

Com.	1	2	3	4	5	6	7
1	1,00	,31	-,15	-,12	,21	,30	-,17
2		1,00	-,17	-,04	-,04	,20	-,14
3			1,00	-,06	,01	-,04	,25
4				1,00	-,01	,06	,03
5					1,00	,01	-,07
6						1,00	,00
7							1,00

Table 8. Eigen values (final)

Component	Initial Eigen values		
	Total	% of Variance	Cumulative %
1	9,854	44,791	44,791
2	3,020	13,726	58,517
3	2,146	9,756	68,273
4	1,786	8,117	76,390
5	1,348	6,128	82,518
6	1,082	4,919	87,438

Conclusion

Based on presented results we can conclude that fitness program Thai-Bo produced significant partial effects as well as affected quality changes of tested functional abilities. We faced statistically positive arithmetic mean value motion in final measuring in variables SHURUN-Shuttle run 20m (Sig. 0,00), variables for maximal oxygen uptake estimation VO2MAX (Sig. 0,00), and other variables presented in tables on the level to Sig. 0,05.

Table 9. Skew factor solution (final)

	Component					
	1	2	3	4	5	6
VCMJ	,235	-,035	,057	,909	-,014	,192
VCPROC	,152	,068	,060	,931	,094	-,289
FVCMJ	,239	-,163	,914	,005	-,059	,066
FVCPROC	,217	-,090	,886	,177	,001	-,214
FEV1MJ	,910	-,512	,461	,197	-,184	,305
FEV1PROC	,910	-,458	,474	,316	-,159	,116
FEV1VCMJ	,842	-,490	,466	-,099	-,148	,276
FEV1 VCPROC	,843	-,512	,479	-,183	-,211	,272
FEV1FVCMJ	,840	-,158	-,055	,311	,047	-,005
FEV1FVCPROC	,844	-,206	-,106	,217	-,015	,025
FMEFMJ	,462	-,929	,203	-,052	-,122	,124
FMEFPROC	,484	-,892	,207	,010	-,137	,040
FMFTMJ	-,447	,836	-,171	-,113	,198	-,183
FMFTPROC	,189	-,877	,054	-,074	,045	,091
FEFMJ	,084	-,699	,503	-,226	,417	,384
FEFPROC	,073	-,671	,533	-,180	,441	,318
PEFMJ	,735	-,579	,276	,247	-,464	,253
PEFPROC	,750	-,572	,299	,245	-,447	,186
MVVINDMJ	,904	-,520	,464	,196	-,183	,309
MVVINDPROC	,891	-,450	,436	,323	-,157	,081
V02MAX	,079	,042	-,189	,002	-,033	,862
SHURUN	,091	,015	-,022	,159	,829	-,039

Table 10. Factor correlations (final)

Com.	1	2	3	4	5	6
1	1,00	-,35	,20	,21	-,15	,12
2		1,00	-,26	,05	,03	-,18
3			1,00	-,01	-,00	,07
4				1,00	-,01	-,09
5					1,00	-,01
6						1,00

Observing matrix of the structure in final measuring, the conclusion is; we isolated six main components and hyper cone narrowing appeared. Isolated latent variables significantly changed structure regarding their positions in initial state. From those data we notice that significance coefficients of certain variables in isolated main components are higher regarding initial set. That fact points out there are significant quality changes of functional abilities under influence of fitness program Thai-Bo, applied on this group of respondents.

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PROMJENE FUNKCIONALNIH SPOSOBNOSTI STUDENTICA POD UTJECajem THAI-BO FITNESS PROGRAMA

Sažetak

Cilj ovog istraživanja je bio utvrđivanje razine transformacijskih procesa u funkcionalnim sposobnostima studentica Univerziteta u Tuzli pod utjecajem fitness programa Thai-Bo. Istraživanje je provedeno na 64 ispitanice. Na temelju prezentiranih rezultata dobivenih testiranjem na početku i na kraju implementiranog programa u trajanju od 6 mjeseci učestalošću dva puta tjedno, na temelju t-testa i faktorske analize pod modelom kongruencije, možemo zaključiti da fitness program Thai-bo uz praćenje funkcionalnih sposobnosti ispitanica producira značajne kvalitativne i kvantitativne razlike.

Ključne riječi: fitness programi, Thai-Bo, kvantitativne promjene, kvalitativne promjene

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ATTRACTIVENESS LOST IN THE WATER POLO RULES

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Review paper

Abstract

Beauty and attractiveness of the water polo game are manifested in combinatory and richness of performed actions during the match. Every technical element carried out in the game are in function of individual tactics in attack or defense, and like that is constituent of collective tactic in attack or defense. The game is regulated by the rules of water polo which from one side concede to the players to demonstrate adopt technical and tactical knowledge's, skills and habits and convert it in result. On under side rules regulated game by the suppression system over which fouls are adjudicated. Rules, hence, give the frame for game. In the last fifty years rules of water polo are changed many times. The basic intention of all the changes was to accelerate the play and make it attractively for viewers. On the look of the play, rapidity of actions and all what water polo makes attractively affected also the changes in training arise from evolution of expert and scientific cognitions in the field of kinesiology in sports. Not always and necessary, changes in the rules of water polo, has created positive effects and water polo makes rapidly and attractively. In this moment, according actually applying rules, water polo became non attractive and uninteresting for viewers about what depose empty auditoriums on league competitions. Attractiveness of this sports game was destroy in a moment when changed rules has permit contact, for position choosing, to center and his opponent, defender, in front of the goal. In the real conditions of the game, collision between center and defender represents unproductive, roughly, sometime badly wrestling in the water, in some cases in duration of thirty seconds. In this considerations of the game, capability of combinatory are completely eliminated, because the second attack line practically is out in the play during positional attack. On the base of provide we suggest, possible, changes in the water polo rules, which can give back beauty, attractiveness and viewers to water polo.

Keywords: water polo, rules, tactics, attractiveness

Introduction

Water polo belongs to the category of polistructural complex motions in which dominated simple and complex movements structures performed in the variable conditions in terms of cooperation with other team members, actively interfering with the opposing team's players. Thus the default conditions, which are the rules of the game, water polo is a complex sport on the IT plan (plan technique, tactics, strategy and theoretical knowledge), and somewhat more complex and difficult on the energetically plan (physiological functional characteristics ultimately measured by the mix of anaerobic and aerobic capacity) (Lozovina, 2009; Smith, 1998). By given duration of the game and the flow of energy processes, water polo belongs to the category of mixed anaerobic-aerobic sports at which dominates the anaerobic phase (Lozovina & Pavičić, 2002; Lozovina, Pavičić & Lozovina, 2007). Thus belongs to extremely difficult and strenuous sports. In terms of the either complexities is not easy to get to the top results all at the same time respecting the factors that have influences at success in this sporting game.

Technical and tactical skills of water polo (IT component) assign appearance of the game and that is what we looking during the course of the match, whether participate as a spectator or coach of the opponent teams in mutual rivalry. For coaches, as a rule, determining in the effectiveness of given tactics and the result arise from it. Viewers, still in smaller number on the official water polo league games, today, primarily interested in a feeling that they can afford the beauty of the game. Viewer experiences of the beauty primarily afford through the number, wealth and attractiveness of the actions performed in a game, directly provided in technical elements derived in parts of the tactics, bounded by the rules of the game. The term tactics accorded harmonized collective activity of the entire team, whose ultimate intention is to achieve the goal, if the team is in ball possession and in the attack phase, or prevent the achievement of goals when the team is out of ball possession and in the defense phase. Collective tactics is defined as the sum of individual tactics actions organized in the attack and in defense.



Picture 1. Attacking

Any of this formation, has the essential characteristics which can be present with a basic scheme, call system. The system is a narrower apprehension than the tactics, presenting exactly defined, expressed and signed movements of players, particularly lines, and overall team movements during the game (Lozovina, 2009; Lozovina, 2009). Repertoire of techniques is the repertoire of activities that define the elements of all possible manners of players during the match. Set of elements that contains all the elements of the individual player manners is defined as a repertoire of techniques of water polo, and all elements of the manners of two or more players as a group together, as a repertoire of tactics in water polo.

Elements of the techniques that make open cluster called the repertoire of techniques. It can be divided into mutually undercover subsets. Elements of those subsets directly define situation and tactics. Criteria that generate and determinate subsets include: possession of the ball, the movement of players, players position, players emplacement, the attack or defense phase of the game, the role in the game, the weight of the carried technical elements, the energy requirements for the execution of the elements, necessary experience, etc. Set forth, are proposed by the water polo rules which provide the framework for all possible, permissible manners in all the tactics (Pavičić, Lozovina & Šimenc, 1987). Another approach is based on the fact that each individual technique element is also an element of individual tactics, which has strongly definite and specified use value in tactic. Each individual element of tactics is also an element of collective tactics, because the water polo game in which is coordinated work of the seven players, who obviously spend a collective tactic which is, in fact, the sum of individual actions (tactics) in order to attack and in defense.

Arguments for changes in water polo rules

Collective tactics, in attack and defense is always given for the current match (Lozovina, 2009). Many of the changes in the last 50-ten years are primarily caused by changes in the water polo rules at the time. The progress in the training process changed water polo simultaneously. Changes in the rules caused the reduction of technical elements as well as elements of individual tactics which is by definition an integral part of collective tactics in to attack and defense. That is precisely what we looking whether as consumers of water polo matches from the auditorium (viewers) or coaches of the teams that competes. Changes in rules, in the long period, are created primarily in respect to speed-up the game and enrich combinatory in the tactics thus advance the attractiveness of the game for the viewers. Changes in rules did not always resulted with more attractive game conditions; indeed, some of them have produced the opposite effect. Near 1950 in the two halves (2 x 10min) the static water polo was played (players had to stay where they are found at the time of referee whistle.



Picture 2. Shoot

During interruption the movements was prohibited. The first and large-scale intervention in the rules acquired the possibility of players moving in the "dead time". The game has become a dynamic and interesting to viewers. After this change, until now, many interventions and changes in water polo rules was performed (Donev & Aleksandrović, 2008; <http://www.waterpolointernational.com>). We will mention those that we consider important.

Significant changes

In (1961.-1971.) decade

1961 - Half-time (2 X 10) min changed in quarters (4 X 5) min. actual playing time (clean play). In the game participate 11 (7 +4) players on both sides. Ball possession is limited to 1 min. Exclusion off the player is limited at 45 sec.

1976 - The third serious major foul (in succession) results with penalty throw. During a match dominated the contact between the players. The game apparently rough and is full off fouls, devoid of combinatory, beauty and attractiveness.

1970 – The rule of three major fouls is canceled.

1971 – Performed major foul resulting with exclusion of the 1 min.

1977 – The ball possession is limited on 35 sec. The player who performed major foul has exclusion of 45 sec. A second referee is import in the game. Any player can execute ordinary foul with condition that he is the nearest place where the foul is performed and do so without delay.

In the decade (1981-1991)

1981 - The team comprises 13 players (7 +6). The duration of the game prolongs. The game lasted 4 x 7 min of actual playing time (clean play).

1984 – Substitution can be performed only from re-entry area, marked 2 meters from the corner of the field of play on the side opposite to the official table. The penalty of excluded player reduces and it takes 35 seconds. Excluded player can return to the game and before expire the penalty time if his team went into the ball possession, but, on the signal of referee.

1991 - The penalty for excluded player reduces and lasts 20 sec. Goalkeeper, who has not allowed direct shot on the opponent's goal door can be achieved by the opposing goal. Possession is limited on 35 sec.

In the period 1991-1996 has not changed anything

In the period 1996-2009

During this period duration extend on the 4 X 8 min actual playing time (clean play). Introduced a line of seven meters out of which the offense after adjudge foul allows direct shoot at goal. The line of four 4 meters moves to 5 meters, from where execute the penalty shot. Blocking with both hands are proclaim. Introduced is the flying substitution, as well as "time out".

Concede the contact in the fight for position between the center and its defense opponent. Referees get instructions that about foul arbitrate by means of "good" or "bad" pass forwarded to center. Line 7m in back of, after foul, is allowed directly shoot on the goal revoked and moves to 5m which is, at the same time, penalty throws line. All the changes in the rules were made to speed up the game, and indirectly increase its attractiveness. The greatest contribution in acceleration of the game is given by reduction of the ball possession from 30 on the 20 seconds, return of excluded player immediately after ball possession change, possibility of the direct.

That is what most contributed to the shortening of possession for 30 sec, 20 sec at the exclusion, admission excluded players immediately after the change of possession, possibility for to direct shoot at goal after fouls in back of 5m line and possibility of flying substitutes as well as prohibition to attempt to block a shot on a goal outside the 5 meter area. Attractiveness of the game can be expressed out of variety of techniques and tactics applied during the match.

In general, one team always defends while the other attacks. In the moment of entering into possession of the ball starts the attack phase of the team. Each attack, in principle realizes through the two phases. First phase carried out attempted counter attack which ultimately finish as players more or less with handicap in complexity form from (1:0 to 6:5) with an attempt of realization when there is a realistic and highly probable chance to shoot at goal, or no attempt of realization if the chance are not achieved. On average, the execution of this action amounts 15 seconds. Next 15 seconds, in today's water polo, water polo teams spent in a positional attack in which the center plays a fundamental role (Lozovina, 2009). According to the current rules center and his defender have permission for very rough contact play. The referees estimated consideration of their duel.



Picture 3. Attack and goalkeeper action

Arbitration depends on the referee's judgment that "good or bad pass" is set out to the center during the duel. In the case of "good pass" to center usually a defender is excluded. In the case of "bad pass" defender usually take up the ball, without foul and change the ball possession (FINA Water Polo Rules 2009-2013). If the foul are arbitrated against the center, usually, that is a ordinary foul, exceptionally as a exclusion foul, for brutality. All dittos are contrary to the rules that define exclusion and penalty fouls. Hold, pull, sink, push or push off from the opponent who is in ball possession (control the ball), but not in contact with the ball, sanction is exclusion or penalty foul.

Existing rules, and this way of arbitration, forcing the teams which pretend to a high placement in the game, to use at least two, if necessary, and three centers, well-prepared to maintain continuity of the positional attack for the all game time. If, during the time estimated for the permissive ball possession center did not achieve the conditions for the shot at the goal than external attackers in the last seconds before the end of attack realize shot on the goal.

That what is not implemented in the game and did not happens is that the second line of the attack, practically, except in terms of attempts ball transmission to center, is eliminated from the attacks mainly in the form of mobile performs, in- swimming that from the standpoint of combinatory positional attack makes unattractive for viewers. Basic characteristics of the game in such conditions are attempted counterattack from which fall a small number of goals.

Unsparring centers and his defender battle which is full of the roughness resulting with a small or neither realization of the centers (Lozovina, Pavičić & Lozovina, 2004; Lozovina & Pavičić, 2002). Fail potential dynamic actions of attackers from second attack line, hence combinatory in the second phase of attack (positional attack). The result of the game dependent of a large amount of time in the game spent with a player more or less and percentage of realization. Result is non attractiveness and hollow auditorium.

Water polo is a game that takes place in a slow medium (water) which in terms of IT (techniques, tactics and strategy) makes a relatively simple game in comparison with football, ice hockey, handball and basketball.

Conclusion

Today's rules and their application did not allow the game to develop up to boundaries that could. With minimal intervention, in the existing and valid rules of the game, that can proclaim possible. This "anomaly" can be repaired with changes in the rules, to regulate the collision between center and its defender, with blocking the hand contact play, otherwise, with permission for one hand contact in the collision between center and its defender. Any contact with a two hands needs to be penalized as a foul. In the case of a contact with one hand foul will be adjudicated in the spirit of existing rules. It is enough, in the spirit of existing rules, give back the ordinary foul to the center. That will mobilized the players from second line in attack, what will bring back beauty and attractiveness of this sports game. In this case players in defense mission will play more actively, without contacts anywhere in the field except in collision with a center, especially in the "dead time" where any ordinary foul become foul for exclusion. Following this logic, any contact and blocking of a free moving in the field must be penalized in the spirit of existing rules, and strictly apply, what referees did not perform in to day water polo.

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ATRAKTIVNOST IZGUBLJENA U VATERPOLO PRAVILIMA

Sažetak

Ljepota i atraktivnost vaterpolo igre ogleda se u kombinatorici i bogatstvu izvedenih akcija tijekom utakmice. Svaki izvedeni tehnički element u funkciji je individualne taktike bilo u napadu ili obrani i kao takav sastavni je dio kolektivne taktike kako u napadu tako i u obrani. Sama igra regulirana je pravilima koja s jedne strane dozvoljavaju da igrači ispolje usvojena tehničko-taktička znanja vještine i navike i pretoče ih u rezultat, a s druge strane reguliraju igru po sustavu zabrana prema kojima se dosuđuju prekršaji. Pravila dakle daju okvir igri. U posljednjih 50 godina pravila vaterpola doživjela su mnoge izmjene. Osnovna intencija svih promjena pravila bila je da se igra ubrza i učini što atraktivnijom za gledatelje. Na izgled igre, brzinu akcija i sve ono što je čini atraktivnom svakako su utjecale i promjene u pristupu treningu do kojih je došlo razvojem saznanja kako stručnih tako i znanstvenih u području kineziologije športa. Nisu uvijek i nužno promjene pravila igre proizvela pozitivne učinke i vaterpolo napravile bržim i atraktivnijim. U ovom trenutku, a prema pravilima koja se primjenjuju, vaterpolo je postao neatraktivan i neinteresantan gledateljima o čemu svjedoče prazna gledališta za vrijeme odigravanja ligaških natjecanja. Atraktivnost ove sportske igre uništena je onog trenutka kada je promjenom pravila dozvoljena kontakt igra za izbor pozicije, centru i njegovu braniču a pred golom. U realnim uvjetima igre sraz centra i braniča sveo se na neproduktivno, grubo, ponekad i opasno hrvanje u vodi koje u nekim slučajevima može potrajati i do tridesetak sekundi. U ovim okolnostima igre potpuno je eliminirana mogućnost kombinatorike u igri jer je druga linija napada praktički eliminirana iz igre tijekom odvijanja pozicijskog napada. Slijedom navedenog predložili smo moguće izmjene u pravilima koje bi, uvjereni smo, vratile ljepotu, atraktivnost i gledatelje vaterpolu.

Ključne riječi: vaterpolo, pravila, taktika, atraktivnost

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TEACHERS' ATTITUDES TOWARDS REALISATION OF PHYSICAL CULTURE PROGRAM WITH PUPILS WITH DEVELOPMENTAL DIFFICULTIES

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Abstract

Pupils who are excluded from physical culture classes, due to some medical problems are isolated, consequently vulnerable and easy to get hurt, even invalid. Most frequent are cardio, respiratory and locomotor difficulties. It is well known that certain procedures in physical culture program successfully prevent these difficulties. Our study deals with: Insufficient following of physical development of pupils with developmental difficulties in first grades of elementary school. Aims of the study: 1. Exploring attitudes of teachers in first four grades towards classes of physical culture for children with developmental difficulties, 2. Exploring differences of given attitudes between teachers in regular and inclusive program. Specific aims: to explore: a) Do teachers in first four grades divide children into groups regarding types of body damage? b) Are there methodological differences applied with different groups? c) Are there differences in attitudes between teachers in regular and inclusive program? d) Does school organisation enable inclusion of these children in physical culture classes? e) We assume that the answer to the last question is negative, and that our teachers have negative attitude toward inclusion of these children in physical culture classes. Sample: teachers of 4 beginning grades (from 1st to 4th), from five elementary schools. Forty-six teachers work in a regular, and eighteen in inclusion program. Results: are given in tables, graphics and histograms

Key words: developmental difficulties, physical culture, teachers' attitudes

Introduction

The inclusive model of education treats the educational model as a problem. Children with difficulties in development enter the educational system without being "corrected" and adjusted to the system. These children go to school which they would attend if they didn't have difficulties in development, and the program of the work methodology is adjusted to their needs. Teachers are able to respond and to include all the children with different individual needs into the learning process; the environment is less restrictive and better adjusted to the needs of every child. People with difficulties in development for years have been institutionalized and marginalized in the society. With the development of the public conscience about the values of each individual, arises inclusion as a movement within the social model. Inclusion itself doesn't imply the equality of the people, but accepting the difference between every individual and giving them possibility to decide about their own existence and to take responsibility. The definition says that the children with special needs are also children and it brings the attention to the fact that children with difficulties in development have all the same characteristics of the children as human beings and that the difficulties in development can't be and must not be the grounds for discrimination of any kind.

Each individual model is necessary to be adjusted to the social and cultural circumstances, local tradition as well as the entire situation, of the country. Of course, none of the mentioned above can be the excuse for acting in contraire to the best interest of the children.

A child with special needs and the society

The acting of the society toward the children depends on the way the society understands a child, its development and learning. The conception of children living in the society and the manner of their upbringing and socialization depend on the way society understands people in general, their nature, possibilities and roles he has to achieve in the society. According to Kone (1988), the implicit theory of the personality or the normative canon of an adult man determines also the understanding of a child and, according to this, effects the forms of the social conducting and upbringing. According to Trebješanin (1991), "in every society, in every culture there is one, unsaid, implicit but coherent and stabile psychological theory of the children, their nature and development". According to Aries (1989), the understanding of children and childhood and the attitude towards children is not different only in different cultures and societies, but in the different epochs of the same society, too.

One of the attributes of the democratic society is actually the aim for not letting the differences become the factors of social discrimination and isolation of individuals and groups, but to contribute the development of the society (Levkov, 2003). The research on the sample of the regular population, conducted in our country, also affirms that there is a social distance regarding the blind: 74% of the questioned people say they wouldn't get married with a blind person, 41% doesn't want to work under a blind person, 25% think that the blind should live in specialized institutions, and 25% doesn't think that the blind should work, but to receive social help (Stanimirović, 1986). Besides, putting children in special schools often implies early and long separation from their families because of the distance from home to school, which is definitely not good for their development.

This way they were not given the right to live with their parents, and about the right to live in a family says section 9 of the Convention of children's rights (Fontaine, 1993). On the sample of 97 regular elementary schools in Serbia, 8,099 students are with the difficulties in development, and there are only 20 hired defectologists in these schools (Karić, 2004). In our country there are periodical works and research about education of the children with special needs, their inclusion in the regular kindergartens and schools and attitude of the teachers toward the inclusion (Vujačić, 2003; Gašić-Pavišić, 2002; Jablan et al., 2001; Karić, 2004; Kojić, 1999; Radoman, 2003; Sretenov, 2000; Strika, 1999; Hrnjica, 1997). But, the place of the children with special needs in society and local community was rarely studied. There is a very little number of published research and theoretical works about this subject, except the studies of orientation and attitude towards the children with special needs (Stanimirović, 1986). Parents often face emotional difficulties: feeling powerless, pessimism, fear, guilt, shame, doubt, etc. the opinion of Rosemary Shakespeare (according to Hrnjica, 1991) the most common reactions of the parents to the difficulties in development of their child are: depression, need for isolation, shock, frustration, guilt, fear, wish for child to die, loss of self-respect, feeling of defeat, fear for child's future after the parents' death. In extremely patriarchal communities there can be a total rejection of the child.

Excessive protection for the children can be a way to express concern, fear of the child getting hurt, or counter reaction on the unconscious destructive ideas, such as "it would have been better if he/she hadn't been born" (Hrnjica, 1991). Parents often have fears about how their child would fit in the regular kindergartens or school if inclusion starts (Heekin & Mengel, 1997).

The experience with some inclusive programs shows the negative attitude of some parents toward the inclusion of the children with special needs into the regular kindergartens and schools (Heekin & Mengel, 1997). According to Gašić-Pavišić (2002), social competency and successful accomplishment of the social relations are related. The children with higher level of retardation have more problems with interaction with the children of the same age and also less stabile relations (Guralnick, 1986). The differences between students which negatively effect to their complete development are successfully overcome by positive interactions (Krnjajić, 2003). The results of the research (Kobeš-Cak, 1998) show that first impressions about the child with special needs are very important and they are created during the starting interactions. It is known that development takes place through the interaction, not only with other people, but also with physical objects that surround the child (Vigotski, 1983). Negative attitude of the society to the children with special needs creates "secondary consequences of the damage", and the reactions of the children to the difficulty in development are in the range from understanding the difficulty as a tragedy to the ignoring of the real difficulties (Hrnjica, 1997). When they are accepted and loved they strongly emotionally bond (Hrnjica, 1997). The assessment that we are capable of successfully accomplishing any kind of activity is one of the basic conditions to even start that activity. Without starting the activity there is neither activity nor success (Opačić, 1995).

Methods

The problem of our research, therefore, we can define as: *The lack of monitoring the physical development of the students with the difficulties in development of younger children in schools.* Independent variable was: The attitude of the teachers towards the physical education of the children with difficulties in development. Dependent variable: Improving the psychophysical abilities and health of the students with difficulties in development. During the research we used the descriptive method which is frequently used in studying the practice of pedagogy. During the research we used questionnaire for the teachers. It is consisted of two parts. The first part is for the general information about the teacher (level of education, do they work in traditional or inclusive education, are they additionally trained for working with the mentioned children). The second part contains the questions related to the problem of our research. The questions are of closed and open type. Population in this research is the teachers on the territory of Nikšić, of the first four grades of five elementary schools 2006/07.

Table 1: The structure of sample

Place	Name of the school	Teachers
Nikšić	OS "Braća Ribar"	18
Nikšić	OS "Braća Labudović"	12
Nikšić	OS "Jagoš Kontić"	12
Nikšić	OS "Luka Simonović"	12
Nikšić	OŠ "Ivan Vušović"	10
Total	5 schools	64

Results

Table 2. Seminar attending

Answers	Traditional education		Inclusive education		Total	%
Yes	4	8,70%	16	88,90%	20	31,3
No	42	91,30%	2	11,10%	44	68,7
Total	46	100%	18	100%	64	100

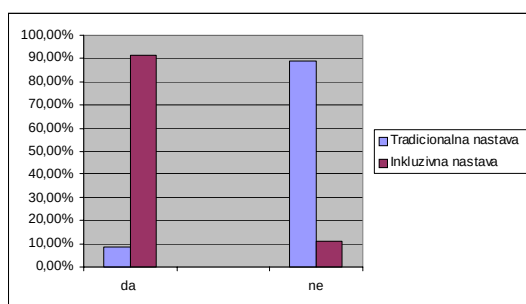


Fig. 1. Seminar attending

From the table table 2. and fig 1. we can clearly see that 91,3% of the teachers of the traditional education didn't attend the seminars for educating for working with children with difficulties in development, while 88,9% of the teachers in inclusive education attended the seminars. It means that only 31,3% of the teachers attended the seminars.

Table 3. Teachers teach children with difficulties

Answers	Traditional education		Inclusive education		Total	%
Yes	15	36,60%	15	83,30%	30	46,9
No	31	67,40%	3	16,70%	34	53,1
Total	46	100%	18	100%	64	100

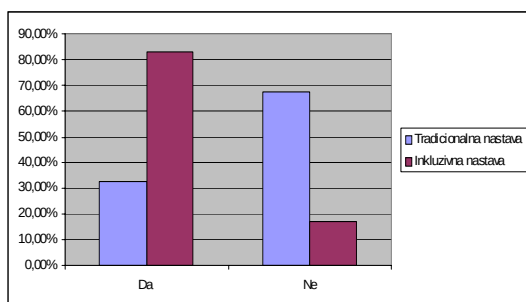


Fig 2. Teachers teach children with difficulties

In the table 3. and fig. 2. we can see that the number of the teachers who answered affirmatively is considerably lower in the traditional education (32,6%) than in inclusive (83,3%). In the answers of the teachers, most frequently were mentioned the hyperactivity, children's neurosis, Down's syndrome, as well as the cardiovascular and respiratory problems in comparison to other difficulties of their students. From the total number of teachers 46,9% said to have children with difficulties in development in their class. The result this high indicates the need for the specific and individual method of work with these children when the physical education is in question.

Table 4. Teacher who monitor the health charts

Answers	Traditional education		Inclusive education		Total	%
Yes	3	6,50%	14	77,80%	17	26,6
Partially	6	13,00%	2	11,10%	8	12,5
No	37	81%	2	11,1%	39	60,9
Total	46	100%	18	100%	64	100

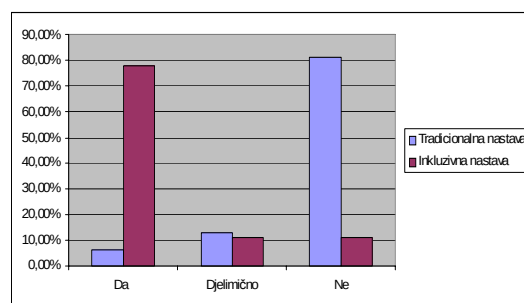


Fig. 3. Teacher who monitor the health charts

From the table 4 and fig. 3 we can see that only 6,6% of teachers monitor the portfolio of the students, 13% partially monitor, while the big percentage (80,5%) say they don't monitor the portfolio. On the other side, in inclusive education 77,8% of teachers monitor the portfolio of the students, 11,1% partially monitor, and the same percentage 11,1% doesn't monitor the portfolio. Totally, 26,6% of teachers monitor the portfolio of the students, 12,5% partially monitor, while 60,9% don't monitor the portfolio.

Table 5. Teachers include children with difficulties

Answers	Traditional education		Inclusive education		Total	%
Yes	10	21,70%	13	77,20%	23	35,9
Partially	4	8,70%	2	11,10%	6	9,4
No	32	69,6%	3	16,7%	35	54,7
Total	46	100%	18	100%	64	100

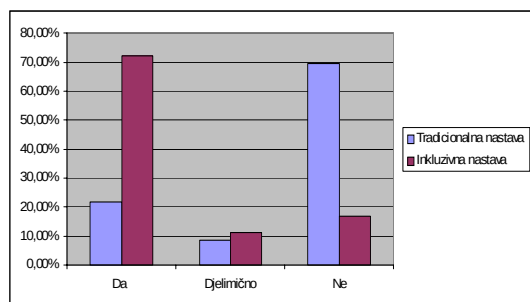


Fig. 4. Teachers include children with difficulties

Table 5 and histogram 4 show that 21,7% of the teachers in traditional education include the children with difficulties in development in the classes of physical education, 8,7% do it partially, and 69,6% don't. In inclusive education, 72,2% of the teachers include the children with difficulties in development in the classes of physical education, 11,1% do it partially, and 16,7% don't. Totally, 35,9% of the teachers include the children with difficulties in development in the classes of physical education, 9,4% do it partially, and 54,7% don't.

Table 6. Making groups

Answers	Traditional education		Inclusive education		Total	%
Always	5	10,90%	9	50,00%	14	21,9
Sometimes	10	21,70%	3	16,70%	13	20,3
Never	31	67,40%	6	33,30%	37	57,8
Total	46	100%	18	100%	64	100

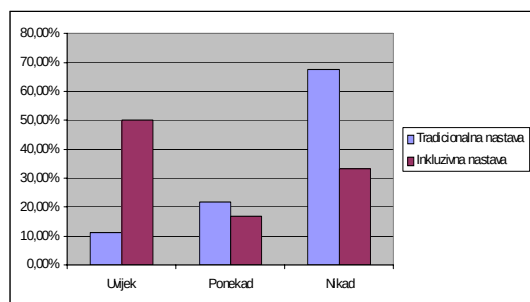


Fig. 5. Making groups

Table 6 and histogram 5 show that 67,4% of the teachers in traditional education never groups children according to the types of disability, 21,7 % does it sometimes, and 10,9% does it always. In inclusive education 50% of the teachers does it always, 16,7 % does it sometimes, and 33,3% never. Totally, 21,9% of the teachers does it always, 20,3 % does it sometimes, and 57,8% never.

Table 7 and histogram 6 show that 6,5% of the teachers in traditional education always prepare the adequate exercises, 15,2 % does it sometimes, and 78,3% never does.

Table 7. Preparing exercises for each group

Answers	Traditional education		Inclusive education		Total	%
Always	3	6,50%	9	50,00%	12	18,7
Sometimes	7	15,20%	4	22,20%	11	17,2
Never	36	78,30%	5	27,80%	41	64,1
Total	46	100%	18	100%	64	100

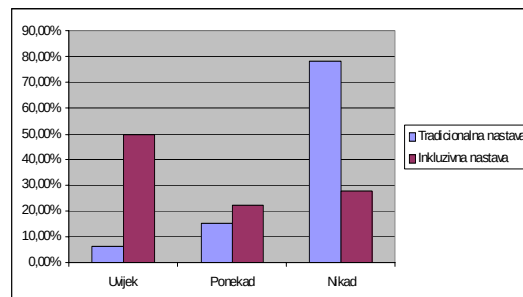


Fig. 6. Preparing exercises for each group

In inclusive education 50% of the teachers does it always, 22,2 % does it sometimes, and 27,8% never adapt the exercise to the type of the difficulty. Totally, 18,7% of the teachers does it always, 17,2 % does it sometimes, and 64,1% never.

Table 8. Monitoring the children

Answers	Traditional education		Inclusive education		Total	%
Always	6	13,00%	3	16,70%	9	14,1
Sometimes	10	21,70%	4	22,20%	14	21,8
Never	30	65%	11	61%	41	64,1
Total	46	100%	18	100%	64	100

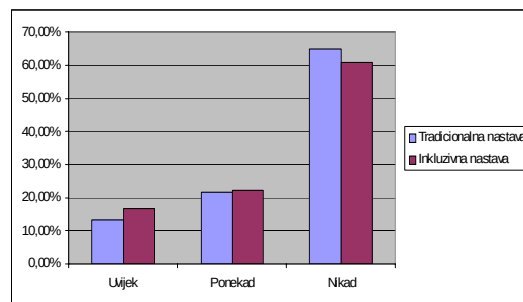


Fig. 7. Monitoring the children

Table 8 and histogram 7 show that 13% of the teachers in traditional education monitor the progress of the children in physical education, 21,7 % does it sometimes, and 65,3% never does. In inclusive education there is a similar situation, 16,7% of the teachers does it always, 22,2 % does it sometimes, and 61,1% monitor the progress. Totally, 14,1% of the teachers does it always, 21,8 % does it sometimes, and 64,1% never.

Table 9. Clear space in the gym

Answers	Traditional education		Inclusive education		Total	%
Yes	3	6,50%	3	16,70%	6	9,4
No	43	93,50%	15	83,3%	58	90,6
Total	46	100%	18	100%	64	100

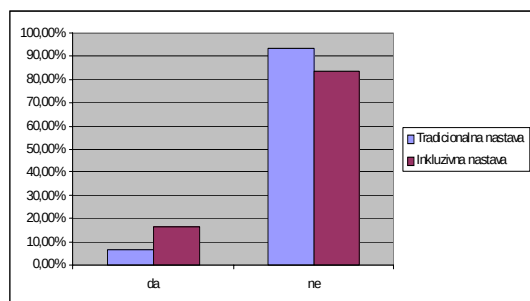


Fig. 8. Clear space in the gym

Table 9 and histogram 8 show that 6,5% of the teachers in traditional education confirmed the existence of the adequate space in the gym, while 93,5% said that such space doesn't exist. In inclusive education 83,3% of the teachers said there was such space, and 16,7% said there wasn't adequate space in the gym. Totally, only 9,4% of the teachers said there was such space in the gym, and 90,6% said there wasn't adequate space.

The results from this research show that the teachers in inclusive education considerably involve the children with difficulties in development into the physical education and adapt the exercises to the abilities of those children and at the same time they don't disturb the work with regular students, in comparison to those in traditional education. The teachers in traditional education (mostly) exclude the children with difficulties in development from the physical education and therefore make it impossible to remove their disabilities. From this research we can also conclude that the teachers are not the only ones to be blamed for this situation. The guilty ones are the problems of low stimulations of teachers, as well as the inadequate space where they conduct the classes of physical education with the children with difficulties in development.

Conclusion

From the research we conducted in five schools in Nikšić where the classes are realized by the traditional and inclusive program, we can conclude that the children with difficulties in development, physical problems, are not in the sufficient measure included in the physical education. In inclusive education the percentage of these children (72,2%) is successfully included in the education.

It is significantly higher than the percentage in the traditional education (21,7%) where these children and their physical progress are almost entirely neglected.

We should notice that even in the inclusive education, where the teachers are somewhat educated for working with these children, the regular classes are not organized in accordance with special program so that these children would be completely included into the work with other students. When we talk about the traditional education, a very small number of teachers (6,5%) monitor the health charts of the children with difficulties in development, while in inclusive education, the cooperation between the teachers and the doctors is much better (77,8% of the teachers monitor the health charts). The children with difficulties in development are neither in traditional nor in inclusive education in the right measure differentiated in the groups in accordance with their disabilities. This result is confirmed by the fact that 90,6% of the teachers denied the existence of the adequate space in the gym for working with the children with difficulties in development. Also, the fact is that the teachers are not motivated (bonuses to the teacher in accordance to the achieved results), so they rarely monitor progress of the children with difficulties in development. It is necessary to provide needed conditions for working with these children, equip the classrooms and gyms with modern technical instruments, as well as motivate the teacher who put in hard work and effort in the interest of these children, not only in physical education, but also in entire educational system. Only then the work with these children will become successful.

We hope that the reforms in Montenegro will make our education better and that they will provide necessary conditions for working with the children with difficulties in development. We only can see in the future how many of the promised will be fulfilled. In the research we conducted in five elementary schools which contain both traditional and inclusive education we concluded that the children with difficulties in development are not in adequate measure included into the physical education, and they should be. The teaching staff is somewhat educated, but that should be in much higher level. Also, the cooperation between teachers and doctors is achieved at insufficient level and it should be improved. The children are not enough differentiated in the groups by the types of their disabilities, and they should be. There should be more teaching instruments and the teaching staff should be more motivated in the interest of the children's progress. All the relevant institutions should be involved in forming the multinational regional team and that would make it possible to fulfill all these needs.

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STAVOVI NASTAVNIKA PREMA REALIZACIJI FIZIČKE KULTURE KOD UČENIKA SA RAZVOJNIM POTEŠKOĆAMA

Sažetak

Učenici koji su oslobođeni nastave fizičke kulture su izolirani pa kasnije i neznatno fizičko opterećenje može izazvati ozljede i teže posljedice, a u najgorem slučaju čak i dovesti do invaliditeta. Najveći broj učenika oslobođenih nastave fizičke kulture ima oštećenja kardiovaskularnog ili respiratornog tipa, a njima po učestalosti slijede poremećaji lokomotornog tipa. Poznato je da su za prevenciju ovakvih oštećenja, između ostalog, bitne i adekvatne mjere fizičke kulture. Problem istraživanja, prema tome, možemo definirati kao: Nedovoljno praćenje fizičkog razvoja učenika sa razvojnim poteškoćama mlađeg školskog uzrasta. Cilj istraživanja je utvrđivanje stavova nastavnika razredne nastave o fizičkoj kulturi djece s razvojnim poteškoćama, kao i utvrđivanje razlika u stavovima nastavnika regularne i inkluzivne nastave. Zadaci istraživanja su: utvrditi dijele li nastavnici razredne nastave djecu u grupe prema tipovima telesnog oštećenja, utvrditi primjenjuju li nastavnici razredne nastave individualizirani oblik rada, postoje li razlike u stavovima nastavnika regularne i inkluzivne nastave i utvrditi je li organizacija života i rada u školi takva da učenicima ovih kategorija omogućava uključivanje u aktivan rad na satima fizičke kulture. Pretpostavlja se da nastavnici razredne nastave imaju negativan stav prema fizičkoj kulturi djece sa razvojnim poteškoćama i da organizacija života i rada u školi ne omogućava učenicima ovih kategorija uključivanje u aktivan rad. Uzorak čine nastavnici prva četiri razreda pet osnovnih škola, točnije 46 nastavnika koji rade u tradicionalnoj nastavi i 18 nastavnika inkluzivne nastave. Podaci dobiveni istraživanjem prikazani su kroz tabele, grafikone i histograme.

Ključne riječi: razvojne poteškoće, fizička kultura, stavovi nastavnika

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EVALUATION OF BOXERS CONATIVE STATUS CONTRIBUTION TO SUCCESS OF SPECIFIC MOTOR STRUCTURES

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Original scientific paper

Abstract

On the sample of 92 boxers of various weight categories, from the Croatian boxing clubs, the system of 14 variables was implemented, out of which 8 were variables of specific motor abilities (the criterion variables) and 6 were conative variables (the predictor variables), with the goal to determine the influence of the system of conative characteristics on individual criterion variables of specific motor variables in top-level boxers. By means of factor analysis (the direct oblimin) two latent variables were isolated. The first is interpreted as the integrated latent variable of specific motor abilities, and the second as the general latent variable of conative characteristics. Between the isolated latent variables there is a significant correlation of 0.57. Regression analyses revealed that the predictor system of conative variables established statistically significant relations with and had the statistically significant influence on all individual criterion variables of specific motor abilities at the level of .00 (p). Out of the individual conative variables only the variable the regulator of organs' functions had statistically significant influence on all criterion variables at the level of .00 (p). Therefore, it could be concluded, on the basis of the obtained results, that the subjects with better scores in every criterion variable also scored better in the regulation of organs' functions, which was formed by the association of subcortical centres for the regulation of organs' functions, predominately located in the region of hypothalamus, and to them superior cortical systems, responsible for the regulation and control. In the criterion variable SSER100, in addition to the variable χ regulator, only the variable the regulator of attack responses (SIGMA) had the statistically significant contribution at the level of .03 (p). It is considered that the regulator of attack responses (σ) is probably located in the limbic system, and similarly as the regulator of defence responses, it modulates tonic excitation, but based on the programme of the destructive reaction.

Key words: influence, conative characteristics, personality traits, specific motorics, boxer

Introduction

Relation determination between specific motor abilities with other segments of anthropological status of athletes of particular sports is still a very actual practical, theoretical and scientific issue due to its importance for the design of as sensible and economic procedures as possible, aimed at the optimal orientation and selection of athletes, at training programming and monitoring, as well as at effective monitoring of the relevant anthropological characteristics development during training process (Malacko & Rađo, 2004).

A lot of various theories exist in psychology about personality development, the basic determinants of activities and relations, and the fundamental structural elements, primarily due to the complexity of the investigated phenomenon (Eysenck's personality theory, Cattell's personality theory, Guilford's personality theory, Momirović's theory of the structure of pathological conative characteristics, and so on). Namely, various authors used different starting points or aspects in personality traits investigations and explanations (Momirović, Wolf, & Džamonja 1992).

The integral model of conative characteristics presumes a definite number of conative regulatory mechanisms which are responsible for human adaptation to variable environmental conditions. According to recent learning theory, which does not oppose the genetic views on personality traits, environmental variations are almost equally powerful in determining the so called normal and pathological modalities of behaviour. Such a notion implies also a hypothesis that approximately same mechanisms are in the foundations of both the normal and pathological conative characteristics (Horga, 1974). The very idea of Eysenck (Eysenck, 1960; Eysenck, H.J. & Eysenck, S.B.G., 1969) instigated numerous researchers (Cattell, 1956; Cattell & Gibbons, 1968; Cattell & Dreger, 1970; Guilford, 1974; Horga, 1974, and others) to start with the investigations of the relations between the normal and pathological personality traits.

However, in later and more complex research studies conative characteristics were explained with the cybernetic model, the one created by Momirović, Wolf & Džamonja (1992).

This model is a kind of a reformulated model proposed by Powell and Royce (1981), then Horga, Ignjatović, Momirović & Gredelj (1982), as well as Momirović, Horga & Bosnar (1982, 1984) and others. The core battery of conative tests (according to Momirović, Wolf, & Džamonja, 1992) was constructed with the help of explorative and confirmative factor analyses from the programme MAIMONID, by Momirović & Karaman (1981). Also, the algorithms were designed which were implemented into the subprogramme for items selection. Selected were the items that had defined the isolated hypothetical factors of most optimal conative functioning in the most valid, representative and reliable way. Application of the mentioned procedures resulted in construction of 6 tests, consisting of 30 items, with the following measurement objects: DELTA – the system for coordination of regulatory functions, ETA – the system for integration of regulatory functions, CHI – the regulator of organs' functions, ALPHA – the regulator of defence responses, SIGMA – the regulator of attack responses, and EPSILON – the regulator of activity. It is a well known fact that certain features from the conative space limit efficiency in various activities directly, whereas in some other they do it indirectly (e.g. due to the contaminating influence they have on other anthropological characteristics). There is even a possibility that in certain activities the same conative features may be restrictors, whereas in some other they facilitate efficiency, especially in the situation when they are an indispensable component of performance (Malacko, 1976). So far no model equation of success in boxing has been established. However, based on certain previous research (where the relationships of boxing performance with morphological characteristics, basic and specific motor abilities, cognitive abilities and conative characteristics were investigated), it is possible to hypothesize that the sport in question is considerably complex. Therefore it is very difficult to presume which anthropological characteristics are more or less important for performance and success in boxing. Therefore, their order is more the result of a subjective assessment than of the actual hierarchy within the specification equation of boxing (Blažević, 2006). In relation to the priory mentioned, we should also point out to the rule that no two subjects exist who would have the identical structure of any, conative also, abilities or characteristics, regardless of their definite number. Therefore, it is very important to recognize the complexity of any activity. Conative characteristics are compounds of that complexity. Such knowledge is a precondition of any activity goal operationalization, boxing as well. The hierarchical structure of performance factors in boxing represents a fundamental precondition of the rational and economical selection and classification of future boxers.

As well as more economical programming and monitoring of training process (Blažević, 2007). The goal of this research was to determine the influence of the system of variables of conative characteristics (being the system of predictor variables) on the individual criterion variables of the specific motor abilities in the top-level boxers in order to eventually design more sensible and more economical procedures for optimal modelling, programming and control of training, as well as for efficient monitoring of the relevant anthropological characteristics during the processes of continuous selection of athletes and sports preparation.

Methods

Participants

With the sample of 92 boxers of various weight categories from the Croatian boxing clubs, a system of 14 variables was applied, out of which 8 variables were measurement instruments of specific motor variables (as the criterion ones), whereas 6 were measures of conative characteristics (as the predictor variables).

Instruments

The following variables were used for the assessment of specific motor abilities: 1. rope skipping in 10 seconds (SSKIP), 2. speed of performing 100 directs (straight punches) against a punching bag (SBR100D), 3. speed of performing combined punches against a punching bag – two directs, two hooks (crochet) and two uppercuts (SBR100K), 4. two-legged hops and performance of left-right directs in 10 seconds (SSUNPOD), 5. two-legged hops and performance of left-right hooks in 10 seconds (SSUNPOK), 6. two-legged hops and performance of left-right uppercuts in 10 seconds (SSUNPOA), 7. defence against the left direct and countering with three directs – defence against the right direct by ducking and countering with three directs against coach's hands (SKONTRA) and 8. a series of 100 combined punches against coach' hands: the left direct, the right direct, the right uppercut, the left-right hook, ducking to the right while defending from the left direct and countering by the right direct (SSER100). Metric characteristics, performance standardization and procedures of the 8 mentioned boxing-specific motor tests were investigated and determined in the paper by Savić (1986). He utilized the diagnostics (factorial) validity, where the first principal component embraced 89.40 % of common variance. The assessment of conative characteristics was performed by means of the following variables: 1. the regulator of activity – EPSILON (ϵ), 2. the regulator of organs' functions – CHI (χ), 3. the regulator of defence responses – ALPHA (α), 4. the regulator of attack responses – SIGMA (σ),

5. the coordination of regulatory functions – DELTA (δ), and 6. the integration of of regulatory functions – ETA (η). Metric characteristics, standardization and procedures for score normalization were determined by Momirović, Wolf & Džamonja (1992).

Procedure

For each utilized variable the following central and dispersive parameters were calculated: arithmetic mean (M), minimum value (min), maximum value (max), standard deviation (S), and standard error of arithmetic mean (Se). Distribution normality of the variables was tested by skewness (Sk) and kurtosis (Ku). The relations between the applied manifest variables for both spaces were established by the matrix of intercorrelation of the manifest variables. Factor analysis with the oblique transformation (the direct oblimin) was utilized to determine the structures of the latent specific motor and conative dimensions, and for the extraction of the number of characteristic roots we applied the criterion of $\lambda \geq 1.00$ (Kaiser). Communalities (χ^2) of the applied variables were also computed in order to obtain their information power. Structures of latent specific motor and conative variables were calculated by means of the matrix of pattern (A-matrix), which contains parallel projections (coordinates) of the variables on the factors, and by means of the matrix of factor intercorrelation (M-matrix). Regression analysis was used to calculate the contribution of the conative variables (the system of predictor variables) on individual criterion variables of the specific motor abilities. The data were processed by means of statistical packages SPSS 10.0 for Windows and STATISTICA 6.0.

Results

In Table 1 the results are presented of central and dispersive statistical parameters of specific motor variables and conative variables as well as their discriminative power.

In analysis of skewness (Sk) the variables are bolded which have normal (symmetrical), meaning that the results range from 0 to 1.00 standard deviation. It is obvious that almost all variables are distributed normally (symmetrically) since their values do not surpass the value of one standard deviation; except for the variable *rope skipping in 10 seconds* (SSKIP) which was not normally distributed. Its asymmetry is declined to the negative direction (-1.11), meaning that certain number of subjects had considerably enlarged values. Goodness of fit of the conative variables was tested. It revealed that the obtained results in the variables CHI – the regulation of organs' functions (1.58) and ALPHA – the regulation of defence responses (1.25) significantly declines from the normal distribution to the zone of higher values (the negative asymmetry). The variables *activity regulation* (EPSILON) and *attack responses regulation* (SIGMA), with the negative signs, displayed the trend towards the better results, whereas the variables *coordination of regulatory functions* (DELTA) and the *integration of regulatory functions* (ETA) towards the poorer results, but they all stay within the range of up to 1.00, meaning that they have normal distribution.

Table 1. Central and dispersive parameters

Variables	M	min	max	S	Se	Sk	Ku
SSKIP	20.70	13	25	2.73	.28	-1.11	.43
SBR100D	185.80	139	269	25.93	2.70	.79	2.00
SBR100K	249.86	160	345	37.65	3.92	.79	1.39
SSUNPOD	18.96	12	24	2.43	.25	-.41	.55
SSUNPOK	17.95	11	23	2.45	.25	-.46	.61
SSUNPOA	17.48	11	24	2.75	.28	.08	-.06
SKONTRA	21.48	14	32	4.79	.49	.76	-.41
SSER100	262.31	180	329	37.38	3.89	-.81	-.13
EPSILON	129.65	105	144	7.38	.76	-.86	.66
CHI	38.94	30	55	4.60	.48	1.58	3.26
ALPHA	38.43	30	51	3.41	.35	1.25	3.45
SIGMA	139.10	122	150	6.22	.64	-.84	.64
DELTA	38.30	30	49	3.24	.33	.96	2.85
ETA	38.18	30	48	3.39	.35	.85	1.40

M = arithmetic mean, min, max = minimum and maximum, S = standard deviation, Se = standard error of arithmetic mean, Sk = skewness, Ku = kurtosis

Table 2. Correlations of the variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1.SSKIP	1.00												
2.SBR100D	-.72	1.00											
3.SBR100K	-.65	.93	1.00										
4.SSUNPOD	.74	-.83	-.78	1.00									
5.SSUNPOK	.75	-.83	-.78	.99	1.00								
6.SSUNPOA	.67	-.85	-.81	.96	.96	1.00							
7.SKONTRA	-.81	.78	.74	-.82	-.82	-.76	1.00						
8.SSER100	-.55	.79	.81	-.83	-.83	-.88	.72	1.00					
9.EPSILON	.65	-.51	-.43	.51	.52	.43	-.54	-.30	1.00				
10.CHI	-.75	.66	.59	-.66	-.67	-.58	.70	.48	-.75	1.00			
11.ALPHA	-.57	.62	.53	-.59	-.59	-.55	.51	.47	-.66	.78	1.00		
12.SIGMA	.59	-.45	-.36	.45	.46	.38	-.43	-.20	.67	-.72	-.59	1.00	
13.DELTA	-.61	.55	.46	-.56	-.56	-.50	.49	.41	-.67	.78	.80	-.63	1.00
14.ETA	-.53	.55	.50	-.54	-.54	-.52	.43	.39	-.66	.73	.80	-.59	.86

In Table 2 the intercorrelations between the individual specific motor and conative variables are presented. High correlations among all the applied variables at the level of .00 (p) are obvious. The factorization of the matrix of intercorrelation variables and the application of Kaiser's criterion ($\lambda \geq 1.00$) resulted in two characteristic roots, which explained 81.48% of common variance (CUM %). Individual contributions to the explanation of the variance amount for the first latent variable 67.24%, and for the second 14.24%.

The structure of latent variables (Table 3) was interpreted by means of the matrix of pattern (A-matrix), which contains parallel projections, that is, the length of vector coordinates in the coordinate system. The first latent variable (Lv-1) can be interpreted as the *integral latent variable of specific motor abilities*, the structure of which is made of the variables of specific speed and coordination (SSKIP, SSUNPOD, SSUNPOK, SSUNPOA) and of speed-strength endurance (SBR100D, SBR100K, SKONTRA, and SSER100) of boxers. Namely, it is defined by all the applied variables with very high projections. The second latent variable (Lv-2) may be interpreted as the *general factor of conative characteristics* because it is defined by all the applied variables with also very high projections. The values of the communalities of individual variables (χ^2) are high and range from .67 to .92, which indicates that the explained parts of the vectors are satisfying, that is, the manifest variables were measured with hardly any error. Out of the matrix of latent variables intercorrelation (M-matrix), which is presented in Table 3, it can be seen that statistically

significant correlation exists between the isolated latent variables at the level of .57.

Table 3. The pattern of latent dimensions and correlations of the variable

Variables	Lv-1	Lv-2	h^2
SSKIP	-.51	-.43	.71
SBR100D	.84	.13	.86
SBR100K	.89	.00	.81
SSUNPOD	-.90	-.08	.92
SSUNPOK	-.90	-.09	.92
SSUNPOA	-.97	.02	.92
SKONTRA	.79	.13	.77
SSER100	1.03	-.20	.86
EPSILON	.01	-.86	.73
CHI	.20	.79	.85
ALPHA	.12	.80	.76
SIGMA	.11	-.88	.67
DELTA	.01	.89	.81
ETA	.01	.86	.76

	Lv-1	Lv-2
Lv-1	1.00	
Lv-2	.57	1.00

In Table 4 the probabilities of regression analyses for the predictors (conative variables) and criteria (specific motor variables) are presented. It is obvious that all analyses are statistically significant at the level of .00 (p), and that the contribution of conative dimensions to the explanation of the criteria was obtained primarily due to the variable CHI (χ) – the regulator of organs' functions. It is also visible that the variable SIGMA (σ) – the regulator of attack responses significantly contributes to the explanation of the criteria SSER100 at the level of .03 (p).

Table 4. The results of regression analysis

Variables	ϵ	χ	α	σ	δ	η	Ro^2	Ro	F	p
SSKIP	.10	.00	.58	.60	.28	.26	.60	.77	21.33	.00
SBR100D	.98	.00	.09	.62	.65	.68	.47	.68	12.74	.00
SBR100K	.40	.00	.22	.09	.30	.27	.47	.69	12.91	.00
SSUNPOD	.87	.00	.26	.57	.97	.84	.45	.67	11.95	.00
SSUNPOK	.92	.00	.27	.60	.98	.86	.46	.68	12.31	.00
SSUNPOA	.63	.01	.21	.54	.73	.40	.37	.61	8.56	.00
SKONTRA	.27	.00	.89	.14	.88	.24	.51	.72	15.34	.00
SSER100	.47	.00	.10	.03	.91	.95	.31	.56	6.48	.00

ϵ , χ , α , σ , δ , η = probabilities of beta coefficients of the criteria, Ro^2 , Ro = multiple determination and multiple correlation, F = a value of F-test, p = a probability of the entire group of regressors

Discussion and conclusion

Boxing pertains to the group of polystructural acyclic sports, in which acyclic, unpredictable movement structures prevail and the final outcome is most frequently a binary variable (victory – defeat). All movement patterns are performed in a direct clash with the opponent where both contestants have the same goals: to avoid the opponent's punches and to symbolically destroy him/her.

Modern boxing is characterized by a high tempo of a bout and by very rich repertoire of technical-tactical activities. Among the specific motor abilities, the following abilities should be underlined: speed, coordination, power (explosive strength), strength endurance of a dynamic type, and speed-strength endurance. Every boxer has a strong drive to fight. However, frequently his/her goal is not only to symbolically destruct his/her opponent, but very often he/she tries to destruct his/her opponent actually.

Therefore, it is indispensable to investigate, among the other relevant anthropological characteristics, the role of conative characteristics. Since the conative characteristics are unquestionably relevant for performance in boxing, it was necessary to determine which ones contributed more, and which contributed less to performance and high level sport achievements. It is well known that the conative characteristics are responsible for human behaviour modalities. As there are normal and pathological behaviour modalities, one should also differ between the normal and the pathological conative characteristics. It is presumed that the pathological conative characteristics have the physiological foundation and that they cause disorders in personality integration, which eventually leads to the imbalance in the processes of stimulation and inhibition. It is also presumed that a disposition has a relative influence on most individual characteristics or group of characteristics. The influence of conative regulatory mechanisms on performance in any sport activity is of various intensities. It depends on both the type of the mechanism and the type of the sport, but also on other predictable and/or unpredictable situations and circumstances, as well as on athletes' abilities, sport skills and level of preparedness. The intensity of conative mechanism that is either smaller or, especially, higher than the desired one diminishes potential sport performance of athletes. This empirical investigation confirmed the presumption that good performance of movement structures (technical elements) of directs, hooks and uppercuts are important in a boxing bout as well as specific motor abilities, like movement speed, hand-leg coordination, power (explosive strength), strength endurance of a dynamic type, and aerobic and anaerobic capacities (speed-strength endurance). Almost equally important for performance in a boxing bout are the conative regulators of: activity, organs' functions, defence responses, attack responses, as well as both the coordination and the integration of the regulatory functions.

The results of the applied regression analysis enabled the expected conclusion: in the statistically significant multivariate relations (R^2 , R_o) the system of predictor variables had statistically significant relations with the system of criterion variables at the level of .00 (p). Out of the individual conative variables, only the variable the *regulator of organs' functions* (CHI) displayed the significant influence on all criterion variables at the levels of .00 and .01 (p).

On the basis of the obtained results it can be stated that the subjects who scored better in each and every criterion variable had larger scores in the regulation of organs' functions, presumably formed by the union of subcortical centres for the regulation of organ functions, predominantly located in hypothalamic region, and to them superior cortical systems for the regulation and control. Disorders of this regulator cause functional disorders of the basic organ systems (cardiovascular, respiratory, gastrointestinal, and uropoetic system), functional disorders of the basic systems for input and output operations, that is, of sensor and motor systems, then disorders of the system for the control, especially those for the inhibition of elementary biotic processes. They also facilitate occurrence of hypochondriac responses system to the fundamental organ functions. In the criterion variable the *series of 100 combined punches against coach's hands*: left direct, right uppercut, left-right hook, ducking to the right to avoid the left direct and countering by the right direct punch (SSER100), statistically significant influence was obtained, besides the variable CHI (X) – the regulator of organs' functions, also for the variable SIGMA (σ) – the regulator of attack responses at the level of .03 (p). This regulator is supposed to be probably located in the limbic system, and similar as the centre for defence responses regulation, it modulates tonic excitation, but on the basis of programmes for destructive responses. Disorders of the system for the regulation and control of attack are manifested as various aggressive reactions and as poor control of direct impulses.

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EVALUACIJA DOPRINOSA KONATIVNOG STATUSA BOKSAČA USPJEŠNOSTI IZVOĐENJA SPECIFIČNIH MOTORIČKIH STRUKTURA

Sažetak

Na uzorku od 92 boksača hrvatskih boksačkih klubova, različitih kategorija, primjenjen je sustav 14 varijabli od čega 8 specifičnih motoričkih (kriteriji) i 6 konativnih (prediktori), s ciljem utvrđivanja utjecaja konativnih značajki na pojedinačne specifične varijable boksača visoke kategorije. Faktorskom analizom (direktni oblik) izolirane su dvije latentne varijable, prva interpretirana kao integrirana latentna dimenzija specifične motorike i druga kao opća dimenzija konativnih značajki. Među njima je zabilježena značajna korelacija od 0.57. Regresijska analiza je otkrila da je prediktorski sustav formirao statistički značajne relacije s pojedinačnim kriterijskim varijablama na razini $p < 0.05$. Od pojedinih konativnih prediktora jedino varijabla za procjenu regulacije organskih funkcija ima statistički značajnu prognostičku vrijednost ($p < 0.01$). Može se zaključiti, na temelju dobivenih rezultata, da subjekti s boljim skorom u kriterijskim varijablama također pokazuju bolji rezultat u regulaciji organskih funkcija, što se uspostavlja asocijacijama subkortikalnih centara za regulaciju organskih funkcija, predominantno lociranih u regiji hipotalamusa, kao i njima nadređenom kortikalnom sustavu, odgovornom za regulaciju i kontrolu. Kod varijable SSER100, kao nadopuna regulatoru organskih funkcija, jedino varijabla za procjenu reakcija napada (SIGMA) ima statistički značajan doprinos objašnjenju kriterija na razini $p \leq 0.03$. Pretpostavljeno je da je regulator reakcija napada (σ) lociran u limbičkom sustavu, te kao i regulator reakcija obrane, modulira regulaciju tonusa i ekscitaciju, ali temeljeno na programu destruktivnih reakcija.

Ključne riječi: utjecaj, konativne značajke, osobne značajke, specifična motorika, boksač

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RELATIONS BETWEEN MORPHOLOGICAL CHARACTERISTICS AND POSTURAL STATUS OF ELEMENTARY SCHOOL STUDENTS

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Abstract

The aim of this study was to investigate the influence of anthropometric characteristics of the postural status of the older pupils of school age. To assess posture status, selected variables were kifosis and lordosis. For the assessment of anthropometric characteristics, taken the following variables: height, sitting height, weight, volume, chest, shoulder width, the width of the pelvis, abdominal skin folds, and skin folds back. Sample included 434 students. To assess kifotic and lordotic bad carriage, used method somatoscopy and somatometry for the determination of poor posture, used on average mild criteria. All respondents who had more value than 35 mm. (Neck), and 45 mm. (lumbar), recorded as subjects with kifotic or lordotic bad posture. Adequate statistical procedures, the results obtained by students indicate that between anthropometric characteristics and kifosis there, and between anthropometric characteristics and lordosis there is a statistically significant correlation. Body weight and length of the trunk significantly affect the appearance lordotic bad posture. Anthropometric characteristics had statistically significant influence on the occurrence and kifosis and lordosis.

Key words: morphological characteristics, postural status, lordosis, kifosis, older school age

Introduction

Modern life, in addition to its advantages and disadvantages, reducing physical activity due to the sudden increase in computerization in all spheres of life leads to negative impacts on the psychosomatic status of the organism. Postural disorders, fixed deformity, growing hypokinesia, accompanying the appearance of urban living. Correct postural position of the less takes place in children's everyday activities. Improper sitting, standing, inadequate bed and sleeping bag, various forms movement activities as well as the endogenous factors, systematic work on the spinal column which causes stress, which often exceed the tolerance zone of soft tissues of the spine, making no major damage, but the cumulative effects by repeating and long positions and movements of tissues experiencing some strain in their morphology and function. Comes to weakening of muscles that leads to muscle imbalance, which is the main cause for the emergence and development of poor body posture and physical deformities. A large number of poor posture and kifotic type lordotic about weaknesses deep dorsal and abdominal muscles. Kifotic poor posture classlessness the students and the student is classlessness lordosis A large number of registered poor whinny kifotic type of intensive talks on the process of growth and development of the skeleton, loss of endurance of the back muscles, lack of bodily hygiene, unmovement physical activity and preventive-corrective exercise model (Dejanović & Fratrić, 2007; Bogdanović, 2008).

Methods

Subject of the anthropometric characteristics and postural status of pupils of the fifth grade of elementary school, defined kifosis and lordosis. The goal of this study was to investigate the influence of anthropometric characteristics of the postural status of the older pupils of school age. Sample for the research included 434 respondents, divided into sub-sample of 221 students and a sub-sample of 213 pupils. To assess postural status, are applied two variables, namely kifosis and lordosis. These two variables, were selected because they cover all disorders of the spinal cord in the sagittal plane. In addition, this type of disorder is a frequent occurrence in the studied populations. To assess anthropometric characteristics we applied the following variables: Height (AVIS), sitting height (AVISS), weight (ATEŽ), the volume of the thorax (AOGK), shoulder width (ASIR), pelvic width (ASIK), abdominal skin folds (AKNT) and skin folds back (AKNL). To reach valid results in the paper, checked the instruments used to measure selected parameters, and techniques that were applied, had proven the validity of previous studies of this type (Dejanović & Fratrić, 2007; Bogdanović, 2008). Kifosis a reinforcement of physiological spinal curvature in the sagittal (Antero-posterior) plane in torakal part of the spinal column, which convexity facing backwards. Basic features are: head bent forward in front-line vertical, shoulder moved forward, slouch and fortified area Backstroke, breast shaped, prominent shoulder blades and

separated from the spine, bulging belly and flabby, knees very bent and moved the whole front and feet often insufficient. If the criterion for taking etio-pathogenesis, then kifosis can be divided into two groups as follows: congenital and acquired. Lordosis increase of physiological spinal curvature in the sagittal (anterio-posterior) plane, whose convexity facing forward. In relation to the etiopathogenesis lordosis be: congenitally and acquired. Clinical picture lordotic poor posture is the following: the head is something laid back from the vertical line, chest plane or convex, physiological lordotic lumbar curve in the fortified, pelvis as a whole moved forward and down, flabby and protruding belly, hips moved slightly forward, extreme of knee extension (hiper-extensy) and feet are usually insufficient. To assess kifotic and lordotic bad carriage used method somatoscopy and somatometry. In setting a bad posture, we use on average mild criteria. All respondents who had more value than 35 mm (Neck), and 45 mm (lumbar), recorded as subjects with kifotic or lordotic bad posture. For measurement of anthropometric parameters, was used in the international biological program (IBP). The instruments were calibrated and standard development before measuring. To measure longitudinal dimensionality, was used antropometar by Martin, to measure the volume of the body is used centimetres metal bar, length 150cm, interpolation, which allows measurement accuracy of 0.1 cm., Measuring body weight, used the decimal scale with an accuracy of 0.1 kg, measuring skin folds, was used calliper (John Bull) with an accuracy of 0.2 mm and measuring the width and shoulder width of the pelvis, was used pelvimetar with scale range of 60 cm. In addition to descriptive statistics obtained in the processing of data applied regression analysis. The interpretation of the analysis begins regression multivariate comparison, if the applied system of significant predictor variables in predicting criterion variables, or whether the correlation coefficient (RO) a statistically significant level of 0.00-0.05 or not, and what percentage of common variance can predict the criterion variable. If yes, then approach the analysis of statistical significance univariant beta coefficient (in this study, t-test) each Predictor variable, also at the level of $p = 0.05$ ($p < 0.05$), which contributes to the overall statistical significance of the whole system of predictor variables. However, if the multiple correlations were not statistically significant, the interpretation of such results will not be done.

Results

Results in Table 1 and table 2 show that the anthropometric characteristics of pupils are in a relatively possible and expected limits for a given age.

The largest deviation from the mean, the pupils, which indicates the standard deviation of the weight, with a value of 6.91 for students and 7.91 for girls. It can be noticed that there are no major differences in the values of the variables studied between pupils, except in skin folds belly and back that with higher values in girls. The biggest difference of minimum and maximum values of pupils at the body height and weight and skin folds.

Table 1. Descriptive parameters anthropometrics characteristics of male pupils

Vars.	M	Min	Max	SD	Skew.	Kurt.
AVIS	146.74	126.0	169.0	6.58	.28	.59
AVISS	75.60	65.5	87.4	3.32	.01	.41
ATEŽ	38.14	28.0	64.0	6.91	1.33	2.43
AOGK	70.83	59.0	91.5	5.55	1.09	1.86
AŠIR	30.19	26.0	34.0	1.58	-.19	-.07
AŠIK	21.34	17.0	27.0	1.44	.08	.68
AKNT	9.86	2.8	35.2	6.52	1.76	2.64
AKNL	8.12	3.6	31.8	4.57	2.56	7.45
KIF	4.01	1.0	7.5	1.03	.33	.33
LOR	3.97	1.5	6.8	.97	.24	-.25

Kurtosis is for all studied variables, except the skin folds of students, less than three, which indicates the homogeneity of the obtained results and leptokurtic curve. All results are normally distributed, since the values skewness in the interval from - 1 to +1, except the value of skin folds with pupils.

Table 2. Descriptive parameters anthropometrics characteristics of female pupils

Vars.	M	Min	Max	SD	Skew	Kurt
AVIS	147.05	124.00	166.80	7.59	.07	.06
AVISS	76.12	64.00	86.80	3.76	.00	.19
ATEŽ	38.38	21.50	63.00	7.91	.61	.24
AOGK	71.42	58.00	90.40	6.39	.52	-.09
AŠIR	30.02	25.00	35.00	1.82	-.27	-.16
AŠIK	21.15	17.00	27.00	1.60	.17	.28
AKNT	13.56	3.80	35.40	7.11	.82	-.16
AKNL	10.80	4.20	33.20	5.88	1.55	2.01
KIF	3.18	1.00	6.50	1.05	.34	.03
LOR	4.39	2.20	7.50	1.01	.48	.42

Characteristic of this age is to increase the body height and equally increase of height and sitting height. Increment of body weight may be more than five pounds a year. Transversal characteristics of this age have a tendency to increase. Shoulder width and breadth of the hips in this age period have permanent development with a tendency to very slow growth to about 1.5 cm per year (Dejanović & Fratrić, 2007). In the fifth grade there is an increase volume characteristic which progress takes up thirteen years. For students, too, is characteristic longitudinal dimension of growth. Height follows the smooth increase in the leg and sitting height.

Transversal characteristics tend to increase the thirteenth year, when they come to their stabilization. The width of the hips and shoulders are progressively developed from the eleventh to the thirteenth year, to be followed by the growth slowed down significantly. Voluminosity evenly developed in the fourteenth year experience stabilization (Dejanović & Fratrić, 2007). Increment of body weight may be more than six pounds a year.

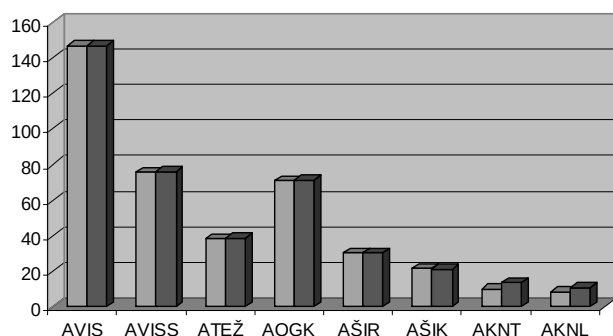


Fig. 1. Descriptive indicators (male / female)

Diagrams columns show that among students and pupils of the fifth grade, the differences in anthropometric characteristics were insignificant, except in skin folds back and belly, whose values were higher in girls. Insight to the table 3rd general conclusion is that the size of multiple correlation ($R=0.088$) shows that this is leaving you with meaningless influence of anthropometric predictor variables on the criterion variable (KIF). The coefficient of determination ($R^2=0.00$) shows that the whole system of applied variables, does not affect the criterion variable (LOR).

Table 3. Relationships predictors system and the criterion variables KIF male students

Vars	R	PART	BETA	t	p-level
AVIS	-.01	-.03	-.08	-.49	.63
AVISS	.01	.03	.07	.44	.66
ATEŽ	.00	.00	.01	.07	.95
AOGK	.01	.05	.13	.74	.46
AŠIR	-.03	-.06	-.09	-.79	.43
AŠIK	.00	.01	.02	.16	.88
AKNT	-.01	.00	.00	-.01	.99
AKNL	-.02	-.04	-.09	-.52	.61

$R_o=.088$ $R_o^2=.007$ $F=.202$ $p=.990$

The value of the level of statistical significance of $p=0.99$ indicates the absence of statistically significant influence of predictor variables on criterion (LOR). Neither variable has any statistically significant influence on the occurrence kifosis students. Based on the results in Table 4 can be concluded that the size of multiple correlation ($R=0.33$) shows that it is a mild influence of anthropometric predictor variables on the criterion variable (LOR).

Table 4. Relationships predictors system and the criterion variable LOR male students

Vars	R	PART	BETA	t	p-level
AVIS	.27	-.01	-.03	-.18	.86
AVISS	.31	.12	.24	.67	.10
ATEŽ	.29	.12	.34	.75	.08
AOGK	.21	-.07	-.16	-.97	.33
AŠIR	.18	-.04	-.06	-.52	.60
AŠIK	.17	-.03	-.04	-.38	.70
AKNT	.19	.00	.00	-.02	.98
AKNL	.17	.00	.01	.04	.97

$R=.338$ $R^2=.114$ $F=3.293$ $p=.001$

Based on analysis of individual contribution (impact) of predictor variables on the criterion variable (LOR), it can be noted that the greatest contribution we can attribute variables that define the body mass ($ATEŽ=0.29$), and variables that define the longitudinal skeleton dimensionality ($AVISS = 0.31$). The coefficient of determination ($R^2=0.11$) shows that the whole system of applied variables, only 11% affect the criterion variable (LOR). The remaining 89% percent of the variability are influenced by other factors unexplainable Value F-test indicates statistically significant impact the entire system of predictor variables on the criterion. The statistical significance level of $p=0.00$, and despite the small value of the coefficient of determination, indicates that the statistically significant influence on the predictor variable. Neither variable has any statistically significant influence on the occurrence lordosis students.

Table 5. Relationships predictors system and the criterion variable of female KIF

Vars	R	PART	BETA	t	p-level
AVIS	.10	.07	.15	.04	.30
AVISS	.07	-.07	-.12	-.97	.33
ATEŽ	.12	.08	.27	.17	.24
AOGK	.10	.07	.21	.04	.30
AŠIR	.01	-.11	-.17	-.59	.11
AŠIK	.03	-.07	-.10	-.94	.35
AKNT	.04	.00	.00	-.03	.98
AKNL	.00	-.13	-.26	-.91	.06

$R_o=.233$ $R_o^2=.054$ $F=1.437$ $p=.182$

Inspection parameters in Table 5 can be concluded that the size of multiple correlation ($R=0.23$) shows that a very small influence of anthropometric predictor variables on the criterion variable (LOR). The coefficient of determination ($R^2=0.05$) shows that the whole system of applied variables, does not affect the criterion variable (LOR). Values of F-test and the level of statistical significance of $p=0.18$ indicating that the investigated anthropometric characteristics have no statistically significant influence on the occurrence kifosis the student.

Table 6. Relationships predictors system and the criterion variable of female LOR

Vars	R	PART	BETA	t	p-level
AVIS	.09	.01	.01	.09	.93
AVISS	.12	.08	.15	.19	.24
ATEŽ	.13	.10	.33	.47	.14
AOGK	.06	-.13	-.38	-.85	.07
AŠIR	.02	-.03	-.05	-.43	.67
AŠIK	.01	-.08	-.11	-1.07	.29
AKNT	.13	.09	.18	1.26	.21
AKNL	.09	.02	0.03	.21	.83

Ro=.249 Ro²=.062 F=1.652 p=.112

Based on the obtained indicators in Table 6 can be concluded that the system of anthropometric characteristics, prediction system, there is no statistically significant impact on the criterion variable (LOR). This statement supporting the value of the level of statistical significance level of $p=0.11$, the size of multiple correlation ($R=0.24$), and the value of the coefficient of determination ($R^2=0.06$) and F-test ($F=1.65$).

Discussion and conclusion

Based on the results can be concluded that anthropometric characteristics had statistically significant influence on the occurrence kifosis students, while significantly influenced the occurrence lordosis students. Lordotic poor posture is present, students with higher body mass and longer hull. For pupils obtained results indicate that the anthropometric characteristics, as predictor system had no statistically significant influence on the occurrence and kifosis lordosis. Based on the results recommendations for the practice would be: At the beginning of the

school year, students undergo the initial measurement and anthropometry posture analysis, and using personal cardboard track changes (Bogdanović & Marković, 2008). Based on the obtained indicators to determine the groups that have largest percentage growth and postural deviations on the basis of the indicators form a group with the risk of postural disorders (Bogdanović & Milenković, 2008). All body-movement exercises that are harmful to eliminate or modify during the process of growth (Bogdanović & Hadžić, 2008). Programs balancing muscle tone agonist and antagonists to work every day (Dejanović & Fratrić, 2007). In parallel with implementation of corrective work done-pedagogical monitoring and control of growth and assessment postural status. Besides internal factors, a large number of externalities that affect the appearance of bad kifotic and lordotic keeping the pupils. Some of them are school furniture and the way sitting in the bench (Bogdanović & Marković, 2008), expertise and role of teachers in the implementation of program content in physical education (Bogdanović & Marković, 2008b), unadjusted furnishings and time spent next to the TV (Bogdanović & Milenković, 2007), the role of parents and their ability to identify deformities (Bogdanović, 2006), school bag, which by their effects have a major impact on the appearance of deformity in this age (Bogdanović, 2005) and many other factors. All the above indicates that a program of physical education to implement the latest scientific knowledge about the deformities and their prevention, permanent train teaching staff for the recognition and prevention of deformities, and for all to ensure adequate material-spatial conditions.

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RELACIJE IZMEĐU MORFOLOŠKIH KARAKTERISTIKA I POSTURALNOG STATUSA UČENIKA OSNOVNE ŠKOLE

Sažetak

Cilj rada je da se istraži utjecaj morfoloških karakteristika na posturalni status učenika starijeg školskog uzrasta. Za procjenu posturalnog statusa, odabrane su varijable kifoza i lordoza. Za procjenu morfoloških karakteristika, uzete su slijedeće varijable: tjelesna visina, sjedeća visina, tjelesna masa, obujam grudnog koša, širina ramena, širina karlice, kožni nabor trbuha, i kožni nabor leđa. Uzorak ispitanika obuhvatio je 434 učenika. Za procjenu kifotičnog i lordotičnog lošeg držanja tijela, korištena je metoda somatoskopije i somatometrije. Za utvrđivanje lošeg držanja, korištena je srednja vrijednost blažeg kriterijuma. Svi ispitanici koji su imali veću vrijednost od 35 mm. (vratna), a 45 mm. (slabinska), evidentirani su kao ispitanici sa kifotičnim odnosno lordotičnim lošim držanjem tijela. Primjenom adekvatnih statističkih procedura, dobiveni rezultati kod učenika upućuju da između morfoloških karakteristika i kifoze ne postoji, a između morfoloških karakteristika i lordoze postoji statistički značajna povezanost. Tjelesna masa i dužina trupa statistički značajno utječu na pojavu lordotično lošeg držanja. Kod učenika, morfološke karakteristike nisu imale statistički značajnog utjecaja na pojavu kifoze i lordoze.

Ključne riječi: morfološke karakteristike, posturalni status, lordoza, kifoza, stariji školski uzrast

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RELATION OF PERCEPTIVE ABILITIES AND SPECIFIC MOTOR ABILITIES OF SITTING-VOLLEYBALL PLAYERS

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Original scientific paper

Abstract

We conducted research in order to assess the relation and intensity of the correlation between perceptive abilities and the specific motor abilities of sitting-volleyball players. Our sample consisted of 68 subjects that are the best registered sitting-volleyball players in Bosnia and Herzegovina. This study describes this sample using one variable for the estimation of perceptive abilities and eight variables for the estimation of specific motor abilities. The methods used for gathering data were a Cybernetic battery of tests, KOG-3, and objective tests for estimating the specific motor abilities of the sitting-volleyball players. The correlation between the variable of efficiency of perceptive processing and the set of variables pertaining to motor abilities has been estimated by means of using Standard Multiple Regression Analysis. The results of the research suggest that there does not exist a correlation between the perceptive and specific motor abilities of sitting-volleyball players.

Key words: perception, specific motor abilities, sitting volleyball, regression analysis

Introduction

The ability of an athlete to momentarily perceive any changes in their environment very often has crucial effects on the final outcome of a competition; the impact of this ability has effects regardless of the difference between team and individual sports. The possibilities in the variation of different combinations of movement and the change in the sequence of these combinations during a game are almost endless; and to further complicate these changes, the speed of change has often been measured in milliseconds. It is therefore of exceptional importance during a game to perform a movement of any kind accurately and to perform that movement in at the correct moment.

These movements then, depend upon an athlete's ability to accurately receive the proper information and afterwards accurately interpret it (perception). Thus, the role of perception is indisputable during the performance of motor tasks, especially at the stages of motor learning. It is well-known that elite athletes have a remarkable control over their movements. However, if we take into account the speed of change that occurs on the field of play during a game, which is an integral component of any competition, the logical question that follows is: how much is that control a function of a perceptive process? Although the role of perception in sport has been subject to scientific investigation during the past few decades their attitude towards the role of perception is not unified.

To quickly summarize these divergent attitudes, some assume that motor performance, especially in sports that involve fast movements of the ball, is a function of the quality of the visual system of an athlete; opposing this view is a group of scientists that assume that perceptive abilities are a measure of a higher function of knowledge that is acquired thru experience rather than simply a function of the visual system of an athlete (Abernethy, 1987; Starkes & Deakin, 1984). From the perspective of later group of scientists then, it can be stated that an elite athlete sees what s/he knows. In this sense the processing of perceptual information is more efficient, more selective, and faster for an athlete that is more skilful. Therefore, considering that sitting-volleyball is a sport in which the game consists of a very dynamic character, which is to say it consists of short actions that are performed as fast and efficient movements, we can assume that the motor performance and the perceptive ability of these sitting-volleyball players will have a very close relation.

Aim: To explore the relation and the intensity of correlation between the perceptive ability and the specific motor ability of sitting-volleyball players. **Problem:** To determine the correlation between the perceptive ability and the specific motor abilities of sitting-volleyball players. **Hypothesis:** There is a close correlation between the perceptive ability and the specific motor abilities of sitting-volleyball players.

Methods

Participants

The research consisted of 68 participants, all of whom were sitting-volleyball players from Bosnia and Herzegovina. The sample enfold all of the best registered sitting-volleyball players from Bosnia and Herzegovina and among them were the members of the national sitting-volleyball team. We can consider these athletes to be elite athletes because the national team of Bosnia and Herzegovina is the current World Champion of sitting-volleyball, six-time champion of Europe, and winner of the Paralympics games held in Athens, Greece in 2004.

Variables

The sample is described by nine variables. A variable for the estimation of the efficiency of perceptive processing (GVT1), which belongs to the cognitive area of the research, and it is measured by a cybernetic battery of tests of intelligence KOG-3 (Wolf, Momirović & Džamonja, 1992). The other eight variables pertain to the situational-motor abilities area of the research. These eight variables are: The ability of consecutively suppressing the ball with the fingers (SMUP), the ability of consecutively suppressing the ball by passing or bumping the ball (SMUO), the precision in suppressing the ball with the fingers (SMPP), the elevated precision of suppressing the ball with the fingers (SMLP), the elevated precision of suppressing the ball by

passing or bumping the ball (SMOL), the ability of alternately suppressing the ball by passing or bumping the ball (SMLD), the precision of a tactical serve of the ball (SMPT), and lastly, the efficiency in spiking the ball (SMLZ). All of these variables are measured using objectified tests designed for estimating the situational-motor abilities of sitting-volleyball players.

Results

Table 1 indicates the values of the basic parameters of descriptive statistics, the values of Skewness, Kurtosis, and the Kolmogorov-Smirnov test. The values of the Kolmogorov-Smirnov test indicate that only two variables in the distribution of results have a statistically relevant variation from a normal distribution.

These two variables are the ability of consecutively suppressing the ball with the fingers and the ability of consecutively suppressing the ball by passing or bumping the ball. Aside from these two variables, since the greatest difference between the relative and the theoretical cumulative frequency of all of the other variables (D max) is lower than the constant (K-S test) 0.20 the other variables are normally distributed. However, since the variation of those two variables is not very large we have decided to use these obtained results within our analysis.

Table 1. Descriptive Statistics of Basic Parameters

	N	Min	Max	Dx	M	SD	Skew	Kurt	Dmax	KS-z
GVT1	68	-2.14	350.65	0.17	0.54	0.73	-0.78	187.19	0.07	0.20
SMUO	68	11.00	115.00	307.73	26.75	20.38	237.74	265.43	0.22	0.20
SMPP	68	10.00	300.00	13.81	67.60	58.12	399.35	286.72	0.08	0.20
SMLP	68	6.00	40.00	197.25	32.01	176.85	-1.64	198.76	0.10	0.20
SMOL	68	3.00	35.00	146.11	399.86	326.29	-0.39	431.91	0.04	0.20
SMLD	68	2.00	26.00	400.57	447.43	216.41	295.87	319.29	0.10	0.20
SMPT	68	1.00	10.00	0.43	278.51	299.52	0.57	154.01	0.04	0.20
SMLZ	68	10.00	40.00	463.88	30.40	132.71	-1.45	143.97	0.09	0.20

Table 2. Standard Multiple Regression Analysis for Criteria Variable Efficiency of Perceptive Processor

	R	Q(R)	P-R	B	P	S-B	Q(B)	F(B)
SMUP	-0.07	0.57	-0.23	-0.78	5.517	0.43	0.07	-0.15
SMUO	-0.12	0.92	0.26	0.79	-0.99	0.39	0.04	-0.03
SMPP	-0.18	0.13	-0.18	-0.30	5.38	0.21	0.16	-0.39
SMLP	0.12	0.67	0.31	0.47	5.68	0.18	0.01	0.26
SMOL	-0.00	0.98	-0.15	-0.27	0.09	0.23	0.24	-0.01
SMLD	0.12	0.32	0.16	0.21	2.58	0.16	0.20	0.27
SMPT	0.03	0.98	0.11	0.12	0.04	0.15	0.59	0.01
SMLZ	-0.15	0.22	-0.15	-0.19	2.84	0.16	0.24	-0.33
	DLT	S-DLT	RO	F	DF1	DF2	P	
	0.21	0.89	0.46	1.98	8	59	0.06	

A regression analysis of the results of Table 2 indicate that a statistically significant correlation between the system of predictor variables (motor variables) and the criteria variable of efficiency of the perceptive processor does not exist ($p=0.06$). This result has been confirmed by low values of the multiple correlation coefficient $RO=0.46$ and the coefficient of determination $DLT=0.21$. Individually, there is a statistically significant impact on the criteria variable by two variables; the two variables are the measuring of the ability of consecutively suppressing the ball by passing or bumping the ball ($p=.04$) and the elevated precision of suppressing ball with the fingers ($p=.01$). However, since the whole system of predictor variables does not have a statistically significant effect on the criteria variable then the effect of these two predictor variables occurred by chance.

Discussion and Conclusion

Even though the results of the regression analysis have shown that there does not exist a significant correlation between motor variables and perceptive abilities, we cannot draw the conclusion that the role of perception during the motor performance of sitting-volleyball is irrelevant. We cannot draw this conclusion especially if we recall that, the combination of motor demands, time restriction, and interaction with moving objects (e.g. a volleyball) generates the need for expertise in the perceptual-cognitive and perceptual-motor skills of sport athletes (Starkes, Cullen, McMahon, 2004). Thus, it is necessary to point out that because there is a level of significance of .06 a tendency towards statistical significance is present; nonetheless, we cannot attribute statistical significance to this correlation based upon the assigned level of significance of ($p<.05$). The above tendency is reinforced if we consider that we are already acquainted with the fact that one of the major tasks of sitting-volleyball players is to perceive and interpret visual information during the process of catching the ball, such as when light reflects off the surface of the ball during this process. While performing this basic task during a game an athlete needs to have precise information of how to locate the ball in space at a given moment. And all of this information is received by an athlete thru a sensor register (Šoške, 2009). This information in space and time pertaining to the object, ball, which is approaching has to be accepted very quickly so the adequate components of the skeletal-muscular system can be activated and coordinated in time (e.g. the muscles of the body, the hand, and the shoulders joints). Also, the visual-perceptive system of sitting-volleyball players demands balance and control of the body position necessary for organizing the body's reaction to a given stimulus.

In this manner, the visual perception of a skillfull athlete contributes to recognizing the proper reaction of the body to particular situations in order for that reaction to become a technical model for further situations that call for such a reaction. Hence, it is obvious that athletes rely a great deal on visual perception during the performance of motor tasks. The question remains though, how can we explain the absence of a significant correlation in the sample of sitting-volleyball players? We can begin to approach this question if we recognize that cognitive psychologists claim that when planning a motor response elite athletes use inner representations of knowledge to:

- Respond to relevant sources of enviromental information and ignore less relevant information
- Search the visual field in a systematic and efficient manner
- Anticipate incidences in sports that are characterisitic of being time restricted before those incidences occur
- Confirm impoverished information that their perceptive system receives from its environment (Williams, Davids & Williams, 2000).

Also, the main premise of cognitive science, regarding perception, is that diverse sensory stimuli are compared with information that resides in memory for an easier planning of a response. That is to say, when information is well retained an athlete relies less on perception and automatically plans and performs their reaction. This is the case because the central nervous system has very limited capacity when it comes to processing information. Therefore, in performing sport actions the task of perception is used by an athlete insofar as an athlete needs to focus their attention on the relevant information to perform such actions. When sensor stimuli are at the same or an athlete is in a similar situation, information transfers from long-term to short-term memory.

It is in this way that short-term memory becomes „warned“ to the information that is relevant, and information that is not relevant. Thus, when a response becomes automatic the reaction time is shorter because it takes less time to process information and efferent organisation occupies less space in an athlete's information channels. More recent research has shown that top level athletes develop strategies that govern their attention that is specific to their sport, i.e. attention governing strategies. In such a manner EEG studies have indicated that top level archers show cortical lateral asymmetry while performing the action of shooting at a target, which suggests that they use different attention governing strategies from those archers that are beginners.

Egg, Hartfield, Landers & Ray, 1984, 1987; Salazar, Landers, Petruzzello, Crews, Kubitz & Han, 1990; Landers, Han, Salazar, Petruzzello, Kubitz & Gannon, 1994. In general this means that considering that top level athletes have access to a wide basis of knowledge that is specific to their certain sport, it is assumed that they only require a limited amount of environmental information to construct a valid perception of occurrences (Williams, Davids & Williams, 2000). In addition, Norman (1968, 1969) accented that an athlete builds an unmeasurable reservoir of experience which can be later used to explain occurrences that are similar to those that they have previously experienced. That is to say, through previous experiences an athlete can recognize important contextual information that can be used as input.

This input, in conjunction with the reservoir of stored knowledge in an athlete's sport, indicates the existence of an abundance of perceptive strategies of an elite athlete. An elite skillful athlete then, recognizes important information that is given as input and can focus his/hers attention on the relevant information and omit irrelevant sources of information. Thus, knowledge adopted through experience minimizes the amount of information that is needed to be processed in order for an athlete to perform an action, and this means that the time needed to perform these actions is minimized, *ipso facto* the speed of response is minimized as well (Starkes & Allard, 1993). This conclusion can be summarized such that the skill of actualizing contact with the volleyball in fast actions, such as catching and hitting the ball (while spiking the ball, organizing actions of attacks, defence, etc.), is established by the ability to discover and interpret perceptive information through a comparison with the internalized memory structure of an athlete, which is based on past experiences in similar situations (Šoše, 2009). Hence, it can be assumed that participants of this research have developed very sophisticated behavioral models that provide them with the ability to predict occurrences and choose preprogrammed movement sequences specifically designed to achieve adequate contact with the ball in a sport situation. Furthermore, there is a belief that the ability for programming basic movements and orientating oneself within the field of play allow an athlete certain movements, e.g. when the ball is approaching, that are delivered to the attention mechanisms of an athlete and allows her/him to concentrate on more important information in order to decide what to do with the ball once its under his/her control, e.g. to bump the ball to this or that player. It is commonly said that these movements that have been acquired in such a way, which become automatic, have developed through motor programing.

This accounts for the notion that although an athlete doesn't always reflect on her/his actions, the brain still receives sensory information from the muscles, joints, and ligaments pertaining to the body's movement. So, once an athlete acquires the skills for performance the appropriate movements of their body become automatically processed. Thus, although the skills for performance are still under the control of the brain the performance of these skills demands very little conscious attention. This level of adopting the skill is very important in sports because it is only when the skill is acquired at this level that an athlete has the time and chance to direct his/her attention on other relevant information that the athlete is receiving from the environment. This notion was pursued by Hubbard and Seng (1954) who were interested in finding whether athletes always need to visually follow the ball while anticipating contact with it. Their research was conducted on a sample of 29 professional batters in baseball.

Despite some individual differences results have shown that skillful batters only need to visually follow the ball up to the point when the ball is 2.4-4.5 m away from the bat. These results may indicate that vast amounts of exercise affect the development of an internal representation of occurrences in these athletes so they can predictably use early information that is produced by the action of the pitcher and the path of flight of the ball towards the batter to make decisions. Some more recent research conducted by Bahill & LaRitz (1984) provided additional support to these findings. These authors claim that pitching in baseball usually reaches the speed which exceed the ability of being able to be followed by the visual system of a batter. If we take this research in conjunction with the above findings, we further support the notion that athletes use of an internal representation to predict the sport situation. For, if the visual system of a batter cannot follow the ball then a batter needs to construct the position of the ball given the small amount of information that is received as input.

In other words, a batter must have an excellent choice of moment while planning their swing given that they cannot visually follow the position of the ball; to account for this they develop an internal representation of the sport situation. For numerous psychologists this indicates the important role of knowledge accumulated during previous experiences which enhance perception in such time restricted situations. From a cognitive point-of-view, it seems that by programming a motor response of a batter's swing it reduces the free moving of different parts of the skeletal-muscular apparatus, which otherwise would freely change their position.

Based on the data collected from literature and accessible research the theoretical assumption can be asserted that the role of perception in sport is determined by the context of the sport situation, amount of previous experience, and the form of the motor task to be performed. Results of the research indicate that sitting-volleyball players have acquired a high level of competency of motor technique and by virtue of this they have reached a level of automation of their movements; i.e. they do not need conscious control over performing these sport actions and the role of visual perception during these motor performances is minimal. In such circumstances a perceptive analysis of the sport situation becomes less and less important because the direction of the moving object (ball) is expected. In addition, it should be expected that visual performance is modified as a result of experience as well; this is because the amount of knowledge which an athlete possesses affects the way in which they process available information.

The acquisition of this level of performance is most likely due to an immeasurable amount of experience that athletes acquire in both league and international competitions. That is to say, the quality of acquired experience (participation in competitions against the best club and national teams in the world) resulted in an enormous reservoir of knowledge of their sport and the area of sports knowledge in general, and for this reason they only need a limited amount of information to construct a valid perception of sports situations. Simultaneously this knowledge decreases the amount of information which is needed to be processed. Thus, the speed of sport action and response is made shorter while also allowing precision in the prediction of the movement of the ball that is independent from perceptive abilities.

As such, the role of knowledge is of crucial importance when performing sport action during a game such as sitting-volleyball; for, sitting-volleyball is a sport that requires the discipline to perform actions in a short period of time, thus, it is demanded that actions be performed fast and efficient. However, it is important to take notice that the estimation of motor abilities for this study were conducted within testing conditions, conditions of motor tasks that represent only sequences of some actual motor performances.

Thus, these actions were performed in a situation wherein the time to perform these actions was longer than in an actual game situation; i.e. the testing conditions do not include all of the complexity of sports situations when the role of perceptive abilities becomes more important in an actual game situation. The lack of testing the motor abilities of the sitting-volleyball athletes in a competitive sport situation is the main factor of uncertainty in the research. Such is the main restriction that is present in the research. Within such designed research conditions the tested athletes weren't suppose to perceive their opponents, their positions on the court, nor take part in organizing actions of their own team, for which we expect to have affected the results.

Each motor task has been isolated from the rest of others, which is not the case in an actual game situation where there is present a significant dynamic of movement that is performed without a well defined order. We would get more rich and more valid discoveries concerning the relation between perceptive abilities and specific motor abilities if we conducted the research in an authentic ambient of a sport competition, which is left as a recommendation for future research.

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RELACIJE PERCEPTIVNIH SPOSOBNOSTI I SPECIFIČNIH MOTORIČKIH SPOSOBNOSTI IGRAČA SJEDEĆE ODBOJKE

Sažetak

Provedeno je istraživanje s ciljem utvrđivanja relacija i intenziteta povezanosti između perceptivnih sposobnosti i specifičnih motoričkih dimenzija igrača sjedeće odbojke. Uzorak se sastojao od 68 subjekata koji su najbolji registrirani igrači sjedeće odbojke u Bosni i Hercegovini. Ova studija opisuje uzorak korištenjem jedne varijable za procjenu percepcije i osam varijabli za procjenu specifične motorike. Inicijalni podaci su dobiveni primjenom testova "Cybernetic battery of tests, KOG-3", i objektivnih testova specifične motorike igrača sjedeće odbojke. Relacije između kriterija (perceptivni test) i skupa motoričkih varijabli utvrđene su primjenom standardne multivarijantne regresijske analize. Rezultati su pokazali da ne postoji povezanost perceptivnih sposobnosti i specifične motorike igrača sjedeće odbojke.

Ključne riječi: percepcija, specifična motorika, sjedeća odbojka, regresijska analiza

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AEROBIC AND ANAEROBIC FOOTBALL PLAYERS CAPACITY IS A BASIC OF SCIENTIFIC TRAINING WORK

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Abstract

Since training has to be adjusted with the level of sportsmen skills and legality of skills development scientific and professional approach is required. That kind of approach implies determination of aerobic and anaerobic skills according which we can determine training zones regarding football game requirements. On the other hand, deflection programming that is maintained in a certain space and time intervals and pauses is required to be in accordance with specific activities supported by situational elements of the game and only then the training is rational. The sample of respondents is 23 football players from „Spartak – Zlatibor voda“ club, First league of Serbia. The sample of variables presents ten indicators of functional skills. We calculated central and dispersion variable parameters and the group respondents, according to their skills, are classified through cluster analysis. The results confirmed that this type of approach is successful and in three years of following it this season they will participate in the biggest Serbian league.

Key words: Training, aerobic and anaerobic capacity, Conconi, football players

Introduction

All components of personality, in other words all anthropological status domains, influence sportsmen to achieve the top result. Morphologic characteristics, motor skills, functional skills, cognitive skills, personality traits and sociological status have crucial importance on the sportsmen result. To adjust training process on one side with the level of sportsmen skills and adjust it with all components of his personality, it is necessary to establish scientific and professional approach and adjust them with legality of development. This can be accomplished only if we use scientific approach in their diagnostics. During sports activity complex functional systems are being formed where all the elements of functional system (skeletal-muscle, cardio-vascular, respirator, humeral, vegetative, central-nervous etc.) act as harmonized. Each man, on a different level, possesses individual systems and they are mostly genetically conditioned, but each individual can develop these systems according to its predispositions. Whether this level enables average, a better or top result is a different issue. We should always have in mind that in a sport result there is a big involvement of sports and technical achievement in a specific way. The level of individual achievement in sports activity depends on the context and harmony of certain domains. Skill development occurs according to natural laws of growth and development.

But it is also possible to influence it systematically. The more muscular activity is intensive the bigger is functional activity of cardio-vascular and other systems responsible for muscle supplying with energetic and other tropic substances. Good knowledge of aerobic and anaerobic skills and capacities (Ekblom, 1986) is a pre condition to training programming scientific approach because there is empiric heritage and trainers that are not educated enough to apply scientific knowledge.

Aim

The subjects of the research are functional skills of football player in a control process and loading management. To raise efficiency of sports training system it is essential to bring the structure of training closer to structure of deflection during the game and depending on the level of abilities of each individual. With this work we want to specify methodical approach of skill determination, planning and observing training process of football players. Since the problem is complex and space and time capabilities are limited, in this work we presented functional test results of functional football player's skills estimation according to Conconi as well as Shuttle Run Test as a starting point to determine skills for scientific approach of planning and managing training process.

Methods

Conconi test is a method applied to establish the point of pulse deviation and deflection without measuring lactate, which means without taking a blood sample. The point of deflection (HR deflection) can be defined as a heart frequency above which lactate concentration increases. The content of lactate on HR deflection is 4 millimoles in 1 liter of blood. (Conconi et al., 1982). The testing was conducted on a treadmill. Shuttle run is the Maximal Multistage 20-Meter running test. The authors are Leger and Lambert (1982). It is used to estimate durability within Eurofit battery of tests used to estimate physical work capacity. Based on a cross section we follow the level of deflection and speed of movement and through appropriate tables we obtain values of maximal relative Oxygen consumption $\text{VO}_{2\text{max}}$. As a sample for training programming we had 23 football players' seniors from "Spartak-Zlatibor voda" club Serbia's First football league. In season 2007/08 they entered the II League. In half season 2008/09 they were 9th position out of 18 clubs. This year they entered the highest ranking in a competition. Variables obtained according to Conconi's test: Meters ran (CDIST), Systolic blood pressure resting (TAIS), Diastolic blood pressure resting (TAID), Systolic blood pressure at the end of a test (TAFD), Maximal pulse frequency (HRMX), Aerobic threshold (ATHR), Threshold percentage regarding HRMX (HRMP) and Heart frequency resting (MIHR). Variables obtained according to Shuttle Run Test: Bip level (BINI), Bip intensity (BINI), Speed km/h (KMHB), Distance ran (DIST)

and Maximal Oxygen consumption, ml/min/kg (VOMX). Successful trainers in their work with athletes are not supposed to be guided by their average results, but should base on a constant observation and monitoring of their individual capabilities regardless individual or team sports. For this reason it is necessary to plan and monitor individual zones of training. Results are arranged and tabled, central and dispersion variable parameters are calculated. Respondents are grouped according to their skills applying Cluster analysis.

Results and discussion

Obtained results of testing are statistically processed and central and dispersion parameters of individual variables are calculated, Table 1, and normality distribution testing was conducted. Obviously, all variables have normal distribution except maximal heart frequency variable (HRMX), $K_{Sp} = .045$. Results obtained indicate sample characteristics, however, in training process more important are individual indicators of functional skills. After determining central and dispersion variable parameters, respondents were grouped by cluster analysis regarding similarity in skills and for them we calculated training zones, deflection duration in that zone and length and type of recovery/pause. We also have to remember that respondents are arranged into groups that match to characteristics supervene from game tactics and systems. Such approach has its justification since many exercises are connected to player's cooperation in the game.

Table 1. Central and dispersion parameters and measures of asymmetry and flatness

Variable	X	Sd	Min	Max	K.V.	Confidence Interval		SK	KU	KSp
CDIST	3902.17	493.02	3000.0	5000.0	12.63	3688.93	4115.42	.12	-.14	.43
TAIS	133.43	10.53	109.0	149.0	7.89	128.88	137.99	-.53	-.52	.82
TAID	76.22	7.37	60.0	90.0	9.67	73.03	79.41	.10	.10	.38
TAFS	160.22	17.24	127.0	185.0	10.76	152.76	167.68	.02	-1.12	.56
TAFD	83.57	10.00	66.0	105.0	11.97	79.24	87.89	.41	-.23	.18
HRMX	194.74	4.82	182.0	207.0	2.47	192.66	196.82	-.29	1.72	.05
ATHR	181.17	4.93	168.0	190.0	2.72	179.04	183.31	-.80	.51	.50
HRMP	93.15	1.00	92.0	95.0	1.08	92.72	93.59	.57	-.82	.20
MIHR	58.39	1.80	55.0	62.0	3.09	57.61	59.17	.06	-.64	.95
VOMX	51.67	2.70	46.3	56.9	5.23	50.50	52.84	-.15	-.04	.02

Examples of training per groups:

Table 2. Training 1. 2x20 min pause 120 b/min

175 b/min	174 b/min	173 b/min	173 b/min
1. group	2. group	3. group	4. group
Z	O	L	V
T	G	J	M
K	D	R	OP
BO	MA	Š	MI
U	F	JA	P
			MA
			NO

Table 3. Training 2. 1x45 min

165	163	164	161o/min
1. group	2. group	3. group	4. group
O	R	L	P
Z	B	K	OP
J	D	G	F
M	T	MA	MI
U	JA	N	Š
			V
			N

Table 4. Training 3. 2x10 min pause 115 b/min

186 b/min 1. group	183 b/min 2. group	176 b/min 3. group	182 b/min 4. group
O	T	R	B
Z	L	K	JA
J	V	MA	MI
G	D	Š	P
F	U	M	MA
		O	N

Table 5. Deflection values regarding respondents condition

Distance m	time	resting	Aerobic %	Anaerobic %
100	14s	60-75 s	5	95
200	30s	60-75 s	8	92
400	65s	60-75 s	10	90
600	110s	60-75 s	15	85
800	160s	90 s	25	75
1500	5,15 min	120 s	50	50
3000	12min	150 s	75	25
5000	18min	180 s	80	20
10000	45 min		85	15

It is well known the deflection has to match to what it wants to develop into, in other words has to be trained. Therefore, to increase aerobic skills, deflection intensity have to remain within pulse limits which matches 70-85% of maximal pulse frequency (HRMX), aerobic-anaerobic skills have to stay within limits 85-95% (HRMX) and to increase anaerobic skills (lactate and an lactate) deflection intensity has to remain within limits 95-100% (HRMX.).

Examples:

Running during 5 min at 85% of maximum, then 1 min of recovery running 8 series, 10 min easy running for relaxation. Running during 3 min at 90% of maximum, then 1 min of recovery running 6 series, 10 min easy running for relaxation.

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Maximum intensity running 60 sec, 150 sec of easy running. Maximum intensity running 55 sec, 120 sec of easy running. Maximum intensity running 50 sec, 110 sec. of easy running. Maximum intensity running 45 sec, 90 sec. of easy running. Maximum intensity running 40 sec, 60 sec of easy running. Maximum intensity running 35 sec, 40 sec. of easy running. Maximum intensity running 30 sec 20 sec of easy running and 10 min of easy running for relaxation. To achieve projected and possible results, player's activity is planned in such way to apply situational exercises with a ball, whenever it is possible, with certain number of participants in certain area (the size of area is determined according to training requirements) and activity duration that is suitable for needs of each individual. This segment of planning and realization is the key for success in training and it is based on large knowledge and experience of realization. Any other approach would be improvisation.

Conclusion

Results obtained indicate that middle values remain in expected limits, no significant deviations from normal distribution. However, individuals have showed individual variations in skills which helped group arrangement. Results demonstrated that the respondents, according to their functional skills, are not on the expected and necessary level. Therefore, based on the testing, functional parameters necessary for aerobic skills and anaerobic capacity were determined and in the following phase they helped in training zone determination for each individual respondent. According to this, all training parameters were determined and the types of exercises are; situational exercises with a ball with certain number of participants in a certain area and activity duration suitable for each individual needs.

AEROBNI I ANAEROBNI KAPACITET NOGOMETAŠA JE TEMELJ ZNAJSTVENOG PRISTUPA TRENINGU

Sažetak

Pošto trening mora biti usaglašen s razinom sposobnosti sportaša i zakonitostima razvoja tih sposobnosti, neophodan je stručni i znanstveni pristup. Taj pristup podrazumijeva utvrđivanje aerobnih i anaerobnih kapaciteta na temelju kojih se određuju zone treninga u skladu sa potrebama nogometne igre. Nadalje, programiranje opterećenja koja se odvijaju u određenim prostornim i vremenskim intervalima, a također i pauze trebaju biti u skladu sa specifičnim aktivnostima oslonjene na situacijske elemente igre, jer samo je tada trening svrsishodan. Uzorak ispitanika čini seniorski sastav od 23 nogometaša „Spartak – Zlatibor voda“ člana Prve lige Srbije. Uzorak varijabli čini deset pokazatelja funkcionalnih sposobnosti. Izračunati su centralni i disperzioni parametri varijabli, a ispitanici su u grupe prema sposobnostima razvrstani pomoću cluster analize. Rezultati su pokazali da ovakav rad donosi rezultat i za tri godine ovakvog rada, momčad je osigurala učešće u najvišoj ligi Srbije.

Ključne riječi: *trening, aerobni i anaerobni kapacitet, Conkoni, nogometaši*

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