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CONTENTS

ORIGINAL RESEARCH PAPER

INTEGRATIVE APPROACH TO THE STUDY AND EVALUATION OF TECHNICAL PREPAREDNESS IN SPORTS BIOMECHANICS

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Abstract

The conception of "sports technique" or "sports technical mastery" is one of the most difficult to define distinctively. This is because it reflects various sides of athlete's technical preparedness. In biomechanics "sports technique" is considered in two aspects. First of all, it is technique of sports exercise through which there's carried out sports struggle and, namely, means of performing sports movement, quantity of such technical elements and their variety. In order to describe and evaluate this side of sports technique there have been introduced indicators like volume, versatility and rationality of sports technique. The second aspect of sports technical mastery is considered to be the technical preparedness of an athlete, who is applying this or another option to perform exercise. The efficiency and the degree of acquiring of sports technique is related to the indicators determining this side of technical preparedness. In practice the quality of sports technique and its acquiring degree quite often is evaluated by the demonstrated sports performance. Such evaluation is not correct as the sports performance is determined not only by technical mastery, but also by a lot of many other important factors, like fitness, motor skills, external conditions, differences in age, body constitution and sex, chosen tactics and etc. Namely thus the scientists strive to work out more objective methods of research and evaluation of athlete's technical mastery, as well as maximally grant it quantitative assessment. The aim of the article is to describe the main research methods used in sports biomechanics and to justify the logic of integrative approach to the study and evaluation of sports technique.

Key words: *sports technique, technique's realization effectiveness, biomechanisms, integrative approach.*

Research methods of the sports movement execution techniques in sports biomechanics

In sports biomechanics the study of the technique of physical exercises and athlete's technical preparedness in majority of cases is carried out by the method of biomechanical analysis of kinematical, dynamical and energetically characteristics of movement by means of application of various research methods - optical-electronic, mechanical-electrical, and electrophysiological, etc. (Bartlett, 2001; Donskoy, 1981; Gratton, Jones, 2004; Lanka, 2003; Safrit, Wood, 1989). However, there also exist other methods, like, logical-static, mechanical-mathematical, as well as – systemic methods (Donskoy, 1981; Gaverdovsky, 2007; Shalmanov, 2002). Each of the listed methods has its advantages and shortages, the knowledge of which is needed not only to successfully solve the research tasks, but also for search of new approach to solve the problems of athletes technical mastery. The development and experimental verification of the efficiency of such approach is considered to be one of the most actual methodological tasks of sports biomechanics.

When studying the technique of sports exercises and evaluating the technical mastery of athletes, researchers faced the problem of selection of namely those indicators that are predominantly informative to evaluate the level of athletes technical mastery. Most often the solution comes to the following: basing on the kinematical, dynamical, electrophysiological and other characteristics of the movement and motor apparatus of man's body, there are chosen various indicators and according to the degree of their correlation with sports result or based on application of some other static procedure, there's determined the most significant of them. The core question of applying such an approach is working out the logic of search and choice of the indicators for a subsequent analysis.

The simplest way of solving the problem is a choice of maximum greater number of indices and selection of only those that highly correlates with sports result. There can be mentioned quite a big amount of studies where authors have exposed for statistical processing tens and even hundreds of biomechanical indicators. Yet, a comparatively low efficiency of such approach is evident and the most important is that the existence of a high correlation with the result doesn't say that this indicator characterizes technique of performing an exercise. In any measurable indicator there's reflected technique, physical capabilities, as well as other factors that define sports performance. Thus, the researchers studied more effective methods to solve problems. One of such methods was worked out to evaluate the level of athletes technical mastery (Donskoy, Zatsiorsky, 1979; Lanka,

Shalmanov, 2004; Lanka, Konrads, & Shalmanov, 2005; Shalmanov, Shalmanov, 1990). It originated on the basis of the idea of making use of athlete's own motor potential in competitive exercise. The most correct quantitative means of realization of this idea is the method of regression remnants.

The main idea of this method reduces to athlete being offered two exercises. The result in the 1st exercise has to significantly depend on the development of some athlete motor ability (for instance, speed, force, power or endurance), and its execution technique has to be maximum simple. In the same way also the motor potential of athlete is evaluated in the exercise. The result in the 2nd exercise has to be determined by athlete's technical preparedness, as well as the already mentioned motor ability. In case the correlation between the results of exercises are high enough, the regression equation is calculated, in which the argument is to be considered the result of the task, evaluating athlete's potential, and the function is – the result in the exercise the technique of which is need to evaluate. On regression equation it's possible to define theoretical result of athlete that he has to show based on his motor abilities. The difference between the theoretical result and the actually demonstrated, named the regression remnants, is used to evaluate the realization efficiency of technique.

For instance, the speed in running hurdles depends on as minimum two factors: maximal velocity in the smooth running and technique of overcoming hurdles. Let's offer a hurdler to perform two exercises. In 1st exercise it's needed to run maximum fast distance of 30 m from stroke and based on the results of this test to evaluate athletes speed capacities. In 2nd exercise it's needed to do the same, yet with hurdles. Afterwards a correlation and regression line between the results of both tests is calculated. The regression line shows the average results a athlete shall show at the given result during smooth running. In case the time in hurdles run is less the time forecasted by regression equation, then one can assume that it's connected with the technique of hurdling. And, wise versa, in case the time in hurdling is more than the time forecasted by regression equation, the athlete's technical mastery is worse. So, the quantitative indicator of the effectiveness of realization of hurdler's speed qualities is the difference between the result in hurdle run and the result computed according to the regression equation and the actual achieved sport result, and not the sport result itself.

Hereinafter the researchers widened the scope of application of the method of regression remnants (Lanka, 1998; Lanka & Shalmanov, 2004; Shalmanov, 2002). Originally the idea of usage of athlete motor potential

was accompanied by an idea of evaluation of the level of usage of any integral action components or of its motor apparatus properties in a competition exercise (for instance, some parts of motor action, swing movements of body segments, biomechanical properties of muscles, etc). For instance, a comparison of the results of track-and-field athletics throws from stand position and from run up allows to evaluate the level of realization of the last (Lanka & Shalmanov, 1982; Lanka, 2007), but the comparison of the results of a standing vertical jump with a upward swing by the arms and without a swing, allows to evaluate the technique of performing arms swing and their contribution to the height of the jump (Shalmanov & Shalmanov, 1990).

Advantage of the method of regression remnants is in the fact that the criterion of the measure of athlete's technical mastery is not the sports results that depends on a great number of factors, but the athlete's ability to realize his motor capabilities. It is assumed that this depends on the level of athlete's technical mastery (Lanka, Konrads & Shalmanov, 2006). Besides, this method allows selectively or complex (in case of usage of a multiple regression analysis) evaluate the realization efficiency of the technique of the athlete. However, the described method has got a significant disadvantage. By means of this method there can be made only a conclusion that the technique of the given athlete is higher or lower the average level, but one can't say – why? An answer to this question might be found by means of other biomechanical research methods and in particular with mechanical-mathematic and systemic methods.

The usage of methods of mechanical-mathematic modeling in biomechanical research can be divided into two stages. The tasks of the first foresee the usage of the existing, as well as the working out of the new mechanical-mathematic models and the control of their efficiency to solve some definite circle of tasks (Bartlett, 1999; Khokhlov, 2000). The primary goal of this stage is to obtain quantitative information about the external picture of movements (angular and linear kinematic features of movements), as well as to study man's movements on the level of dynamics, t.i., define strengths and moments of strengths in joints, the work, power and mechanical energy of the whole body and separate segments of body, mechanical characteristics of muscular contraction and much more. When solving these tasks the researchers faced many difficulties like the precision of measuring device and its capabilities; problems with preliminary processing of input data; construction of the model, as well as the corresponding software; experimental examination of its efficiency and much more (Zatsiorsky & Prilutsky, 1989).

The tasks of the second stage foresee the usage of the mechanical-mathematic apparatus to study biomechanical problems, including sports biomechanics. For instance, to evaluate the efficiency of performing different variations of technique, to define different indicators of mechanical efficiency of some motor activity, to estimate load values in joints in order to find out the mechanical causes of injuries, to exercise sourcing of mistakes in exercise performance technique and much more. In this way one can use the mechanical-mathematic approach as one of the methods to solve the tasks of sports biomechanics. The solution is carried out on the bases of many principles and laws of mechanics that are put into the grounds of any method. As an example may be used the work of V. Nazarov (Lanka & Shalmanov, 2004) on the application of methods of mechanics of the controlled body in order to study and construct sports movements. The research of G. Popov and others (Lanka, 2004) on application of methods of wave mechanics to study the technique of track-and-field athletics throws, the works of J. Dapena (2000), M.R. Yeadon (2000), J. Gaverdovsky (2007) and others on usage of laws of conservation of impulse and the moment of impulse in order to study athletes movements in a support-free position and etc.

The initial use of the methods of mechanics reduced to the measurement and calculation of kinematic and dynamic characteristics of the movements of individual points, links or whole-body using various experimental techniques (goniometry, speedometer, accelerometery, opto-electronic systems, various options dynamometry, etc.). The quantitative data on human movement that was obtained using these methods mainly related to its interaction with the external environment.

The desire to penetrate into the internal dynamics, and through it reach the solution to the problem of the control of movements of such a complex system, that is a human, required the development of various models of the human body, from the model of a material point to multi-link models. The development of more advanced models, their mathematical and software basis, has led to the fact that there began to be included into their composition not only the hard links, but also the muscle-tendon structures as the main and most interesting in terms of the control of movements. Therefore to learn to measure or calculate the mechanical properties of muscles in the human body (muscle contraction forces, force arms, types of muscle contraction, etc.) is crucial (Khokhlov, 2000; Zatsiorsky, Aruin & Seluyanov, 1981; Zatsiorsky, 1998). To implement these models there is also needed information about the mass-geometrical characteristics of the human body (masses and moments of inertia of the segments of the human body, the position of segments centers of mass, etc.) (Zatsiorsky, 2002).

The use of mechanical-mathematical methods in conjunction with recording electrical activity of muscles makes it possible to obtain a large number of kinematic, dynamic and electrophysiological parameters in the movements of athletes. However, their application, on the one hand, is very time-consuming and requires skilled professionals and on the other hand, it allows to evaluate the technical skills of athletes, so to speak, in its purest form. A special place in biomechanics is taken by the methods based on the idea of block structure of human motor actions (Berkenblit, Gelfand & Feldman, 1990) and on the principles of consistency and hierarchical, multilevel construction of motor control system (Abernethy, Hanrahan & Kippers, 2005; Bernstein, 1947; Zatsiorsky, 1998). Although the authors of these works have different concepts of blocks, they all share the idea that these units exist, they are quite a lot, and they interact with each other and operate parallel or sequentially. From the standpoint of cybernetics, the organization of motor acts allows us to solve the problem of minimizing the number of control parameters and makes easier for the central nervous system to control the movements of man. The ideas of systemic approach based on the principles of integrity and systemic structure of complex objects and phenomena are widespread and used in human sciences (Donskoy, 1981; Gaverdovsky, 2007). In relation to the motor actions of man it can be said that the properties of the system are not the result of the mechanical properties summing its constituent elements, but it is determined by the property of the structure as a whole, by specific backbone bonds of the object (Donskoy, 1981). Based on this, in order to understand the essence of the structure of motor actions, including sports movements, it is needed to develop a method for separating and studying both the system elements (blocks), and the relations between them, i.e. its structure. Hence the emphasis in a systemic approach is put on identifying and studying the elements of the manifold connections, both inside the system and its interaction with the external environment (Donskoy, 1981).

One of the options for a systemic approach is the method of biomechanical substantiation of the structure of motor actions of man. The method is based on the concept of biomechanisms proposed in the work (Seluyanov, Shalmanov, 1995). The introduction of this concept was preceded by works associated with the study of basic kinematical mechanisms that lies in the basis of different jumping exercises (Lanka, Konrad, & Shalmanov, 2006; Seluyanov & Shalmanov, 1983), hits and throwing actions (Lanka & Shalmanov, 1982; Lanka, 2000; Lanka, 2004; Lanka, 2005) and the movements associated with preserving the body stability in an exercise in balance (Lukunina & Shalmanov, 2000).

Biomechanism is a model of a part or all the locomotor system of man that enables achieving the objectives of the movement at the expense of converting one form of energy into another or the transfer of energy between the body segments (Shalmanov, 2002). As an integrated subsystem biomechanism consists of a set of elements that belong to it. Each element has certain properties that can be manifested differently in the movements of man. Muscles, bones and joints - are structural elements, of which the brain creates more or less complex subsystems – biomechanisms by means of which there can be reached the goal of the movement target set before.

It is important to emphasize that biomechanism combines a certain structure (subsystem), which consists of a set of body segments, as well as the interaction of these segments, which allows the use of the properties of elements in the system.

When developing our version of the method of biomechanical substantiation of the structure of human motor actions, we proceeded from the following assumptions.

1. Since the human body is a complex multisegment system, then, to control the movement, the brain, integrates the relevant units in the subsystems (biomechanisms), which can act independently of each other, yet their operation is aimed at achieving a common goal of action.

2. Each of the biomechanisms can be formed both from different and from the same parts of the body; has got a fundamental difference in their functioning, though it may be implemented differently depending on the motor tasks to perform.

3. The implementation of each biomechanism is caused by the structure of the human musculoskeletal system and the biomechanical properties of muscles involved in the performance of motor actions.

4. Relatively independent biomechanism depend on each other during the execution of motor actions, ie realization of one of them can positively or negatively influence the realization of others.

Thus, when using this method of study of various motor actions it is necessary to, first of all, on the basis of meaningful analysis, allocate the biomechanism, then, based on experimental data examine patterns of realization and, finally, using the knowledge of the peculiarities of structure and functions of the human musculoskeletal system, explain how they function.

The method of biomechanical substantiation of the structure of the motor action includes a phased implementation of the following tasks:

Stage 1. Logical-meaningful analysis of the studied motor actions with a description of the kinematics and dynamics of movements of the body parts and of the whole body.

Stage 2. An explanation of the physical mechanism of motion.

Stage 3. Establishing the structure of motor actions, based on the selection of biomechanisms of their organization and functioning.

In the first stage the main task of the researcher is to analyze the external picture of the motion and the forces acting on the body. In this analysis it is necessary to identify the source and nature of acting forces and their role in achieving the goal of action.

The main objective of the second phase of biomechanical studies of the motor task is to reveal the physical mechanism of motion. By the mechanism of movement one understands the process of changing movements that result of applied forces, including muscular strength, based on the laws of mechanics. In essence, the question is to according the fact of change of the movement establish the causes of these changes and find the relevant forces and the law of their application.

The third stage involves establishing ways to organize all the action, at the same time basing on the following key provisions:

1. Numerous joint movements are combined into blocks, which are regarded as biomechanism.

2. Each of biomechanisms has their own organization and function, aimed at achieving the ultimate goal of action.

3. Management of the blocks is based on the multi-level motor control system, taking into account the characteristics of the structure and properties of the human musculoskeletal system.

Thus, the establishment of the structure of the motor task is reduced to determining biomechanisms, methods of their realization and mutual relationship in the whole operation, as well as a contribution to the final result.

Successful application of the method involves the examination of selected biomechanisms in the exercises, that have a common goal (for example, to achieve the greatest height or distance in jumping), but are performed with different motor tasks (for example, jump up with or without upward swing by the arms, drop jumps, long jump from run up, etc.). The main purpose of this methodological procedure is that the variation of the motor task alters the significance of any biomechanism or eliminates the possibility of its use at all, that allows a deeper study of the patterns generated by other biomechanisms and methods for their realization. In addition, a methodological procedure in some cases makes it possible to indirectly evaluate the quantitative contribution of a biomechanism to complete the action.

The method of biomechanical substantiation of the structure of motor actions allows penetrating deeper into the essence of the organization

of the set of joint movements during the integral motor acts. However, using only this method to study the techniques of sports exercise and assess the level of technical skill of athletes can not completely solve the problem. So, it is necessary to use an integrative approach, that could combine the advantages of these methods of research and to establish the sequence of their application.

Integrative approach to study and assessment of athletes' technical mastery.

The main idea of the integrative approach is to combine the positive features of the method of biomechanical substantiation of the structure of motor actions, the logical-statistical method for assessing the realization effectiveness of athletes' motor potential and the method of mechanical and mathematical modeling to improve the study of technical preparedness of athletes. Let's consider the application of an integrative approach on a simple concrete example while study and evaluate a jump up from stand position. This exercise is used in training process, testing athletes' motor skills preparedness and most often is considered a subject of research in sports biomechanics.

The main purpose of a jump is to achieve maximum lift height of body's center of mass (COM) when it loses contact with the ground. The upward force exerted by the ground on the athlete changes the vertical velocity of the COM from a value zero to a large upward vertical velocity. The vertical velocity of the athlete at the end of the takeoff phase determines how high the COM will go after the athlete leaves the ground, and is therefore of great importance for the result in the jump. To maximize the vertical velocity of the takeoff phase, the product of the vertical force exerted by the athlete on the ground and the time during which this force is exerted should be as large as possible. This can be achieved by making a large vertical force while the COM travels through a long vertical range of motion during takeoff phase. Thus, the impulse of a body created by the time of the takeoff is determined by the impulse of the vertical component of the force of ground reaction, created by the athlete. This is the essence of the physical mechanism of the body of athlete.

The impulse of the vertical component of the force of ground reaction and the nature of its change depend on the speed and power capabilities of the athlete and the nature of the interaction of a body parts during a jump. Using the method of biomechanical substantination of the structure of motor actions to study technique of jump showed that they are based on three main biomechanisms: biomechanism of leg extension, trunk extension biomechanism (torso and head) and biomechanism of the arms upward swing. The main regularities of the implementation of these biomechanisms have been identified the experimental study of

biomechanisms revealed common patterns of their implementation, regardless of athlete's preparedness.

The implementation of biomechanisms of leg and trunk extension leads to the following basic facts:

1) legs extends sequentially, first hip joint, then knee and ankle joints at the end; The factor of subsequence is due to differences in muscle force capabilities, servicing these joints, ie from strong to weak.

2) during their extension in the adjacent leg joints (hip and knee, knee and ankle) there is a multidirectional movement. During transition from flexion to extension there takes place multidirectional changes in the angles of hip and knee joints. During active extension of the hip joint in the knee joint there takes place a flexion. Such a movement allows a possibility for two-joint muscles for a long time contract in excentric and isometric mode, and thus creates a greater force to the bone. In addition, the two-joint thigh muscles transfer part of power from the extensor muscles of the hip joints in the knee joints (Shalmanov, Shalmanov, 1990; Zatsiorsky, Aruin & Seluyanov, 1981; Zatsiorsky, 2002). Similar laws apply to motion in the knee and ankle joints.

3) While squatting an optimal flexion of a leg at the knee joints makes about 85º. Reducing or increasing the depth of squatting reduces the height of the jump.

4) Because the torso and head have a large mass (about 50% of body weight), the active extension during the take-off from the ground gives rise to a large inertial forces that increase pressure on the ground and creating significant resistance to the muscles extending legs (Lanka, Konrad & Shalmanov, 2005; Lanka, Konrad & Shalmanov, 2006).

The effectiveness of the realization of the leg and trunk extension biomechanisms is enhanced by the implementation of prior squatting. The contra movement allows storing energy of elastic deformation in the muscles of the lower limbs, the use of which increases the impulse of the vertical component of the force of ground reaction.

The implementation of biomechanism of upward swing by the arms is as follows:

1. An accelerated upward arms swing leads to inertia forces in the centers of mass of segments that increase or decrease pressure on the ground. In addition, these forces create additional resistance to the extensor muscles of the lower limbs at the end of amortization phase and at the beginning of the takeoff that allows us to develop a large force of muscle pull.

2. Velocity of the jumpers COM at the time of separation from the ground depends on the position and acceleration of the arms, so active and

timely properly execution of arms swing increases the height of the jump.

Logical manifestation of the considered biomechanisms was identified in the study of jumping exercises, when the criterion of the effectiveness of their performance was the height of the jump (Shalmanov, Shalmanov, 1990). However, as noted above, the result is not a sufficiently reliable criterion for the characterization of the technique of performing the exercise. So, before you learn biomechanism you need some way to assess the level of technical skill of athletes. For example, how an athlete is using the swing actions with body parts to increase the height of the jump. Such an assessment can be made using the method of regression remnants, comparing the results of the jumps with and without upward swing.

The subjects performed standing vertical jumps without and with an arms swing movements on a force platform (AMTI). According to the vertical component of force of support reaction there was calculated the height of jump, and other kinematic and dynamic indicators. In the experiment, there participated 68 subjects, specializing in different sports. The average age was 23,3 ± 4,6, the mean body weight 68,9 ± 12,6 kg, average body length 1,70 ± 0,06 m. The average result in a jump without arms swing was 0,28 ± 0,058 m, and in a jump with swing 0,33 ± 0,077 m ($p < 0,001$). Thus, the use of arms swing in an average increases jump height by 0.05 m. Figure 1 shows the correlation and regression equation between the results of two kinds of jumps.

The way how effectively the athlete uses the upward swing by the arms in a standing vertical jump, can be determined by the regression equation and the effectiveness of the biomechanism can be evaluated. For example, if the athlete showed in a jump without arms swing the result of 0.3 m, then theoretically (calculated from the regression equation) when jumping with a swing he needs to show the result of 0.35 m. In fact, athletes can show both the same, as well as a higher or lower result. If the result is higher than the calculated one, it can be assumed that the technique of execution swinging movements is above average, and if the result is less than estimated, then the technique is worse average. As can be seen from Figure 1, there are athletes whose hands "interfere" because their jump height with hands swing is lower, than the height of the jump without hands swing.

Thus, a quantitative measure of swinging technique is the difference between the actually reached result in jumping with arms swing and the result calculated by the regression equation. It is important to emphasize that such an assessment can be made throughout the range of demonstrated results.

And the indicator is not the result in a jump with arms swing, but the extent of the use of this biomechanism.

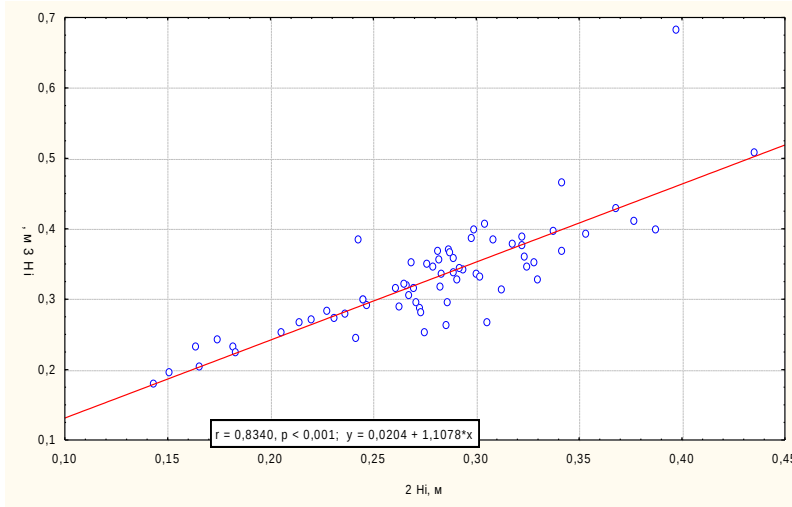

Figure 1. The correlation between the results in standing vertical jump without and with upward arms swing

Based on the regression equation there can be constructed a table on which it is easy to estimate the implementation efficiency of the swinging body parts in the jump (Table 1).

Table 1

The rating scale of the efficiency of the arms swing movement technique in a standing vertical jump

X	«VERY BAD»	«BAD»	«AVERAGE»	«GOOD»	«EXCELLENT»
0,20	<0,13	0,13-0,20	0,20-0,28	0,28-0,36	>0,36
0,22	<0,15	0,15-0,23	0,23-0,30	0,30-0,38	>0,38
0,24	<0,17	0,17-0,25	0,25-0,32	0,32-0,40	>0,40
0,26	<0,19	0,19-0,27	0,27-0,35	0,35-0,42	>0,42
0,28	<0,22	0,22-0,29	0,29-0,37	0,37-0,45	>0,45
0,30	<0,24	0,24-0,31	0,31-0,39	0,39-0,47	>0,47
0,32	<0,26	0,26-0,34	0,34-0,41	0,41-0,49	>0,49
0,34	<0,28	0,28-0,36	0,36-0,44	0,44-0,51	>0,51
0,36	<0,30	0,30-0,38	0,38-0,46	0,46-0,53	>0,53
0,38	<0,33	0,33-0,40	0,40-0,48	0,48-0,56	>0,56
0,40	<0,35	0,35-0,43	0,43-0,50	0,50-0,58	>0,58
0,42	<0,37	0,37-0,45	0,45-0,52	0,52-0,60	>0,60
0,44	<0,39	0,39-0,47	0,47-0,55	0,55-0,62	>0,62

In this table, each result in a jump without arms swing (X) correspond to the five intervals results in a jump with swing, that are characterized by qualitative assessment of the appropriate technique, "Very bad", "Bad", "Average", "Good" and "Excellent" . The width of the intervals are calculated on the basis of the average standard deviation of the results of jumps with arms swing referring to the regression line, and the number of intervals is chosen by the researcher.

The table can be used as follows. If the athlete performed a jump without a hands swing at 0.4 m (X), and jump with hands swing at 0.56 m, his technique can be considered as "Good."

As noted above, these methods can only state the fact that the technique of the athlete is better or worse than average. Hence, to answer the question of why this is happening there are applied mechanical-mathematical methods of research.

The analysis of upward swing by the arms technique in the jump from a stand was carried out by using force plate AMTI and opto-electronic systems «Qualify» with software «QTM» and «Visual 3D» (C-Motion). To register the movements of man's body parts, passive markers are attached to those body parts that are of interest for analysis. In this study, there were marked anatomical references recommended by the manufacturer (C-Motion). Thus, 38 reflective markers were sealed on the man's body (Fig. 2).

Figure 2. The subject with the fixed passive markers

In the program «Visual 3D» (C-Motion) it is possible to construct a skeletal model of the man making use by means of the «QTM» of the coordinates of the passive markers, (Fig. 3). To do this, the program uses built-in regression equations.

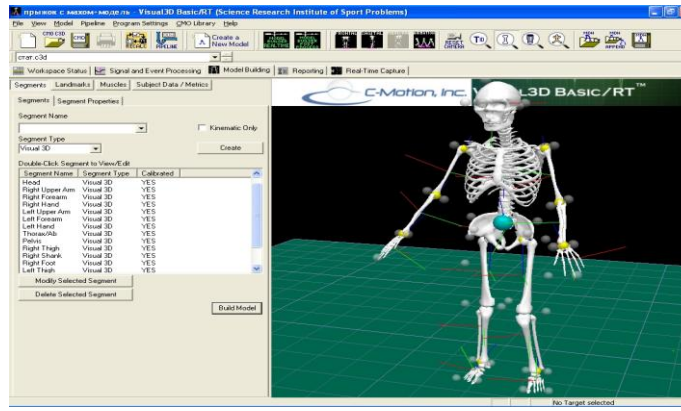

Figure 3. The program interface «Visual 3D» (C-Motion), part of building a model of skeleton

The data on the kinematics and dynamics of parts of a body in the performance of motor tasks are obtained in the result of integration of the static file into the Visual 3D, with the help of which there has been constructed skeletal model of the test, and the dynamic data file on the same subject performing motor tasks. In the result, the program carries out visualization of the performance of motor tasks of the skeletal model, as well as a graphical representation of changes in characteristics as trajectory of body's COM, trajectories, velocities and accelerations of body segments centers of mass, as well as the dynamogram of ground reaction force (excluding the weight of the body). The example of analysis of motor tasks using Visual 3D is shown in Figure 4.

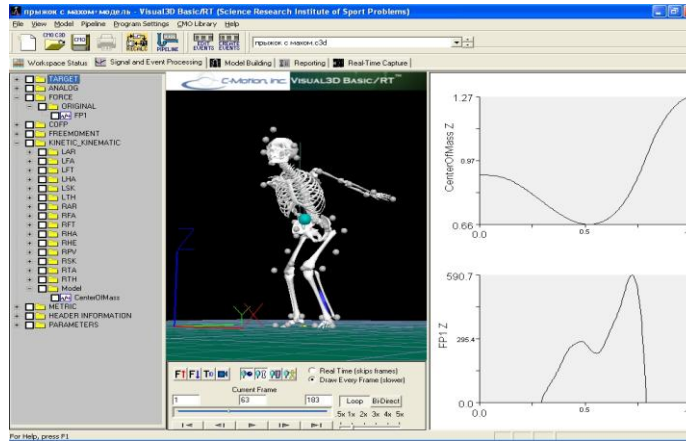

Figure 4. The program interface «Visual 3D» (C-Motion), the part of analysis of motor task

To study the differences in the technique of execution of arms swing there were selected four athletes with different levels of technical skill. The level of technical skill was determined by the data in Table 1. Information on the subjects is presented in Table 2.

Table 2

Characteristics of subjects with different levels of arms swing technique efficiency in a standing vertical jump

№	Subject	Weight (кg)	Height (м)	Age (years)	Rating of technique
1	P. V.	63,7	1,77	22	Bad
2	A.A.	45,2	1,63	18	Bad
3	I. D.	75,7	1,78	24	Good
4	T. M.	56,0	1,70	19	Good

A comparative analysis showed that the total impulss of inertia force in the centers of mass of arms parts in athletes with a good technique creates a greater contribution to the impulse of a takeoff force than in athletes with a poor technique (Fig. 5).

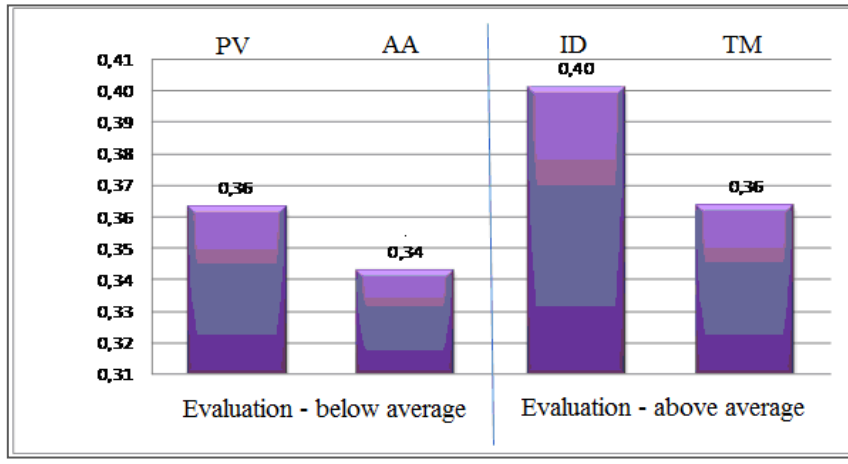

Figure 5. The contribution of arms swing in subjects with various efficiency of technique

In addition, the use of arms swing for athletes with a high estimate of realization effectiveness leads to a significant increase in the contribution of the impulse of the inertial force arising at the center gravity of the trunk.

The torso and head has a large mass, so at an accelerated movement, it improves the result of jump. (Fig. 5) And in spite how strange it is, but effectively performed arms swing promote a more efficient movement of the upper body and the realization of biomechanisms of legs and trunk extension.

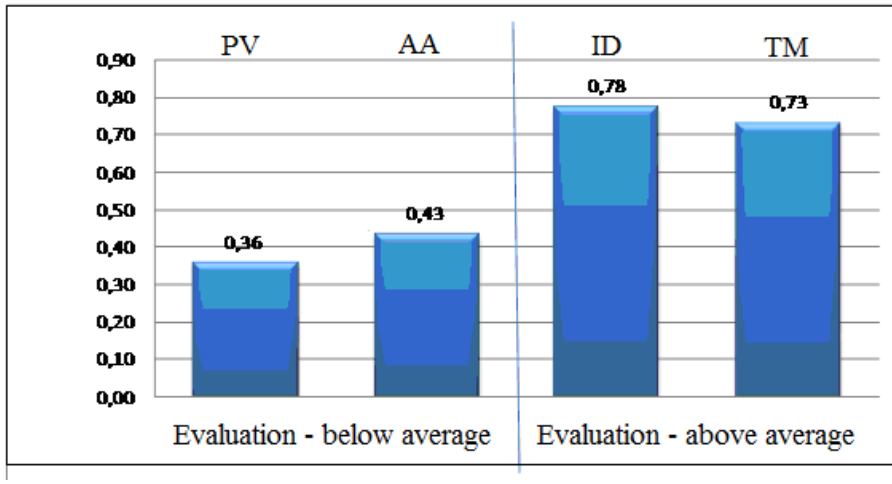

Figure 5. The contribution of trunk swing in subjects with different technique effectiveness

Conclusion

As the main purpose of this article was to outline the logic of the integrative approach to the analysis and assessment of technical skills of athletes, we will not discuss in detail the results obtained using the mechanical-mathematical methods. It was important to show the possibility of a consistent application of existing methods of investigation, to discover their strengths and weaknesses.

Thus, on an example of learning and assessment of techniques of performance of a jump up from a stand shows the need for an integrative approach. The main essence of this approach is to successively apply the method of biomechanical substantiation of the structure of motor actions, logical-statistical method of regression remnants and mechanical and mathematical modeling to improve learning and assessment of technical skill of athletes.

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ORIGINAL RESEARCH PAPER

CORRELATION BETWEEN ANTHROPOMETRY OF FOREARM AND ENDURANCE INDICATORS IN KETTLEBELL SNATCH

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Abstract

Kettlebell lifting is characterized by a work, with a constant hold of kettlebell in the hands. Most of this load gets in kettlebell juggling and kettlebell snatch pull. Therefore, taking into account this fact, the forearm and palm size might be just as important as strength indicators. Aim of our study was to analyses correlation indicators between anthropometry of forearm and aerobic, anaerobic performance indicators and results in kettlebell snatch. In study voluntarily participated, 20 kettlebell lifters, 11 of them were first sport class athletes and nine athletes were SMK (sports master's candidates), SM (sport masters). Kettlebell snatch results were determined in competitions and registered in protocol. To determine aerobic and anaerobic work capacity, kettlebell lifters executed complex load test with expiratory gas analysis. Testing was executed on cardiopulmonary diagnostic device "MasterScreen CPX". In forearm and hand size determination we used anthropometry. A palm and finger longitudinal dimension of the circumference of the forearm and finger strength was measured. In assessing the results of correlation between kettlebell snatch and the hand anthropometry has shown that the tight correlation is just between finger and hand joint longitudinal dimensions. At aerobic threshold we observed medium correlation in all cases, but at anaerobic threshold all correlation results were tight. Such a correlation confirms the fact in the literature, that the anaerobic threshold is essential for high results cyclical kind of sports where one of the prerequisites is high rate of work capacity. Longitudinal size of hand is significant and can be useful to take into account when realizing selection of new coming athletes in this kind of sport.

Keywords: *Kettlebell snatch, load test with expiratory gas analysis, anthropometry of palms and forearms, handgrip strength, correlation.*

Introduction

The kettlebell lifting is cyclic kind of sport. For the beginners the main physical ability is strength. Fort the beginners achieving 15 repetitions in kettlebell lifting the main physical ability becomes strength endurance (Romasin et.al., 1998), then one of the most important aims in training process is to increase strength endurance level, so it is easy to lift kettlebell for 30–40 reps, but nowadays it is not enough to successfully compare in competitions, where takes place average of 100 reps.

Italian authors (Impellizzeri et al., 2005) have determined that the anaerobic threshold load capacity is a good cyclist work capacity indicator: between the cycling track time and the aerobic capacity of the indicators is reliable correlation (correlation coefficient ranges from – 0.68 to – 0.94, p <0,05). No doubt, high endurance indicators is one of main factors in kettlebell sport, so one of the conditions for success in competitions are athlete's high aerobic and anaerobic capacity. Russian author (Pilipko, 2004) conducted a study, by means of which clarified the factors that affect the high achievement of results in kettlebell sport. It was found that high achievement at the same time depends of several factors. Five key factors include such the physical abilities as the special endurance (72%) and overall endurance (66%).

It is therefore possible to win by another factor - their movement economy, ability to lift kettlebell at high speed with less oxygen consumption (Franch et.al., 1998; Ingham et.al., 2002).

Despite the kettlebell lifting is characterized by a work, with a constant hold of kettlebell in the hands. Most of this load gets in kettlebell juggling and kettlebell snatch pull. Analyzing the muscle topography during exercises in kettlebell sport, a several Russian authors (Romasin et.al., 1998; Sikunov, 2005) determined that the most important muscle groups in kettlebell snatch are the forearm muscles.

Forearm muscle is the smallest muscle group involved in this movement, but as the leg and spinal muscles they are very loaded during competition. Estonian author (Visnapuu, 2009) has found that the hand and wrist anthropometric parameters significantly affect the performance with the ball in handball.

Therefore, taking into account these facts, the size of forearm and palm might be just as important as indicators of endurance. Aim of our study was to analyses correlation indicators between anthropometry of forearm and aerobic, anaerobic performance indicators and results in kettlebell snatch.

Material and methods

In study voluntarily participated, 20 kettlebell lifters, 11 of them were first sport class athletes and nine athletes were SMK (sports master's candidates), SM (sport masters). All the subjects involved in the experiment average age was 23 ± 1.2 years, mean height 181.4 ± 2 cm, mean weight 76.9 ± 3 kg.

Correlation analysis was conducted among kettlebell competition results, complex load testing indicators (veloergometry with expiratory gas analysis) and fingers /palms /forearms anthropometric measurements.

Kettlebell snatch results were determined in competitions and registered in protocol. The results presented by the left and right hand were summarized.

To determine aerobic and anaerobic work capacity, kettlebell lifters executed complex load test (Galasko et.al., 2008) with expiratory gas analysis. This method combines veloergometry and expiratory gas analysis techniques. Testing was executed on cardiopulmonary diagnostic device "Master Screen CPX" (figure 1).

Figure 1. Cardiopulmonary diagnostic device „Master Screen CPX”

The load test was carried out in sports physicians’ supervision and is composed of several parts; duration of them has been established by sports physician, taking into account the state of health and fitness levels (Sanosjan et.al., 1999). Test consisted of four stages: 1. stillness; 2. warm-up; 3. load – progressively increasing physical load; 4. recreation. Each kettlebell lifter gradually increased the load on veloergometer to starvation. Load intensity starting load phase was 50W, then it was increased by 10W each minute. Carrying out a load, cardiopulmonary diagnostic device "Master Screen CPX recorded parameters of aerobic and anaerobic threshold, which were used for correlation: heart rate (beats/min), oxygen consumption (l/min), relative work capacity (W/kg) (Lescinskis, 2010).

In forearm and hand size determination we used anthropometry. We determined longitudinal dimensions of palm and fingers, forearm circumference and finger strength. For the measurement of finger and palm

lengths we used specific measurement methods (Jurimae et.al., 2009; Visnapuu, 2009).

The test subject place his palm with freely extended fingers on a sheet of paper, then outline of the hand was drawn on the paper. The outlines where drawn with a thin marker that was placed perpendicularly onto the paper. The contour of the hand was drawn with maximal active voluntary adduction of thumb and other fingers. After drawing palm contour, the measurement of longitudinal dimensions with precision of 0.1cm takes place. The specific parameters of the forearm and palm were measured by the following formula: palms lengths (A_1+B_1+C_1+D_1), overall length of fingers (A+B+C+D) and these measurements were summed ((A_1+B_1+C_1+D_1) + (A+B+C+D)), so we determined overall length of palm and fingers (figure 2). Parameters of both hands were summed together.

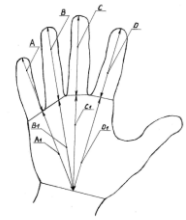

Figure 2. The measurement of specific anthropometric parameters of hand

Circumference of forearm was measurement in most slender and largest part of forearm (figure 3).

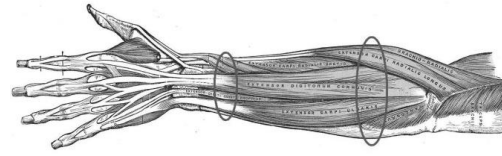

Figure 3. The measurement of forearm anthropometric parameters

Measurements were made by measure tape with 0.1cm precision, and measurements of both hands forearms were summed together. For determination of finger and palm flexors maximal strength, we used electronic hand dynamometer (figure 4).

Figure 4. Camry Electronic Hand Dynamometer of handgrip strength

Best results of each hand were summed together. To process various data and results, we used descriptive statistics, Pearson [r] and Spearman [r_s] correlation coefficient. The difference was considered to be reliable when P>0,95 (Dravnieks, 2004).

Results

Correlation analysis between all hands, forearm anthropometric measurements and physical training tests with complex load and kettlebell snatch results were carried out (Table 1).

Table 1

Correlation results of kettlebell snatch with anthropometric parameters of hands and forearms and load test indicators at aerobic (AeT) and anaerobic (AnT) threshold

Measurement		module of correlation coefficient [r], [r_s]	Significance of correlation [P]
Anthropometric parameters	palm longitudinal size (cm) (A_1+B_1+C_1+D_1)	r=0.486	Correlation significant (P>0,95)
	finger longitudinal size (cm) (A+B+C+D)	r=0.553	
	finger and palm summed longitudinal size (cm) ((A_1+B_1+C_1+D_1)+(A+B+C+D))	r_s=0.889	
	forearm circumference (cm)	r=0.075	Correlation insignificant (P<0.95)
	handgrip strength (kg)	r= - 0.346	
AeT	relative work capacity (W/kg)	r=0.644	Correlation significant (P>0,95)
	heart rate (beats/min)	r_s=0.652	
	oxygen consumption (l/min)	r=0.670	
AnT	relative work capacity (W/kg)	r=0.942	Correlation significant (P>0,95)
	heart rate (beats/min)	r=0.742	
	oxygen consumption (l/min)	r=0.786	

In kettlebell snatch result correlation with palm's longitudinal size we observed significant (P>0.95), but weak correlation - r = 0.486, between the finger longitudinal size r = 0.553, with the fingers and palms overall longitudinal dimensions r_s = 0.889, with the relative work capacity at the aerobic threshold r = 0.644, with relative work capacity at anaerobic threshold r = 0.942, with the aerobic threshold heart rate r_s = 0.652, with the anaerobic threshold heart rate r = 0.742, with the respiratory capacity at aerobic threshold r = 0.670, with the volume of the respiratory at anaerobic threshold r = 0.786 The correlation results of kettlebell snatch is not significant (P<0.95) with arm circumference r = 0.075, with a palm handgrip strength parameters r = - 0.346.

In figure 5 we see correlation results between kettlebell snatch and palm and forearm anthropometrical measurements, where: A – palm longitudinal size; B – fingers longitudinal size; C – fingers and palms summed longitudinal size; D – forearm circumference; E – handgrip strength.

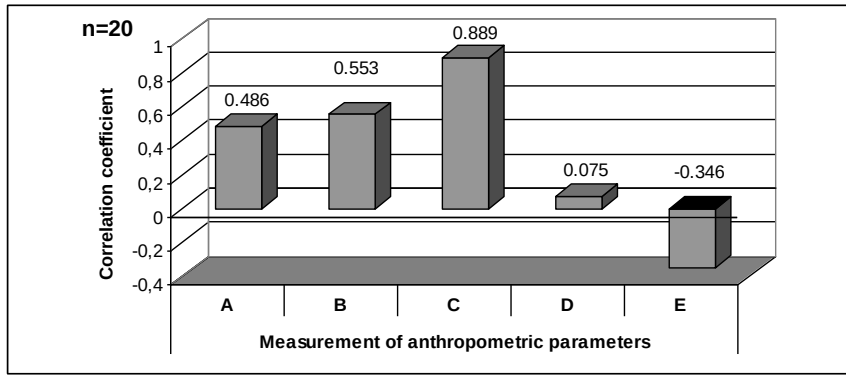

Figure 5. Correlation results of kettlebell snatch results with anthropometric parameters of hands and forearms

In figure 6 can be seen correlation results of kettlebell snatch with the results of complex load test at aerobic (AeT) and anaerobic (AnT) threshold: A – relative work capacity (W/kg), B – heart rate (beats/min), C – oxygen consumption (l/min).

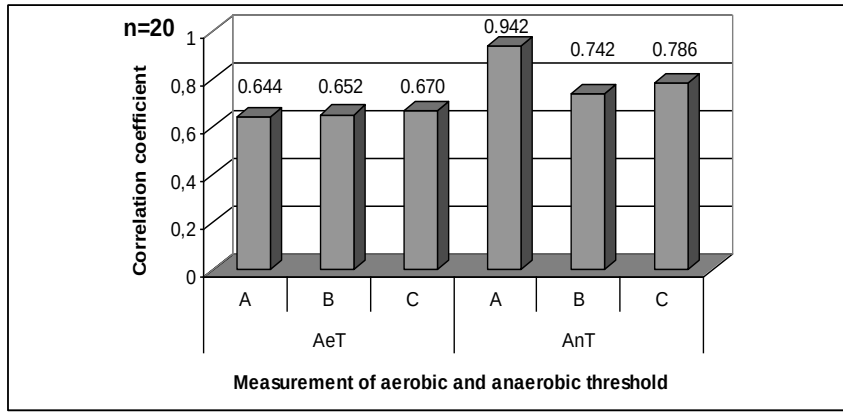

Figure 6. Kettlebell snatch results correlation with load test indicators at aerobic (AeT) and anaerobic (AnT) threshold

At aerobic threshold we observed medium correlation in all cases, but at anaerobic threshold all correlation results were tight.

Discussion

Adult amateur level athletes have observed a close correlation between their aerobic capacity and the result in resistance loads.

A close correlation has been observed between kettlebell snatch and the anaerobic threshold parameters. Such a correlation confirms the fact in the literature, that the anaerobic threshold is essential for high results cyclical kind of sports where one of the prerequisites is high rate of work capacity.

In other endurance sports like marathon, there is a close correlation between the run results and workload of anaerobic exchange threshold, where the correlation coefficient between these parameters is from – 0.88 to – 0.99.

Assessment of the results of correlation between kettlebell snatch and the hand anthropometry has shown that the tight correlation is just between sum of finger and palm longitudinal dimensions, which means that the longitudinal size is significant and can be useful to take into account when realizing selection of new coming athletes in this kind of sport.

Theoretically, this could be explained by the fact that covering the kettlebell handle with taller fingers and palm will be able to keep kettlebell in hand much longer (the same as to pick up two dumbbells with different diameter handles, the smaller diameter handle will be kept in hand much longer).

The study showed that the correlation is not reliable with the circumference of the forearm and handgrip strength, which means that athletes, reaching a certain maximum force level of handgrip and forearm circumference, should pay greater attention to the forearm muscle specific endurance development (development of mitochondrial systems of forearm muscle).

This can be explained by the fact that execution time of work in the kettlebell sport is 10 minutes and significance of maximum strenght decreases, while the significance of endurance increased.

Conclusions

Correlation analysis of the data showed that correlation of one part parameters is not statistically significant. One part of the correlation coefficients of the modules is not greater than the critical value.

A close correlation has been observed between kettlebell snatch and the anaerobic threshold parameters.

Anaerobic threshold depends of functional condition of cardiovascular and respiratory systems, therefore, to achieve an adequate development of heart, circulatory and respiratory systems, resistance training should start right from young age.

In assessing the results of correlation between kettlebell snatch and the hand anthropometry has shown that the tight correlation is just between finger and hand joint longitudinal dimensions.

The study showed that the correlation is not reliable with the circumference of the forearm and handgrip strength.

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ORIGINAL RESEARCH PAPER

QUALITY EVALUTATION OF THE COMBAT INDIVIDUAL PROTECTION SYSTEM BY EUROFIT PHYSICAL FITNESS TESTING

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Abstract

Researchers from the National Armed Forces (NAF) Republic of Latvia in cooperation with researchers from Riga Technical University (RTU) and Latvian Academy of Sport Education (LASE) carried out a quality evaluation of the combat individual protection system (CIPS) of the NAF by the EUROFIT physical fitness testing complex and Harvard step testing, covering flexibility, speed, endurance and strength. Experiments were split into five days. Five different sets in total have been evaluated during the experiments with the following loads – 1,7 kg (light clothing mode), 11,0 kg (light armour mode), 20,2 kg (heavy armour mode), 19,6 kg (heavy armour mode without combat jacket), 11,8 kg (backpack mode). Six NAF soldiers were involved in the experiments. Results of the experiments show up to 43% of muscular endurance decrease, cardiorespiratory endurance decreased by 35%, trunk strength decreased by 22%, explosive

leg power decreased by 26%, flexibility was lost to an amount of 18%, sweating during maximum load increased by 47%, with the combat jacket removed sweating was decreased by 29%. The Harvard step testing results identify the adaptation of the muscle groups to the specific load type and did not show significant changes in strength. The 10×5 m shuttle run (running speed and agility) demonstrated the high quality of the light armour load mode 18:16 sec. (1.7 kg) versus 18:30 sec. (11.0 kg), meaning a high level of modularity of the CIPS. The Flamingo balance test, plate tapping (speed of limb movement) and the handgrip test (static arm strength) showed no influence of the CIPS onto the soldiers' physical conditions.

Keywords: *CIPS, combat clothing, load bearing, EUROFIT tests, Harvard step test, anthropometry, spirometry, endurance, cardiorespiratory system*

Introduction

The state defence concept of the Republic of Latvia (State Defence Concept, 2008) defines initiating operationally tactical requirements of the combat capabilities of the NAF for the protection of the Latvian national interests worldwide. Considering the Latvian membership in NATO and the European Union, as well as the involvement in strengthening international security, Latvian soldiers should be prepared to participate in international operations in geographically distant regions from Latvia and the unusual climate patterns that affect the materials soldiers have to carry to fulfil the tasks on ensuring the national interests of the Republic of Latvia. The soldiers are exposed of artificial threat from hostile forces and operate in an environment where risks, natural or artificial, are connected. The combination of risks influences the architecture of the protection system, the number of elements and their possible combinations. Artificial and natural threats can affect a soldier's life and health from all possible directions, namely, it is isotropic in nature.

The parts of the body of a soldier have to be protected basing on the priority principle of protection. The National Armed Forces have developed an combat individual protection system (Šitvjenkins, 2008) based on a number of operational, technical, political, economical sets of requirements, according to the current global geopolitical situation (Šitvjenkins, Viļumsone, 2009). Currently, the newly created combat individual protection system technological material components protect soldiers from artificial and natural threats only to a certain level. But soldiers could face the modern war. The new system is based on layering of the protection. Depending on the task, a soldier puts on or removes, as well as modulates

the equipment to achieve the most effective combination of layers for a particular task, providing themselves the comfort and sense of security about their equipment, allowing them to focus on tasks.

The combat equipment of soldiers to carry will grow in future as command and control system soldier outfits complemented with a variety of electronic devices and systems for military operations, surveillance, communication, reconnaissance and tracking are developing rapidly. There are a series of solutions for further improvement the future soldier's personal equipment and personal protection system to deal with the increasing weight problem. The solutions mainly show two directions: increasing the soldier's physical ability by applying biotechnologies and textile technologies and combining electronic and information technologies. Currently, these two areas are the main points of interest for military researchers. The NAF and RTU continue to improve the combat individual protection systems on the basis of future developments of material technologies. Currently the RTU based scientific group 1DP/1.1.1.2.0./09/APIA/VIAA/148 "Multi industry scientific group establishing for the purpose of developing new functions of e-textiles and its implementation in innovative products" continue working in the direction of applying new developments in different clothing systems, including military. The implementation of new quality evaluation methodologies to be applied for the analysis of CIPS, is one of the group tasks. One such new quality evaluation technique is the physical fitness testing in the analysis of CIPS influence on the physical condition of the soldiers during different loads.

Materials and methods

In general five different sets of CIPS have been evaluated during the experiments (Table 1). Load types were chosen to modulate CIPS wearing in warm weather condition since testing was carried out in-house with the average temperature 20^0C and air humidity 60%. The main purpose of the research was to evaluate the combat clothing system and load bearing armour system influence on a soldier's physical condition depending on different loads. Combat boots were exchanged with sport shoes, otherwise it would not be possible to identify the individual influence of both types of loads.

Six NAF soldiers were involved in the experiment. Results of the experiments were evaluated as an average score of the unit, consisting of the six soldiers. Two soldiers were from the NAF Joint Headquarters battalion and four soldiers from the NAF Special Task unit. The EUROFIT physical fitness testing (Lāriņš, 2004; EUROFIT) complex covering flexibility, speed, endurance and strength as well as the Harvard step test (Lāriņš, 2004;

The Harvard Step test) were used during the evaluation of the CIPS influence on soldiers.

Table 1

Load modes for CIPS evaluation by EUROFIT and Harvard step testing

Load	20.03.12	21.03.12	22.03.12	23.03.12	24.03.12
	weight, kg	weight, kg	weight, kg	weight, kg	weight, kg
combat underwear (1.level)	0,2100	0,2100	0,2100	0,2100	0,2100
combat jacket	NA	0,5980	0,5980	NA	0,5980
combat pants	0,6160	0,6160	0,6160	0,6160	0,6160
combat pants belt	0,1500	0,1500	0,1500	0,1500	0,1500
combat socks (summer)	0,0480	0,0480	0,0480	0,0480	0,0480
ID-combat patch "LATVIJA and flag"	NA	0,0040	0,0040	0,0040	0,0040
ID-combat patch "Name and last name"	NA	0,0040	0,0040	0,0040	0,0040
ID-combat patch "Rank"	NA	0,0030	0,0030	0,0030	0,0030
ID-combat patch "Unit logotype"	NA	0,0070	0,0070	0,0070	0,0070
BEAR II-combat load bearing vest	NA	1,5250	1,5250	1,5250	NA
pocket set	NA	1,8000	1,8000	1,8000	NA
BEAR II-armour plate 25×30 cm pair	NA	5,3400	5,3400	5,3400	NA
BEAR II-armour vest	NA	NA	2,3550	2,3550	2,3550
BEAR II-armour plate 15×20 cm pair	NA	NA	2,2100	2,2100	2,2100
BEAR II-armour plate 14×20 cm pair	NA	NA	1,4100	1,4100	NA
BEAR II-upper arm protector (right)	NA	NA	0,3900	0,3900	0,3900
BEAR II-upper arm protector (left)	NA	NA	0,3900	0,3900	0,3900
BEAR II-shoulder protector	NA	NA	0,7550	0,7550	0,7550
BEAR II-neck protector	NA	NA	0,2200	0,2200	0,2200
BEAR II-groin protector	NA	NA	0,5950	0,5950	0,5950
BEAR II-groin protector extender	NA	NA	0,2850	0,2850	0,2850
BEAR II-coccyx protector	NA	NA	0,5500	0,5500	0,5500
MMS-assault/3 day backpack	NA	NA	NA	NA	1,7000
sport shoes	0,7100	0,7100	0,7100	0,7100	0,7100
total, kg:	***1,7***	***11,0***	***20,2***	***19,6***	***11,8***

NA – not applicable this testing day

Anthropometric data of the soldiers is reflected in Table 2. The unit's average Body mass index (BMI) is 24,70 kg/m^2, which is considered to be a normal BMI (Lāriņš, 2004; Sauka et al., 2011), and is calculated as a proportion between body weight and height in square.

Table 2

Anthropometric data of the soldiers

N.	*Name*	*Age*	*Height (cm)*	*Weight (kg)*	*BMI (kg/m^2)*	*FVC (l)*	*LI (ml/kg)*	*Chest girth (cm)*
1.	Soldier 1	23	176,00	68,90	22,24	5,55	80,60	102
2.	Soldier 2	30	184,50	92,80	27,26	6,10	65,73	110
3.	Soldier 3	27	178,50	77,40	24,29	5,70	73,64	102
4.	Soldier 4	21	174,50	73,50	24,14	5,90	80,27	98
5.	Soldier 5	20	186,50	84,30	24,24	5,30	62,87	100
6.	Soldier 6	20	188,50	92,50	26,03	6,00	64,86	107
	Average:	***23,5***	***181,40***	***81,60***	***24,70***	***5,76***	***71,33***	***103***

Forced vital capacity (FVC) is the amount of air which can be forcibly exhaled from the lungs after taking the deepest breath possible, measured with a spirometer. Average FVC of the unit is 5,67 l. Average life index is 71,33 ml/kg (considered as normal). LI of and average person is within a range of 65 – 70 ml/kg, for sportsman 75 – 80 ml/kg, for women 55 – 60 ml/kg. The life index is calculated as a proportion between FVC (ml) and body weight (kg) (Lāriņš, 2004; Sauka et al., 2011). According to the anthropometric data the physical condition of the soldiers is appropriate for the EUROFIT physical testing and Harvard step testing.

Anthropometric data of the soldiers chosen for the CIPS evaluation fully complies with the anthropometric data of the main ground combat unit of NAF – Special Force, Infantry Brigade and HQ battalion see Table 3.

Table 3

Anthropometric data of the HQ battalion, Infantry brigade and Special Force

	HQ battalion		Infantry brigade		Special Force	
	heigh, cm	chest, cm	heigh, cm	chest, cm	heigh, cm	chest, cm
Mean	180,55	101,37	179,22	103,88	177,40	104,20
Standard Error	0,44	0,55	0,31	0,38	0,69	0,84
Median	180,00	100,00	180,00	103,00	178,00	105,00
Mode	180,00	96,00	180,00	110,00	176,00	100,00
Standard Deviation	7,01	8,66	7,32	9,01	7,29	8,91
Sample Variance	49,16	75,03	53,57	81,15	53,19	79,47
Kurtosis	0,65	1,71	0,14	1,45	-0,01	0,09
Skewness	-0,05	0,76	-0,06	0,79	-0,18	-0,15
Range	45,00	57,00	40,00	64,00	36,00	45,00
Minimum	162,00	80,00	160,00	80,00	158,00	80,00
Maximum	207,00	137,00	200,00	144,00	194,00	125,00
Sum	45137,00	25139,00	100362,00	58278,00	20046,00	11775,00
Count	250	248	560	561	113	113
Confidence Level (95,0%)	0,87	1,08	0,61	0,75	1,36	1,66

The average height of the CIPS evaluators is 181 cm. The average height of the HQ battalion is 181 cm, Infantry brigade 179 cm, Special Force 177 cm. The average chest girth of the CIPS evaluators is 103 cm. The average chest girth of the HQ Battalion is 101 cm, Infantry Brigade - 104 cm and Special Force - 104 cm. Anthropometric data is reflected basing on the passive experiment made by NAF according to the source [7].

Average results of the EUROFIT physical testing **Table 4**

Loading / Date	*Nr.*	Right hand grip test (kg)	Left hand grip test (kg)	Flamingo balance test	Sit-Ups in 1 min	Flexibility (cm)	Plate tapping (sek.)	Bent arm hang (sek.)	Standing broad jump (m)	Shuttle run (10x5m) sek.	Endurance shuttle run (20 m) min	Sweating (kg)
20.03.12.	***1.***	64	56	6	54	18,50	12	38	2,28	19	7,41	0,40
	2.	50	76	9	54	6,00	10	47	2,38	19	5,50	0,40
	3.	63	64	10	60	3,00	9	43	2,35	18	8,36	0,70
	4.	66	58	8	59	9,00	10	50	2,37	18	7,23	0,40
	5.	72	70	6	56	12,00	9	48	2,32	17	9,15	0,40
1,7	***6.***	76	75	8	64	5,00	10	54	2,50	18	8,38	1,00
Mean		65,17	66,50	7,83	57,83	8,92	10,00	46,67	2,37	18,17	7,67	0,55
Standard deviation		8,95	8,53	1,60	3,92	5,66	1,10	5,57	0,07	0,75	1,28	0,25
Standard error of mean		3,66	3,48	0,65	1,60	2,31	0,45	2,28	0,03	0,31	0,52	0,10
Coefficient of variation		13,74	12,82	20,45	6,78	63,48	10,95	11,94	3,16	4,14	16,63	45,64
Confidence interval		9,36	8,91	1,67	4,10	5,92	1,14	5,83	0,08	0,79	1,33	0,26
21.03.12.	***1.***	58	54	8	44	18,00	9	35	1,98	18	6,1	0,54
	2.	52	76	9	47	4,00	10	40	2,36	20	4,21	0,90
	3.	58	60	6	51	2,00	8	22	2,21	19	8,03	0,78
	4.	65	62	13	57	9,00	8	49	2,08	18	7,39	0,68
	5.	68	66	7	59	14,00	7	39	2,22	18	8,25	0,54
11,0	***6.***	78	72	4	56	5,50	8	44	2,37	18	7,35	1,06
Mean		63,17	65,00	7,83	52,33	8,75	8,33	38,17	2,20	18,50	6,89	0,75
Standard deviation		9,22	8,07	3,06	5,99	6,19	1,03	9,24	0,15	0,84	1,51	0,21
Standard error of mean		3,76	3,30	1,25	2,44	2,53	0,42	3,77	0,06	0,34	0,62	0,08
Coefficient of variation		14,59	12,42	39,07	11,44	70,80	12,39	24,21	6,96	4,52	21,94	27,49
Confidence interval		9,63	8,44	3,20	6,26	6,47	1,08	9,66	0,16	0,87	1,58	0,22
22.03.12.	***1.***	61	56	5	35	13,00	10,00	18,13	1,98	21,09	5,08	0,60
	2.	53	83	5	43	2,00	10,22	25,93	2,32	18,62	2,34	2,40
	3.	67	64	8	43	1,00	9,44	8,47	2,14	19,94	5,52	0,70
	4.	66	61	14	51	10,00	12,87	34,35	1,88	19,34	5,41	0,80
	5.	76	69	7	50	11,00	9,00	21,00	2,15	18,85	6,16	0,60
20,2	***6.***	84	78	5	50	7,00	10,63	25,93	2,29	18,62	5,05	1,10
Mean		67,83	68,50	7,33	45,33	7,33	10,36	22,30	2,09	19,41	4,93	1,03
Standard deviation		10,94	10,33	3,50	6,22	4,93	1,36	8,74	0,18	0,97	1,33	0,69
Standard error of mean		4,47	4,22	1,43	2,54	2,01	0,55	3,57	0,07	0,39	0,54	0,28
Coefficient of variation		16,13	15,08	47,76	13,72	67,17	13,11	39,19	8,37	4,98	26,98	67,23
Confidence interval		11,44	10,80	3,66	6,50	5,15	1,42	9,13	0,18	1,01	1,39	0,73
23.03.12.	***1.***	60	52	7	37	17,00	9,79	18,47	1,87	20,38	4,26	0,40
	2.	52	84	7	45	2,00	9,91	31,53	2,32	19,66	3,23	0,90
	3.	68	65	9	41	2,00	7,88	17,38	2,2	19,75	6,07	0,90
	4.	65	64	13	51	10,00	8,53	35,5	1,92	19,19	5,2	0,50
	5.	79	72	5	52	10,00	7,4	29,31	2,1	18,29	7,15	0,60
19,6	***6.***	76	78	8	53	7,00	8,03	31,91	2,14	18,6	6,25	1,10
Mean		66,67	69,17	8,17	46,50	8,00	8,59	27,35	2,09	19,31	5,36	0,73
Standard deviation		10,03	11,36	2,71	6,57	5,69	1,04	7,57	0,17	0,78	1,43	0,27
Standard error of mean		4,10	4,64	1,11	2,68	2,32	0,43	3,09	0,07	0,32	0,59	0,11
Coefficient of variation		15,05	16,42	33,23	14,12	71,15	12,12	27,69	8,14	4,02	26,74	37,26
Confidence interval		10,49	11,87	2,84	6,86	5,95	1,09	7,92	0,18	0,81	1,50	0,29
24.03.12.	***1.***	60	55	7	NA	22	9,13	25,22	1,95	19,91	5,44	0,30
	2.	51	78	10	NA	3	9,3	30,84	2,3	19,53	4,3	1,20
	3.	66	65	9	NA	4	8,47	16,97	2,24	19,69	6,53	1,00
	4.	63	61	9	NA	10	8,65	25,93	2,01	19,19	7,21	0,70
	5.	70	64	7	NA	12	7,55	32,62	2,22	18,34	8,22	0,70
11,8	***6.***	78	70	10	NA	1	8,75	43,03	2,37	18,34	7,34	0,80
Mean		64,67	65,50	8,67	NA	8,67	8,64	29,10	2,18	19,17	6,51	0,78
Standard deviation		26,40	26,74	3,54	NA	3,54	3,53	11,88	0,89	7,82	2,66	0,32
Standard error of mean		9,16	7,87	1,37	NA	7,79	0,62	8,74	0,17	0,68	1,42	0,31
Coefficient of variation		14,16	12,01	15,76	NA	89,87	7,14	30,02	7,60	3,56	21,88	39,07
Confidence interval		9,57	8,22	1,43	NA	8,14	0,65	9,13	0,17	0,71	1,49	0,32

Table 5.

Correlation of the testing groups and main results

	Flamingo balance test	Sit-Ups in 1 min	Flexibility (cm)	Plate tapping (sek.)	Bent arm hang (sek.)	Standing broad jump (m	Shuttle run (10x5m) sek	Endurance shuttle run (20 m) min.	Sweating (kg)	Right hand grip test (kg	Left hand grip test (kg)
1,7	7,83	57,83	8,92	10,00	46,67	2,37	18,17	7,67	3,30	65,17	66,50
11,0	7,83	52,33	8,75	8,33	38,17	2,20	18,50	6,89	4,50	63,17	65,00
20,2	7,33	45,33	7,33	10,36	22,30	2,09	19,41	4,93	6,20	67,83	68,50
19,6	8,17	46,50	8,00	8,59	27,35	2,09	19,31	5,36	4,40	66,67	69,17
11,8	8,67	NA	8,67	8,64	29,10	2,18	19,17	6,51	4,70	64,67	65,50
Corelation group	0,0241	0,9945	0,0069	0,8811	0,8811	0,9794	0,8403	0,9488	0,6343	0,3861	0,4346

Results

The Excel statistics package was used to calculate the statistical data of the results. Refer to Table 4 and Table 5 as well as source [10]. Five different sets were evaluated during the experiments with the following loads – 1,7 kg (light clothing mode – day 20.03.12), 11,0 kg (light armour mode – day 21.03.12), 20,2 kg (heavy armour mode – day 22.03.12), 19,6 kg (heavy armour mode without combat jacket – day 23.03.12), 11,8 kg (backpack mode – day 24.03.12). Six NAF soldiers were involved in the experiment. Results of the experiments were evaluated as an average score of the six soldier unit. The total score of the results was calculated in sweating test. Muscular endurance measured by Bent Arm Hang test showed a decrease of 43% when load was increased – (Figure 1). The location of the load had a significant influence on the decrease of muscular endurance – load 11,0 kg (light armour mode) - 38 sec., compared to 11,8 kg (backpack mode) - 29 sec. due to location of the load on the back. Explosive leg power measured by the Standing broad jump test showed a decrease by 26% when the load was increased - 2,36 m. (1,7 kg), 2,20 m. (11,0 kg), 1,75 m. (20,2 kg).

After removing the combat jacket, explosive leg power increased by 15% (Figure 1). Combat jacket restricts impulsive movement of the both hands before jump, what influents on the jump distance. Results of both tests statistically proved that strength is directly correlated with load modes (Table 4, Table 5).

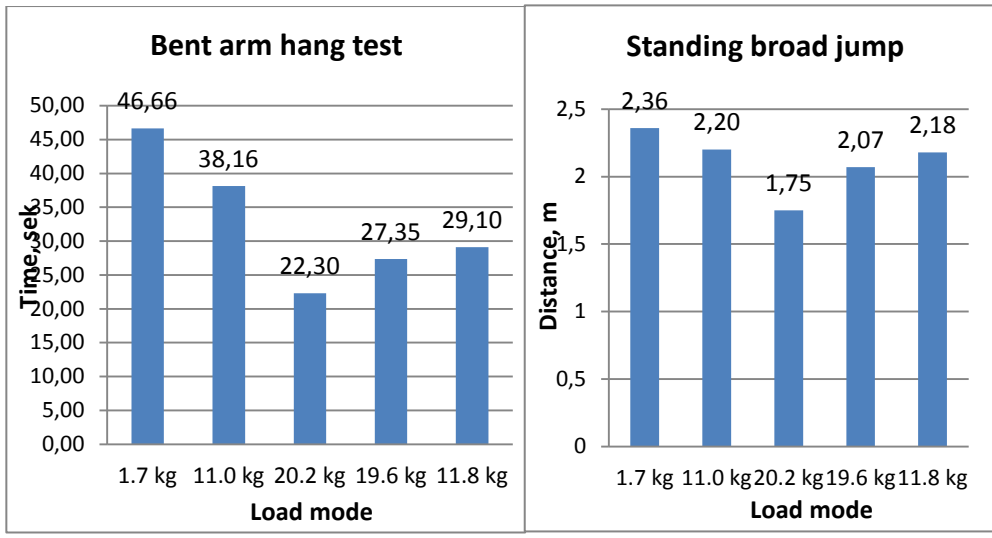

Figure 1. Results of the bent arm hang strength and leg power testing

A decrease of trunk strength by 22% was observed, measured by the 1 min sit-ups test. Sit-up testing was not carried out with the backpack load mode due to limitations of the space between soldier's back and floor (Fig. 2).

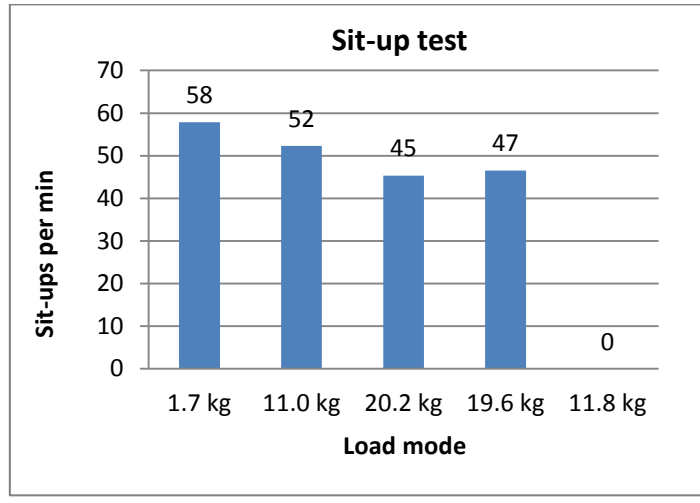

Figure 2. Results of the trunk strength testing

Results of the tests statistically proved that strength is directly correlated with load modes (Table 4, Table 5). There is no significant decrease in running speed and agility measured in a 10×5 m shuttle run

test between load mode 1.7 kg and 11.0 kg. However there is significant decrease in running speed and agility between load 11.0 kg and 20.2 kg. (Fig. 3). Results of the shuttle run test show the high quality of the CIPS light load mode (11.0 kg) at high speeds, short time moving conditions. When performing long time, low speed movements, results show significant decrease in the cardiorespiratory endurance in maximum load mode of 20,2 kg by 35% (Figure 3). Heavy load mode is considered to be used for the load speed stationary type of the operations. Results of the tests statistically proved that strength is directly correlated with load modes (Table 4, Table 5).

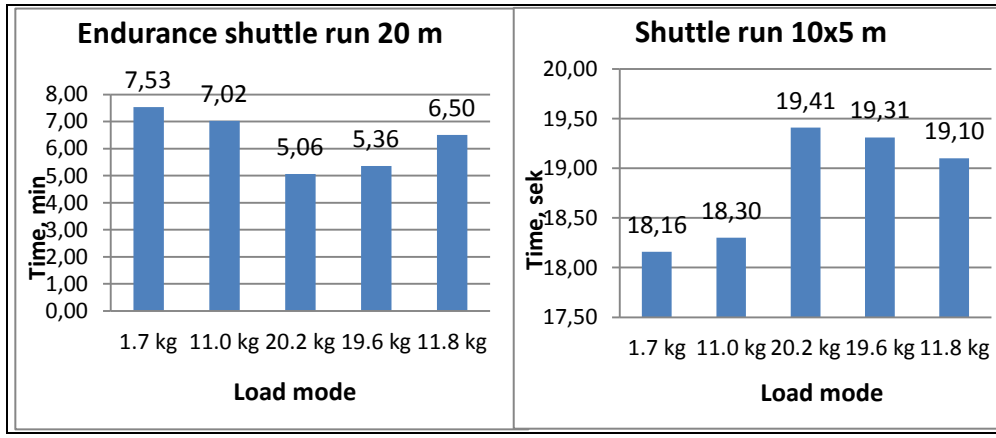

Figure 3. Results of the shuttle run and endurance shuttle run

The amount of water lost by sweating is a vital parameter in the quality evaluation of the CIPS. During the experiments the amount of water lost by sweating was measured by the difference in the soldier's weight before testing and after. They were not allowed to drink water during testing. The highest average water loss increase was 47% for the unit (Fig. 4). The amount of water lost decreased by 29% when the combat jacket was removed from the set with an equal amount of armour load 6,2 kg (20,2 kg), 4,4 kg (19,6 kg – without combat jacket). Such a decrease of sweating proves the necessity of a combat shirt as a design combination between combat underwear (1.level) T-shirt and a combat jacket (Figure 4). The influence of the combat jacket is one of the load modes from the aspect of the heat transfer and physiological evaluation of the clothing systems [11], proved also by EUROFIT testing. Due to the combat jacket removal during the load mode 19.6 kg, there is no strong correlation between sweating and the load mode, showing another type (thermal) loads' strong influence on

the soldier's combat ability, which complies with the theory of the rectal temperature depending on the clothing system due to water vapour resistance. With the removal of the combat jacket the water vapour resistance decreased thereby decreasing the amount of water lost by sweating by 29% under the same armour load. The accuracy level of the results is higher than with separate measurements (Table 4), which, from the statistical aspect, made results not acceptable for interpretation. The reasons for such wide variations are the differences of the body strength to the reaction on increased load. Soldier Nr.6 showed following sweating results - 1.0 kg (1.7 kg load), 1.06 kg (11.0 kg load), 1.10 kg (22.2 kg load), 1.10 kg (19.6 kg load), 0.80 kg (11.8 kg load). Such results of one soldier in the group of six soldiers only create larger statistical variations. From the perspective of the heat transfer theory and physiological evaluation, with the growing armour load, sweating is increasing; with the increasing thermal load (clothing), sweating is increasing in all other equal conditions [11]. From the point of view of the heat transfer theory the results of the testing can be considered as acceptable.

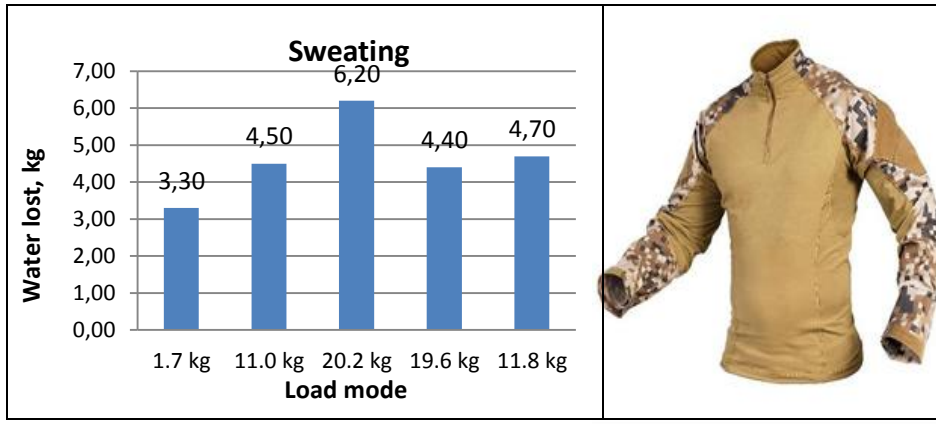

Figure 4. Results of the sweating evaluation and the combat shirt

During the flexibility evaluation by Sit-and-Reach testing, 18% of the flexibility lost was scored at maximal load – 20,2 kg accordantly 7,3 cm (Figure 5). Losing flexibility is not so significant. Even with full protection of the load bearing armour system, flexibility decreases by 18% only (Figure 5). Results of the flexibility testing were not statistically proved (Table 4). The reason for the wide variations of the results was the wide variation of the soldiers' body flexibility (Table 4). Example - day 21.03.2012, Soldier 1 (18.5 cm), Soldier 2 (6 cm), Soldier 3 (3 cm), Soldier 4 (9 cm), Soldier 5 (12 cm), Soldier 6 (5 cm). Further days of testing

showed little influence of the CIPS, even when analysing every soldier's results (Table 4). Low CIPS influence on the flexibility was also proved by the low correlation with the load modes (Table 4). The low influence on the soldier flexibility demonstrates the high quality of the CIPS. From the perspective of the gained measurements, the CIPS can be considered to be of high quality, however, for future testing soldier groups should be set a flexibility range with a statistical deviation.

There is no significant change in CIPS balance evaluation by the Flamingo Balance test - 8 see (Fig. 5). However, the most frequent average number of falling actions (9) is scored during the 11,8 kg (backpack mode) load. The backpack is located behind the back with some distance between the body mass centre and the backpack mass centre, which causes a decrease in the level of stability and more frequent falling actions during the Flamingo Balance test. The results show the high quality level of the ergonomics of the load bearing armour system (Fig.5).

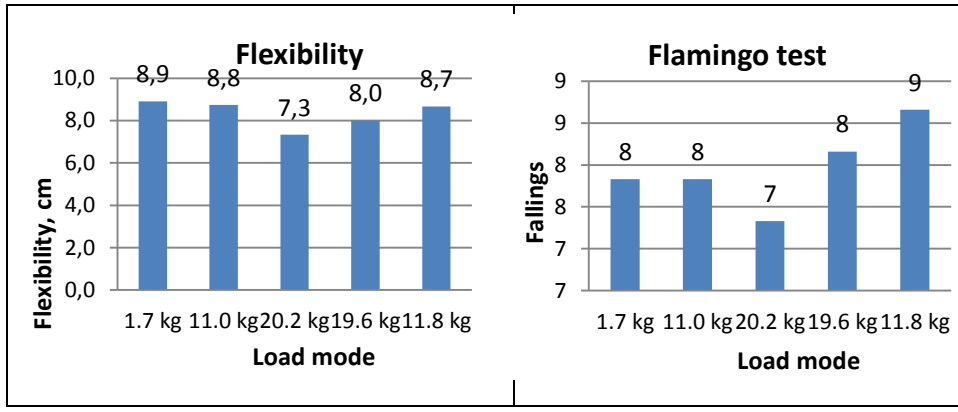

Figure 5. Results of the flexibility and balance evaluation

During the measurement tests of static arm strength by hand grip the following results were recorded showing insignificant influence of the CIPS on arm strength. Both tests show the high quality of CIPS. No significant decrease in arm strength and limb movement has been recorded. A supremacy of the left hand has been detected due to the significant strength of the left hand evaluator Nr.2 (Table 4). In the limb movement speed test, measured using the plate tapping method (Fig. 6). The results testify that limb movement is not influenced by load in this particular test, even with the heaviest load of 20,2 kg. The results of the plate tapping test showed no influence on soldiers by CIPS in the particular test method (Fig. 6). For future testing it is necessary to evaluate the necessity of arm strength and

limb movement testing for the evaluation of CIPS due to the low correlation to load modes, not allowing interpreting the results as quality characteristics of the CIPS (see Flamingo test low correlation).

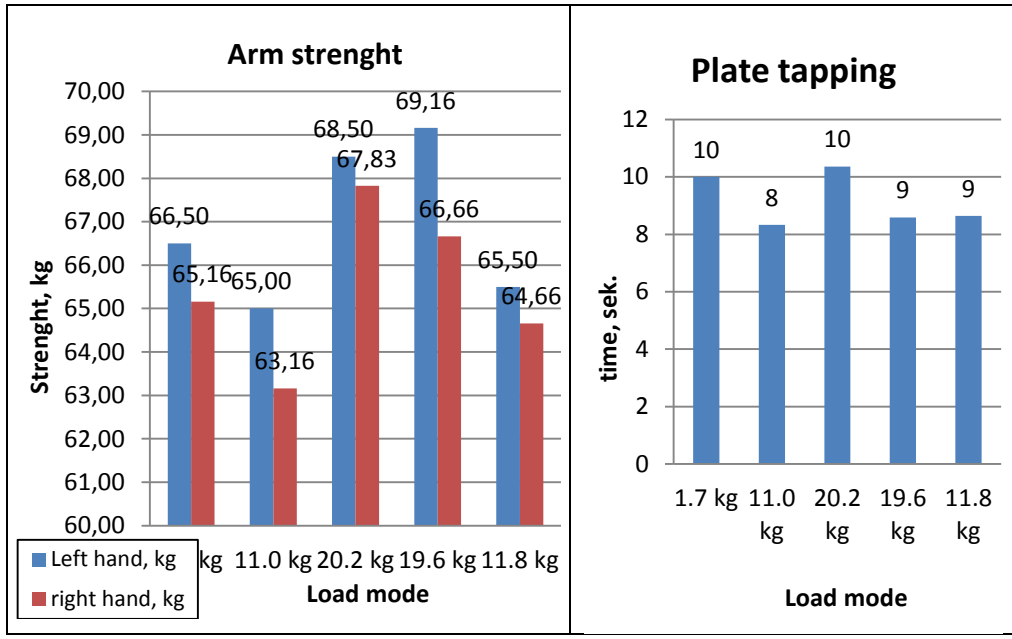

Figure 6. Results of the arm strength and limb movement evaluation

The Harvard Step test is an aerobic fitness test, developed by Brouha et al. (1943) in the Harvard Fatigue Laboratories during World War II [6]. The features of this test are that it is simple to conduct and requires a minimum of equipment. Harvard step testing results identify the adaptation of the muscle groups to the specific load type, not showing significant changes in strength.

During the tests some psychological influence of the results has been identified (Fig. 7). The recovery line of the heart rate on 1st test of the load mode 1,7 kg is higher compared to the 2nd test at load mode 11,0 kg. Such results can be explained by the psychological influence on the heart rate. Psychological influence can be avoided by a more thorough explanation about the testing aspects to the soldiers during the testing preparation period, as it is suggested by the EUROFIT testing methodology.

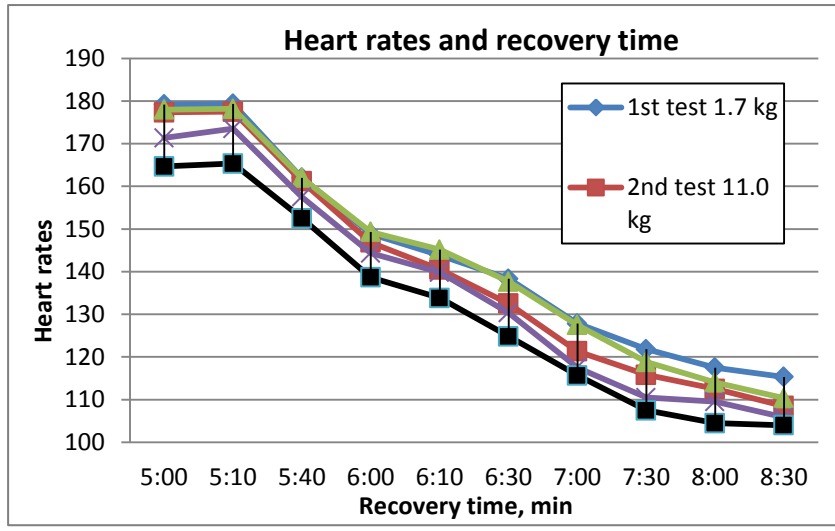

Figure 7. Results of the Harvard step test

Discussion

Since Republic of Latvia is the member of the North Atlantic Treaty Organization (NATO) the requirements of the Standardization agreement (STANAG) has been followed in the field of the quality evaluation combat clothing and personal protective equipment. Relevant STANAG 2138 PCS "Troop trial principles and procedures – Combat clothing and personal equipment" covering user trial of material (item of clothing or personal equipment) by military units in the field under operational conditions [12]. However negative feedback of the US Marine Corps (USMC) deployed modular tactical vests (MTV) [13, 14] after successful field trial [15] raises doubts about troop trial correct methodology and results analysis and interpretation. Unfortunately there is no such possibility to evaluate testing methodologies and result interpretation due to data not availability on open information sources. Such a doubt in the troop trials showing necessary in trial by imitation combat activity in laboratory condition by such EUROFIT and Harvard step test system before starting field trial by combat units in operational area. More over quality of the plate carrier mode type of the body armour (load mode 11.0 kg) comparing with full load bearing armour load (load mode 20.2 kg) can be evaluated during EUROFIT and Harvard step test. Both testing systems can be provided without involving military units like USMC did with evaluation of the body armour vest and scalable plate carriers [16]. Comparing with troop trial results laboratory troop trial

by EUROFIT and Harvard step test showing statistically proved and trusted results with the same conclusions like troop trial.

Conclusion and future tasks

EUROFIT and Harvard step test are effective and statistically trusted testing tools can be applied on the quality evaluation of the CIPS influent on soldier by measurement several soldier body parameters, describing combat ability. Both testing systems can be successfully applied to newly developed body armour systems as well as benchmarking evaluation between several body armour system solution and other personal protection equipment in the event of the sole source decision making or decision of the implementation prototypes into Army logistics supply. From the perspective of the human sources EUROFIT and Harvard step test system are cost effective testing solutions without influent on the combat unit daily standard operation procedure, training and military tasks. EUROFIT and Harvard step test system are not required expansive laboratory equipment and facilities and can be provided by the responsible personnel for the Soldier Systems quality assurance as well as under supervision of Army fitness instructors. EUROFIT and Harvard step test results are statistically analysed, which avoid any doubts about trust to the results. After applying EUROFIT and Harvard step test the requirements in the troop trial also should be fulfilled as required STANAG 2138 PCS "Troop trial principles and procedures – Combat clothing and personal equipment". For the future task beside CIPS physiological influence on the soldiers body, additionally the psychological influence should be evaluated and testing system should be established to provide full spectrum evaluation system for the CIPS quality.

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INVESTING IN YOUR FUTURE

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ORIGINAL RESEARCH PAPER

COMPARISION OF ANTHROPOMETRIC AND PERFORMANCE CHARACTERISTICS IN AMATEUR AND PROFESSIONAL LEVEL HANDBALL PLAYERS

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Abstract

The aim of our investigation is to compare anthropometric and performance characteristics of Latvian male young amateur level handball players with these characteristics in amateur and professional players from European countries. Eleven 19 - 21 year old male players trained in handball from ten to 14 years five times per week and playing regularly in weekends from the team of Latvian Academy of Sports Education (LASE) voluntary participated in the investigation. A vertical jump height is measured on a special platform. The throwing speed of the ball was measured by a reflected light method. The aerobic capacity of handball players is measured by load test on a treadmill, the speed of running increased step by step. The oxygen uptake and heart rate are measured during the test. The lactic acid level in the plasma is detected in periphery blood samples by special strips. The height and weight of LASE amateur handball players correspond with these characteristics in European amateur players. Our athletes are 2 – 4 cm shorter and have approximately 10 kg less weight in comparison with the professional level handball players. This can be explained by greater skeletal muscles mass in International level athletes. The vertical jump height and maximal ball throwing speed in LASE athletes are close with the data of Spanish amateur and professional players. Aerobic capacity of our handball players is approximately for 20 % lower in comparison with the amateur and professional athletes from France. Its value coincides with the norm for young untrained males. This means that our handball players need to improve their aerobic endurance.

Key words: *anthropometric characteristics, vertical jump, throwing speed, aerobic capacity, handball*

Introduction

Mean height and weight increase is observed in international level handball players during the last 20 - 30 years (Gorostiaga et al., 2005). A large height and lean body mass due to hypertrophied skeletal muscles are beneficial for performance in adult professional handball players (Gorostiaga et al., 2005). A taller stature is an advantage for throwing, stealing and handling of the ball in a direct duel with an opponent during the game.

Handball is a very strenuous team sport. Therefore handball players need high levels of anaerobic capacities determining the muscle power to achieve a fast running speed, powerful jumping and ball throwing (Rannou et al., 2001; Ziv & Lidor, 2009). This is proved by the fact that the maximal power, produced by arm muscles in a heavy weight horizontal bar press from supine position does not differ significantly between the handball players and weight lifters, but the strength for the weight lifters is significantly higher (Izquierdo et al., 2002). The higher absolute maximal strength and muscle power in the professional handball players in comparison with amateur players indicate that these parameters are important for successful performance in high-level handball (Gorostiaga et al., 2005). The effect of great skeletal muscles mass may be beneficial for throwing power improvement, but may decrease jumping abilities of the players.

An aerobic capacity also should be important to maintain high performance level of the athletes throughout all the game (Gorostiaga et al., 2005; Rannou et al., 2001). Buchheit M. et al. (2009) determined that approximately 90% of the energy released during a handball game is supplied by aerobic mechanisms. This means that an improved aerobic capacity must be important for a faster recovery between high-intensity efforts during match-play (Rannou et al., 2001), and a greater resistance to fatigue during training and competition (Zapartidis et al., 2009). The fatigue causes a reduction in throwing accuracy towards the end of each half in a simulated handball game (Zapartidis et al., 2007).

Significantly greater power characteristics (counter-movement jump height, handgrip strength, sprint running speed) and aerobic capacity are observed in elite adolescent (14 – 18 year olds) handball players in comparison with the non-elite adolescent athletes (Stijn et al., 2011).

The aim of our investigation is to compare anthropometric and performance characteristics of Latvian male young amateur level handball players with these characteristics in amateur and professional players from European countries.

Material and Methods

Eleven 19 - 21 year old male players trained in handball from ten to 14 years five times per week and playing regularly in weekends from the first league handball team of Latvian Academy of Sports Education (LASE) voluntary participated in the investigation. The study was performed in conformity with the standards of the Ethics Committee of the Latvian Council of Sciences. The anaerobic and aerobic performance tests are performed in the end of the first part of competition period.

Vertical jumps heights are measured on special platform (PD. 3A, Moscow, Russia). Before the jumping test the players performed general warming up for 15 minutes. Two kinds of jumps are performed: from standing position on the apparatus platform: 1) squat jump (SJ): from the standing position and before to jumping squat was performed until the knee was flexed approximately to 90˚ and hands on hips (SJ) and 2) countermovement jump (CMJ): from the standing position and before to jumping squat was performed until the knee was flexed approximately to 90˚ and free movements of the arms (CMJ). Every kind of jumps repeated five times, and the best results (highest SJ and CMJ) are taken into account.

The ball throwing speed (m/s) was measured by a special system "Superschus" (EDV-Beratung Arbeiter, Bremen, Germany). Before the throwing test the athletes performed general warming up for 15 minutes. The handball player threw a 0.4 kg ball at a maximal speed six times holding feet (including a front foot) on a floor. A distance between the athlete and the ball speed measuring device was 2.5 m. The speed was recorded by reflected light rays. The best result (highest speed of the ball) was taken into account.

Every handball player performed incremental load test to exhaustion – a running test on a treadmill. Cardiopulmonary diagnostic equipment „Oxygen Mobile Via Sys" (Via Sys Healthcare GMBH, Germany) was used to register an electrocardiogram and respiratory characteristics. A mean duration of the test was 28 ± 2 minutes. A lactic acid concentration in the capillary blood was detected by a special lactate analyzers „Biosen 5030" (EKG – diagnostic, Germany) every two minutes (in the end of every load intensity step). The speed of running on a treadmill increased step by step every two minutes for 0.15 m/s.

The aerobic capacity characteristics: absolute and relative oxygen uptake, running speed and power are determined at the aerobic and anaerobic threshold, as well as, the maximal oxygen uptake loads. The average aerobic performance characteristics were determined at aerobic threshold intensity load. It was the workload, when a lactic acid concentration started to increase above the rest level. A break point was

seen in the relationship between the workload on the ergometer and the lactic acid concentration in the capillary blood (Coyle, 1995). They were determined at the anaerobic threshold intensity workload (onset of the blood lactate accumulation), when the lactic acid concentration in the capillary blood rapidly increased (it was below or close to 4 mmol/l). The break point was seen in relationship between the running speed on treadmill and concentration of the lactic acid in the blood (Sjodin & Jacobs, 1981). The same aerobic performance characteristics were determined at the maximal oxygen uptake load.

The mean values and standard deviations are calculated for all determined characteristics in handball players. A correlation analysis was done to determine the relationships between the anthropometric parameters, and the anaerobic and aerobic performance characteristics (significance $p < 0.05$).

Results

The mean anthropometrical characteristics of the handball players are shown in the Table 1. The mean height of LASE players is above 180 cm, only two players are shorter. The mean body weight is close to 85 kg, the weight greater than 90 kg is observed in two athletes, as well as, more than 100 kg in two players. The mean value of the body mass index is close to the upper border of norm, but this value is increased and exceeds 26 kg/m² in thee players.

The mean height of squat jump is 47.5 ± 7.0 cm (Table 1), this value exceeds 50 cm in five athletes. The countermovement jump height is higher for approximately 9 cm, the mean value is 57 ± 10 cm, the height is more than 60 cm in four players and exceeds 70 cm in one athlete. The relationship between the body mass index in the handball players and the vertical jump height is not significant for both kinds of jumps: squat jump (coefficient of correlation $r = - 0.08$; $p > 0.05$) and countermovement jump ($r = - 0.11$; $p > 0.05$).

Table 1

Mean anthropometric and power characteristics of the LASE team amateur handball players

Charac-teristic	Age, years	Height, cm	Body weight, kg	Body mass index, kg/m²	Squat jump height, cm	Counter-movement jump height, cm	Ball throwing speed, m/s
Mean ± S.D.	20 ± 1	186.7 ± 8.1	84.7 ± 11.1	24.2 ± 1.7	47.5 ± 7.0	57,1±10,1	26.4 ± 1.5

The mean ball throwing speed is 26.4 ± 1.5 m/s. This value varies from 24 to 29 m/s in different players. The relationship between the body mass index and handball throwing speed is not significant (r= - 0.33; p>0.05).

The aerobic capacity characteristics of our handball players are shown in the Table 2. The mean heart rate at the aerobic threshold load in handball players reaches 78 ± 2 % of the maximal heart rate (HR_{max}). This means that the aerobic threshold load intensity in LASE handball players is between medium and high intensity (McArdle et al., 2000).

The mean heart rate at the anaerobic threshold load intensity in our players is fast: 169 ± 6 beats per minute. It coincides with 91 ± 2 % from the maximal heart rate. This means that the aerobic capacity of the athletes is rather low. From the data of other authors (Gorostiaga, 2005) the mean heart rate of handball players during the match-play is over 80 % from the maximal heart rate. This value for our players relates to 149 beats per minute and more. This means that the mean load intensity during the game is between the aerobic and anaerobic thresholds and some time periods the heart rate exceeds the anaerobic threshold. The mean relative maximal oxygen uptake in LASE handball players is 46.4 ± 4.4 ml/kg min.

Table 2

Aerobic capacity characteristics of LASE handball players at the aerobic and anaerobic threshold load intensity

Load intensity	**Running speed, m/s**	**Heart rate, beats per minute**	**Heart rate, % from the HR_{max}**	**Oxygen uptake, ml/kg min.**	**Oxygen uptake, % from VO_2 max**
Aerobic threshold	2.70 ± 0.22	145 ± 6	78 ± 2	33.5 ± 4.0	72.1 ± 6.0
Anaerobic threshold	3.63 ± 0.24	169 ± 7	91 ± 2	41.1 ± 4.9	88.7 ± 4.4

Discussion

The mean height of the professional handball players in Spain: 188.7 ± 8.0 cm (Gorostiaga et al., 2005) and in France: 190.0 ± 1.2 cm (Rannou et al., 2001) exceeds the mean stature of LASE amateur players (186.7 ± 8.1 cm). The height of our players is close to this characteristic in Spain amateur handball players: 183.8 ± 7.0 cm (Gorostiaga et al., 2005), but amateur players in France are shorter (their mean height is 177.0 ± 1.4 cm (Rannou et al., 2001).

The mean body weight in LASE handball players 84.7 ± 11.1 kg is slightly greater in comparison with amateur athletes from Spain (82 ± 10 kg), but the professional players from Spain (body weight 95 ± 13 kg) are

heaver for approximately 10 kg than our players (Gorostiaga et al., 2005). This can be explained by greater skeletal muscles mass in the professional level Spanish athletes (their fat free body mass is 81.7 ± 9 kg and body fat is in norm: 13.8 ± 2 % (Gorostiaga et al., 2005) in comparison with Latvian amateur players. Our handball players are heaver in comparison with the amateur (mean body weight 74 ± 2 kg) and professional (mean body weight 79 ± 1 kg) players from France (Rannou et al., 2001).

The mean squat jump height (47.5 ± 7.0 cm) in LASE athletes coincides with the data of Spanish amateur (46.9 ± 7.0 cm) and professional players (46.8 ± 7.0 cm) (Gorostiaga et al., 2005). The significantly higher body mass of the professional European handball players can be a reason of the maximal squat jump height decrease.

The mean height of the countermovement jump in our players is 57.1 ± 10.1 cm. This characteristic is not measured in the Spanish and France handball players but the data from the former Soviet Union professional handball players at 70-ties of the 20 century are available: their mean countermovement jump height was 93 cm (Wallace & Cardinale, 1997). The body weight of players was lower before some decades (Gorostiagaet al., 2005). Therefore it was safer to use plyometric training to improve the vertical jump height. The plyometric exercises must be used with caution in athletes with the body weight above 90 kg because the risk of sport injuries is increased (Wallace & Cardinale, 1997). The weight greater than 90 kg is observed in two athletes and more than 100 kg in two players in the LASE team.

The mean maximal ball throwing speed in LASE athletes (26.4 ± 1.5 m/s) also is close to Spanish amateur (21.8± 1.6 m/s) and professional players (23.8± 1.9 m/s) (Gorostiaga et al., 2005). The maximal ball throwing speed in Latvian amateur male handball players is measured as the maximal forceful ball throw velocity from the standing position. In Spanish athletes the maximal ball throwing speed from the standing position to the goal is measured. It must be more difficult task and needs additionally good coordination of movements to throw ball to the goal.

The relative maximal oxygen uptake of our handball players (46.4 ± 4.4 ml/kg·min.) is approximately for 20 % lower in comparison with the same characteristic in amateur (57.3 ± 3.1 ml/kg·min.) and professional (58.7± 0.9 ml/kg·min.) athletes from France (Rannou et al., 2001). The mean relative maximal oxygen uptake in LASE amateur players coincides with the norm for young (20 – 29 year olds) untrained males: from 42.5 to 46.5 ml/kg·min. (Cooper, 1982). This means that our handball players need to improve their aerobic endurance and performance of cardiovascular system.

Conclusions

1. The height and weight of LASE amateur handball players correspond with these characteristics in European amateur players. Our athletes are 2 – 4 cm shorter in comparison with the professional level handball players. LASE handball players have approximately 10 kg less weight in comparison with the Spanish professional level handball players, but our players are heaver in comparison with the amateur and professional players from France.
2. The vertical jump height and maximal ball throwing speed in LASE athletes are close with the data of Spanish amateur and professional players. The correlations between the body mass index in the LASE handball players and power characteristics (the vertical jumps height and the ball throwing speed) are not significant ($p > 0.05$). This means that skeletal muscles hypertrophy in professional handball players does not give them advantages in jumping and throwing abilities. The plyometric exercises must be used with caution in professional athletes with great body mass due to muscles hypertrophy. Therefore the height of vertical jumps in professional players is not higher in comparison with amateur athletes.
3. Aerobic capacity of our handball players is approximately for 20 % lower in comparison with the amateur and professional athletes from France. Its value coincides with the norm for young untrained males. This means that our handball players need to improve their aerobic performance.

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ORIGINAL RESEARCH PAPER

UNIVERSITY STUDENTS` COMPLEX ESTIMATION OF A PHYSICAL CONDITION

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Abstract

Various studies about the physical health and lifestyle of studying youth are conducted in all developed countries. The particular interest was created by research of Russian scholars (Баевский, Иванов & Рыбыкина, 1999; Чуян, Бирюкова & Раваева, 2008) on application of new technologies for defining the functional state of young people's bodies. The aim of our work is to define the current body functional state of students of Liepaja University (LiepU) and Medical College – Liepaja branch of Riga Stradins University (RSU). For definition of the current body functional state of students we used the program "Omega-M", which analyses extensively and interprets the electrosignals of cardiac rhythm. 182 full-time and 28 part-time students of LiepU and RSU medical college Liepaja branch were involved in our research; students were divided into 3 groups. The new technique is portable, convenient to use and provides detailed information on the functional state of the human body; already prepared conclusions have been pre-programmed into the equipment that inform about the current functional condition of a human body, so there is an opportunity to inform the young people about the physiological processes taking place in their bodies, encouraging them to focus more on health-promoting measures. The obtained results indicate the weakening of body's functional state of part-time students. Therefore the further research is needed in order to define which factors significantly affect the overall functional status of students' bodies.

Keywords: *students, heart rate, functional condition of human body, "Omega – M" programm*

Introduction

In Youth Law of Latvia, the youth is defined as persons in the age of 13 to 25. The aim of Youth Law is to ensure the life quality of young people by promoting their initiatives, work virtue and patriotism, participation in decision-making and social life, as well as supporting the youth work. One of the priorities of Youth Policy State Programme for years 2009-2013 is to improve the health situation of young people. (Youth Policy State Programme for years 2009-2013, IZMProg_270111_JPVP). The "White Paper" of Council of Europe stresses the need for health improvements, developing next Strategic approach for health preservation and improvement for years 2008-2013. (White Paper. Together for Health: A Strategic Approach for the EU 2008-2013). But the resolution of European Union Member States from November 2008 emphasizes the need to address the key health protection factors such as diet, physical activity, consumption of alcohol, drugs and tobacco and environmental hazards, the importance of the gender, and also to highlight the need to promote health in everyday life - in families, schools, workplaces and leisure activity sites (Official Journal of the European Union C 319/1. 13.12.2008). Nowadays the higher education policy is directed towards the quality of studies and application of latest scientific achievements in the study process, involving students in scientific research work. The higher education policy of Latvia does not provide the health monitoring of students, and also sports activities are not provided in all higher educational establishments, regardless of Latvia Law of Higher Education, Article 5, paragraph 1, which states the following: The founders of the higher educational establishment set the goals for a particular institution. The establishments within their autonomy provide the integrity of studies and research, the opportunity to acquire knowledge, academic education and vocational skills, academic degrees and professional qualifications in the spheres of social life, economy, culture, healthcare, government institutions and other professions. Through activities they cultivate and develop science and arts. Higher education establishments provide students with opportunities for sports activities (Law of Higher Education). The Law of Higher Education do not have provisions for health improvements of students or health-related educational programs placing the health care of students in their own hands. Three-quarters of surveyed higher education and vocational school students (75%) evaluate their health as good or quite good (Koroļeva, 2010) , but the study process is connected with intensive and intellectual work, which requires high adaptability of the organism, which in turn depends from a number of factors – young person's genetics, lifestyle and environmental factors. One can change his/her

lifestyle, but considering the general trend of human activity – to follow the „normal" or „easiest" path, the higher education establishments should think not only about providing academic knowledge but also about targeted young people's involvement in regular health-promoting activities, because a healthy and skilled workforce is an invaluable benefit to each country. "Young people are an important resource for the future of each country; therefore society has to invest in their health and development. Young people are not a source of the problem – they are the resource for addressing the problems. They are not expenses, but rather investments: not only young people but citizens of the world both now and in the future" (Trapenciere, Baltiņš, 2010).

Various studies about the physical health and lifestyle of studying youth is conducted in all developed countries, for example, in USA (Johnson, 2006; Hicks & Miller, 2006; Irazusta, Ruiz, Jauregi, Irazusta & Gil, 2006; Adams & Moore, 2007), Spain; (Gómez-López, Gallegos & Extremera, 2010), Poland (Soroka, Baj-Korpak, Korpak & Pocztarska-Dec, 2011), Russia (Баевский, Иванов & Рыбыкина, 1999; Сорокина & Сорокин, 2009; Чуян, Бирюкова & Раваева, 2008; Судиловская, 2005). The particular interest was created by research of Russian scholars (Баевский, Иванов & Рыбыкина, 1999; Чуян, Бирюкова & Раваева, 2008) on application of new technologies for defining the functional state of young people's bodies. The new technique is portable, convenient to use and provides detailed information on the functional state of the human body; already prepared conclusions have been pre-programmed into the equipment that inform about the current functional condition of a human body, so there is an opportunity to inform the young people about the physiological processes taking place in their bodies, encouraging them to focus more on health-promoting measures.

The aim of the research: to define the current body functional state of students of Liepaja University (LiepU) and Medical College – Liepaja branch of Riga Stradins University (RSU).

Materials and methods

Equipment "Omega-M" (St.Petersburg, "Dynamics", 2009) is complex scientific equipment (Compliance Certificate of the Russian Federation, Nr. POCC RU.ME01.BO5487), which analyses extensively and interprets the electrosignals of cardiac rhythm. The analysis of biorhythmic processes is based on new information technologies and the latest findings in biology, physiology, genetics and clinical medicine. Any changes in the body are reflected in heart rate. In response to the impulses of central nervous system, the heart rate determines the rhythm of the entire body, so

on the basis of heart rate dynamics, it is possible to determine objectively the body's functional status and predict possible changes in the future. (Баевский, Иванов & Рыбыкина, 1999; Чуян, Бирюкова & Раваева, 2008). In our research, 182 full-time and 28 part-time students of LiepU and RSU medical college Liepaja branch were involved, who were divided into 3 groups: group 1 – full time students; group 2 – part-time students; group 3 – students who want to associate their future life path with sports and dance. The screening diagnostics of students' heart rate was performed by equipment "Omega-M", and the heart rate of all participants was determined at rest position, and within 3 to 5 minutes 300 cardio-complexes were recorded. (Fig.1)

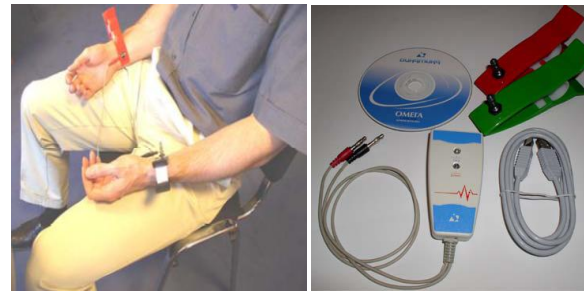


Figure 1. Attributes of apparatus „Omega-M"

"Omega-M" programme is based on fractal neurodynamic heart rate analysis. The method analyses five stages of heart rate, but as the result of neurodynamic analysis a double code combination is elaborated, which consists of sequentially registered heart impulses with equal parameters. (Ярилов, 2001) Such methodical algorithm, obtained in a particular time period, provides information on the functional state of human organism based on basic levels of heart rate regulation. (Fig.2)

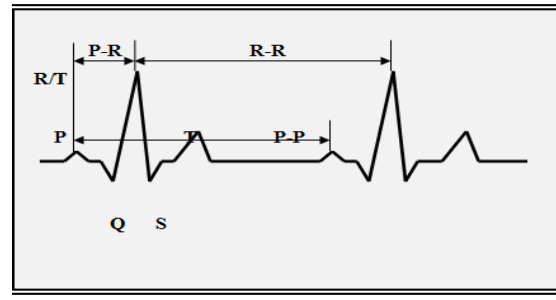


Figure 2. The principle of neurodynamic processing of a rhythmogram (Ярилов, 2001)

For this study we chose the general parameters of functional diagnosis, which are automatically analysed by "Omega-M" system, revealing quantitative criteria (in presents), which define health qualities of the human body: 1) (A) parameter (blue) –adaptation level of cardiovascular system; 2) (B) parameter (green) – autonomous regulation of vegetative system; 3) (C) parameter (yellow) – central heart rate regulation; 4) (D) parameter (violet) – psycho-emotional state; 5) (Health) parameter (red) – integral parameter of a functional state (Fig.3).

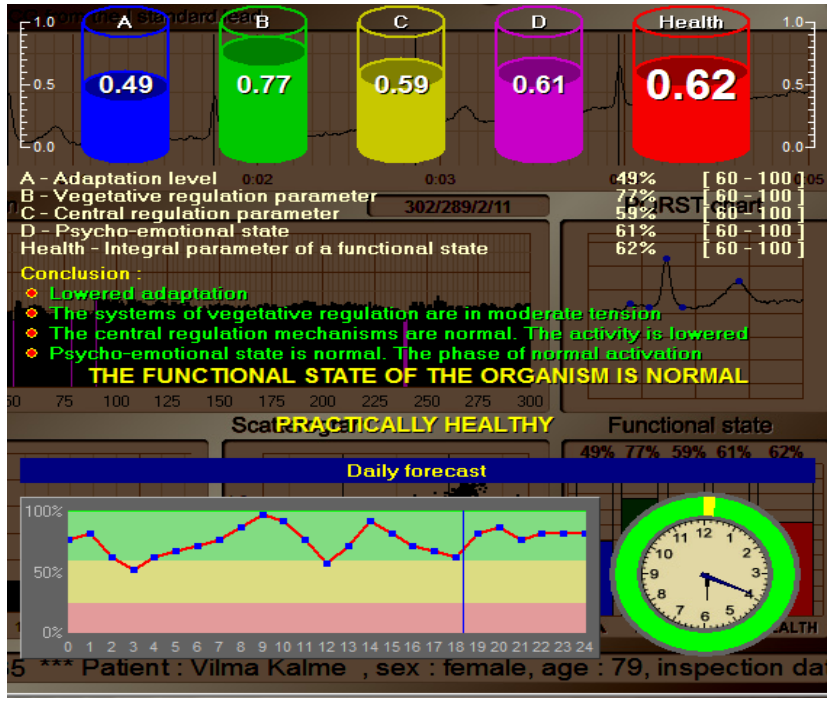
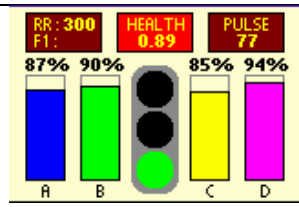
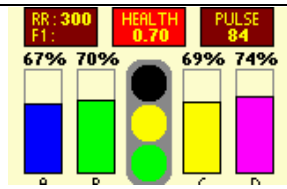
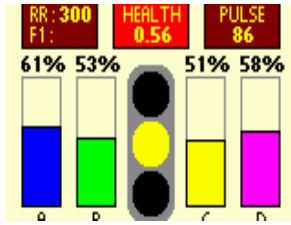
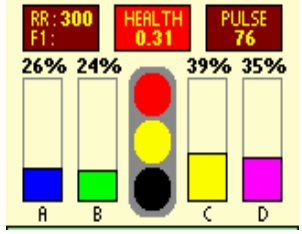


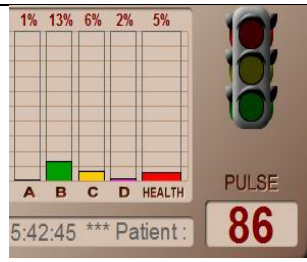
Figure 3. Parameters of functional diagnostics of human body

Following the research results, Table 1 reveals classification of overall functional state of an individual, and this was employed performing the screening diagnosis of functional state of students. (Баевский, 2009)

Table 1

Classification of functional states

INDICATORS	STATE OF FUNCTIONAL SYSTEMS OF THE ORGANISM	CONCLUSIONS OF COMPUTER PROGRAMME
	PHYSIOLOGICAL NORM OPTIMAL ADAPTATION LEVEL	HIGH ADAPTATION LEVEL. NORMAL VEGETATIVE REGULATION. OPTIMAL SUPPLY OF ORGANISM'S ENERGY RESOURCES. HIGH PSYCHO-EMOTIONAL ACTIVITY. HEALTH STATE IS WITHIN THE NORMAL RANGE.
	PHYSIOLOGICAL NORM NORMAL ADAPTATION LEVEL MODERATE FUNCTIONAL TONUS	NORMAL ADAPTATION LEVEL. LOW VEGETATIVE REGULATION. NORMAL SUPPLY OF ORGANISM'S ENERGY RESOURCES. GOOD PSYCHO-EMOTIONAL CONDITION. HEALTH STATE IS WITHIN THE NORMAL RANGE.
	TOO HIGH TONUS OF REGULATION SYSTEMS	MODERATE LOWERED LEVEL OF ADAPTATION. MODERATE LOW LEVEL OF ADAPTATION. VEGETATIVE REGULATION IN TONUS. SUPPLY OF ORGANISM'S ENERGY RESOURCES WITHIN THE NORMAL RANGE. LOWERED ACTIVITY OF PSYCHO-EMOTIONAL CONDITION. SIGNS OF FATIGUE. HEALTH CONDITION - ABNORMAL
	PRE- ILLNESS STATE. TOO HIGH TONUS OF REGULATION SYSTEMS. LOW LEVEL OF ADAPTATION. SEVERE DEPLETION OF THE REGULATORY SYSTEM	LOW ADAPTATION LEVEL. VEGETATIVE REGULATION IS IN STRONG TONUS. THE BODY'S ENERGY SUPPLY IS BELOW NORMAL LEVEL. ABNORMAL PSYCHO-EMOTIONAL CONDITION. SIGNS OF FATIGUE AND OVERLOAD. PRE-ILLNESS STATE, CONSULTATION OF

		DOCTORS/SPECIALISTS RECOMMENDED
	PRE-ILLNESS STATE. TOO HIGH TONUS OF REGULATION SYSTEMS. LOW LEVEL OF ADAPTATION. SEVERE DEPLETION OF THE REGULATORY SYSTEM PATHOLOGICAL CHANGES IN MECHANISMS OF REGULATORY SYSTEMS.	LOW ADAPTATION LEVEL. VEGETATIVE REGULATION IS IN STRONG TONUS. THE BODY'S ENERGY SUPPLY IS IN CRITICAL CONDITION. ABNORMAL PSYCHO-EMOTIONAL CONDITION. SIGNS OF DEPRESSION. PRE-ILLNESS, ILLNESS STATE, CONSULTATION OF DOCTORS/SPECIALISTS RECOMMENDED

Results

The average age of the first group (x_1) is 21,3 years. The average HR indicators (HR 77,5) correspond to the norm. The average indicator of adaptation level (A) is 70,35% , the parameter of vegetative regulation system (B) is 77,5%, the parameter of central heart rate regulation (C) is 64,9 %, the parameter of psycho-emotional condition (D) is 66,1%, the total integral parameter (H) is 69,6%. The norm given by the programme (Omega-M) is from 60% – 100%. Therefore it is possible to conclude that the average functional state of the organism in group x_1 is within the normal range (Fig.4).

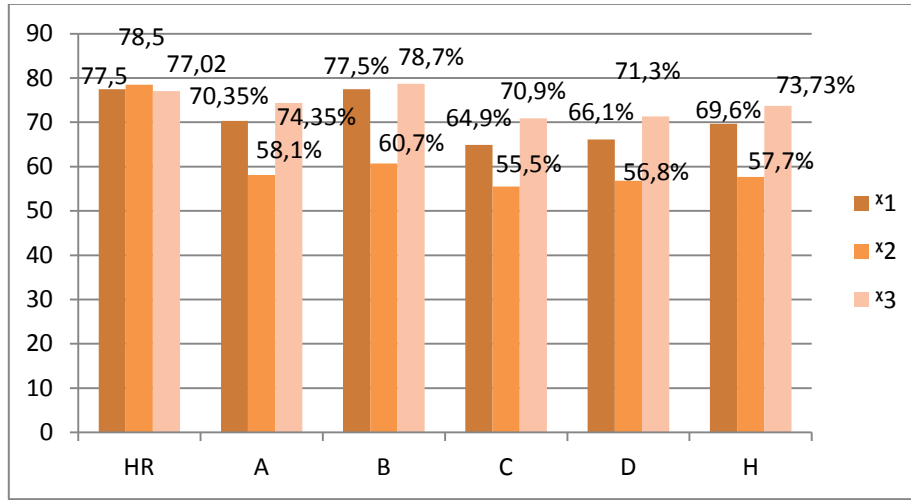


Figure 4. Comparative indicators of the functional state of students' organisms in groups x_1, x_2, x_3

The average age of the second group x_2 (part-time students) is 27,1 years. The average HR indicators (HR 78,5) correspond to the norm. The average indicator of adaptation level (A) is 58,1%, the parameter of autonomous vegetative regulation system (B) is 60,7%, the parameter of central heart rate regulation (C) is 55,5 %, the parameter of psycho-emotional condition (D) is 56,8%, the total integral parameter (H) is 57,7%. The norm given by the programme (Omega-M) is from 60% – 100%. Therefore it is possible to conclude that the average functional state of the organism in group x_2 is slightly below the norm (Fig.4).

The average age of the third group of students x_3 (full time students who want to associate their future life path with sports and dance) is 22,1

years. The average HR indicators (HR 77) correspond to the norm. The average indicator of adaptation level (A) is 74,35% , the parameter of

vegetative regulation system (B) is 78,7%, the parameter of central heart rate regulation (C) is 70,9 %, the parameter of psycho-emotional condition (D) is 71,3 %, the total integral parameter (H) is 73,73%. The norm given by the programme (Omega-M) is from 60% – 100%. Therefore it is possible to conclude that the average functional state of the organism in group x_3 is within the normal range (Fig.4).

Comparing student groups x_1 and x_3, the slight percentage differences can also be noticed. The average age of x_3 group students is 22,1 years, which is one year more than for students in group x_1 (21,3), but x_3 group has higher results in the following parameters: in (A) parameter – 4%, in (B) parameter – 1,2%, (C) parameter - 6%, (D) parameter 5,2 % and (H) parameter – 4,1 %. SPSS data processing results (Mann Whitney/ U Test) reveal essential differences between the following parameters of groups x_1 and x_2: parameter (A) $U=1240$; $p<0,009$; parameter (B) $U=1102,5$; $p<0,001$; parameter (C) $U=1306$; $p<0,022$; parameter (D) $U=1265$; $p<0,013$; parameter (H) $U=1154$; $p<0,003$. Significant statistically credible differences between groups x_2 and x_3 are found in two parameters – parameter (C) $U=2696$; $p<0,025$ and parameter (D) $U=2790$; $p<0,05$. Statistically credible differences were also observed between parameters of groups x_2 and x_3: parameter (A) $U=429,5$; $p<0,002$; parameter (B) $U=440,9$; $p<0,003$; parameter (C) $U=392,5$; $p<0,001$; parameter (D) $U=410$; $p<0,001$; parameter (H) $U=383$; $p<0,001$.

Discussion

Russian scholars (Чуян, Бирюкова & Раваева, 2008) surveyed fifty 20-22 year old students, and acquired the following average results of the group: parameter (A) – 57,3 %; (B) – 61,9 %; (C) – 53,5 %; (D) – 54,8 and (H) – 56,9 %, which in comparison with measurements obtained in our research corresponds to average results of part-time student group x_2.

The obtained results show that the increase of students' age can weaken the body's functional conditions (see Fig.4). The average age of part-time student group x_2 is for 5 years higher than of groups x_1 un x_3, and it can explain the weakening of body's functional condition with the aging of the body; the functional parameter of the organism (A) lowers from 12,5% to 16.2%, (B) parameter lowers from 16,8% to 18 %; (C) from 9,4% to 15,4%, (D) from 9,3 to 14,5 %, (H) from 11,9% to 16 % .

The higher results of functional state of the organism can be connected with the chosen speciality of x_3 group students – sports and dance teacher that requires good movement skills and abilities, which develop and strengthen general functional condition of the organism. But praxis has proved that following a healthy lifestyle systematically and for sufficiently

long time can improve the functional state of the organism. As an example see Figure 2, which shows the results of 79 years old woman: (A) – 49%; (B) – 77%; (C) – 59%; (D) – 61% and total integral parameter (H) – 62%. The total integral parameter (H) is for 4,3% higher than for students of group x_2, but the age difference between x_2 group and this woman is 52 years. This demonstrates that the human body's functional state can be preserved within the norm even in old age.

Conclusions

1. The average functional state of the organism in group x_1 is within the normal range (the norm given by the programme (Omega-M) is from (60% – 100%): HR indicators 77,5; adaptation level (A) is 70,35%; vegetative regulation system (B) is 77,5%, central heart rate regulation (C) is 64,9 %; psycho-emotional condition (D) is 66,1%; the total integral parameter (H) is 69,6%.
2. The average functional state of the organism in group x_2 is: HR indicators 78,5; adaptation level (A) is 58,1%; vegetative regulation system (B) is 60,7%, central heart rate regulation (C) is 55,5 %; psycho-emotional condition (D) is 56,8%; the total integral parameter (H) is 57,7%.
3. The average functional state of the organism in group x_3 is: HR indicators 77,02; adaptation level (A) is 74,35%; vegetative regulation system (B) is 78,7%, central heart rate regulation (C) is 70,9 %; psycho-emotional condition (D) is 71,3%; the total integral parameter (H) is 73,73%.
4. The higher results of functional state of the organism can be connected with the chosen speciality of x_3 group students – sports and dance teacher that requires good movement skills and abilities, which develop and strengthen general functional condition of the organism.
5. Application of new technologies and research results in the study process creates interest in students about general functional status of their bodies and thus stimulates them to pay more attention to the health issues and healthy lifestyle.

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ORIGINAL RESEARCH PAPER

THE EFFECT OF LOCAL VIBRATION ON ANAEROBIC POWER OF ROWERS

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Abstract

Whole body vibration is a worldwide innovation as a part of training method that helps athletes to regain the power and get ready for next training faster. However less attention is paid to local vibration where an selected muscle groups is stimulated by the use of a vibration device. For the reason to determine the effect of local vibration on anaerobic power of rowers, two research groups were assembled from the students of Murjāņi Sport Gymnasium (MSG) during the period of time from November 13, 2010 to March 20, 2011 - the experimental group (EG) and control group (CG). We manage tests with stationary Concept-II ergometer, EMG and goniometry before and after the sessions of local vibrations. After the local vibration sessions for experimental group, the anaerobic test results prove considerable increase on the stationary rowing ergometer Concept - II. As for the control group, there was no considerable increase observed. The t-test significant correlation is determined between ($r=0,802$; $p<0,05$)on first test and ($r=0,003$; $p<0,05$) on second test. EMG proves considerable Triceps Brachii muscle activity improvement for the experimental group, yet the activity improvement were not observed for the control group.

Keywords: *Anaerobic Power, local vibration technology, rowers, vibrations parameters, electromyography*

Introduction

Whole body vibration is a worldwide innovation as a part of training method that helps athletes to regain the power and get ready for next training faster. However less attention is paid to local vibration where a definite part of body, muscle or muscle group is stimulated by the use of a vibration device. In sports the mechanical vibration device is used both as a training method and as a massage device. As a vibration training (VT) method it has been used for many years and formerly there was an opinion

that only two tasks could be allocated to vibrations: to increase and maximize the force and also the whole body vibrations were used to exercise separate motor skills or increase physical capacity for work. Vibration as part of massage course or rehabilitation was known for many thousands of years, but VT method is more recent thing. Scientists have discovered that there are two different kinds of effects of vibrations in sports: the first is immediate and short term effect, but the second is long term effect and it is called the vibration training that is performed under the same conditions as conventional methods of training.

Sport scientists have been studying vibrations since 19th century. In the 1960's and 1970's high frequency vibration was already used to determine the response to irritation by using electromyography (Gail & Lance, 1966; Desmedt, & Godaux, 1978). In scientific researches vibration was used in its electromagnetic version (Desmedt & Godaux, 1978; Jackson & Turner, 2003). Direct vibrations or manual vibrations are used in researches when vibrations are performed on muscle belly or its tendon both on human and animals (Gail, 1966; McCloskey, 1972; Bongiovanni & Hagbarth, 1990). Formerly and also in nowadays vibration was examined from professional point of view and was questioned whether it is harmful for health (Cardinale & Pope, 2003; Martin, 2008). There are other studies where vibration was used as a method of rehabilitation in cases of lower back pain or osteoporosis etc. (Rittweger, 2003; Verschaueren, 2004).

There are fewer researches on local vibration, because in scientific literature there are studies for the whole body vibration platforms. A tonic vibration reflex is furnished when a specific muscle is subjected to local vibration and only the specific muscle on which the local vibration device has direct impact receives the agitation (Cardinale, 2003), and general muscular activity increases when muscular spindles are innervated simultaneous with each cycle of vibration (Issurin, 1994).

Mechanical parameters that determine the load is frequency (Hz) and amplitude (maximum distance between the most distant ends of both vibration waves). It means that the amount of vibration waves, cycles or oscillation are determined by frequency and its units are hertz - Hz. The vibrations can be delivered to the person by whole body vibration devices using waves of different frequencies from 15 to 60 Hz, but the amplitude is from <1 to 10mm of wave intensity or acceleration degree (Cardinale & Bosco, 2003; Cochrane, 2010, 2011). There are two methods used in VT. The first one is characterized by its local impact, when vibration is used directly on muscle belly (Curry & Clelland, 1981, Jackson & Turner, 2003) or tendon of the muscle that is being trained (Bongiovanni & Hagbarth,

1990). The person can hold the vibration device in his hands, but it can also be attached or fixed with special equipment (Jackson & Turner, 2003). Second method provides indirect application of vibration and trains the muscle. Thereby the vibration from the device to target muscle is delivered via other parts of body (Delecluse, 2003; Issurin, 1994).

The improvement of acute and chronicle muscle working capacity as a result of whole body vibration is proved in research papers of different authors, but there are also studies that prove no positive outcome of vibration trainings. The efficiency of training with acute and chronic vibration depends on methodology that includes amplitude, frequency, duration and mode of application of vibration; also it depends on content of vibration training notes (type of exercise, amount and intensity of working loads). Analysing the results of scientific researches leads to conclusion that whole body vibrations give positive effect on trainings under condition if the interconnection between general theory of training and vibration trainings are realised precisely. There are many factors that affect results of research and show the dynamics of efficacy: differences of experiment's participants, differences of vibrations parameters - frequency, amplitude and acceleration, as well as warm-up and variations of execution of the same exercise can cause substantial changes in test results.

The opinion of scientists about frequency of vibration varies starting from 5Hz to 300Hz and more. But the amplitude is from 1mm to 10mm and more, as well as the time of vibration varies from 5 seconds to even 30 minutes. Also the amount of repetitions can vary from one single time to several months. For the purposes of the study of rowers the vibration device was set on 100Hz frequency, 2 – 4mm amplitude and the variable vibration time added in each session was 5 to 20 minutes for the total of 12 weeks with 2 to 3 vibration sessions per week.

Muscle cooperation during any kind of physical activities is determined by intramuscular coordination. When muscles agonists contract, muscles antagonists contract simultaneously, shoving that contractions of antagonists reduce the expression of agonist’s force therefore reducing the activity of these muscles (EMG). There are indices that acute indirect vibration's load can develop identical changes - just like trainings of force and power (Bosco, 2000). If it is so, there definitely is a chance that activity of agonist increase when the activity of antagonists reduces. Synchronization of motor units indicates the amount of motor units that are involved in the process of force production. Increase of motor units synchronization is one of the factors used to increase the force and power during force trainings. Research authors have studied the intensity of discharge in muscles and have realized that synchronization of motor units

is greater for heavy-lifters than for students of control group. Though the eligibility of the method is discussed, still the synchronization of motor units can theoretically be established via indirect method – surface EMG method. However the method can certainly be used to establish the dimensions of motor units' electric activity – amplitude.

Materials and methods

For the reason to determine the effect of local vibration on anaerobic capacity of rowers, two research groups were assembled from the students of Murjāņi Sport Gymansium (MSG) during the period of time from November 13, 2010 to March 20, 2011 – the experimental group (EG) and the control group (CG). We chose the students of MSG because they all have equal training systems and all the students have similar daily regimen. There were 15 students in the experimental group and 12 students in the control group, aged from 18 to 24 years, with different experience in rowing. The pedagogical experiment can be divided in three stages:

Stage 1. The first test using the stationary Concept-II ergometer (Fig.1) was performed. The stationary Concept-II ergometer is one of the best anaerobic power test device for rowers.

Figure 1. Stationary CONCEPT-II ergometer

Also the EMG was determined (Fig.2) that took place from November 13, 2010 to November 30, 2010.

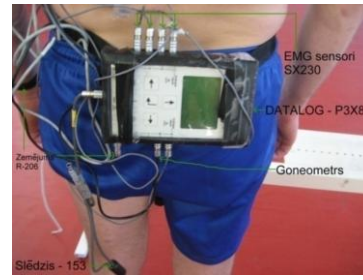

Figure 2. DataLog – model Nr. P3X8 (electromyography)
Transcription: zemējums – ground, slēdzis – switch, sensori – sensors, goneometrs – goniometry

To determine the changes in muscle action and the synchronization in muscles during strokes, the portable data acquisition device Biometrics Ltd P3X8 (fig. 2) was used.

Stage 2**.** Body local vibration sessions performed with Vibromassager WM-1, S/N09/01 (Fig.3) for the participants of experimental group.

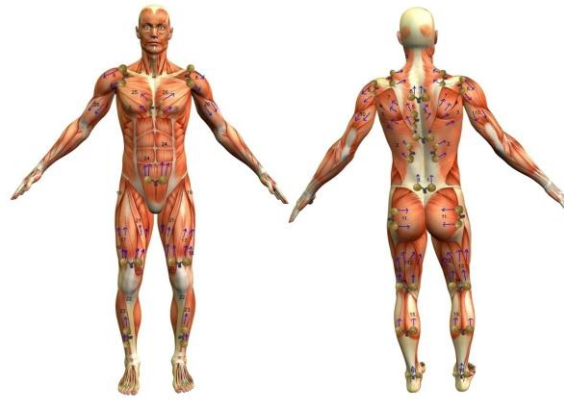

Figure 3. Vibratod vibration direction of the muscles

Sessions of local vibrations were performed with Vibromassager WM-1, S/N09/01, with the power of 220 V, with frequency 100 Hz, 500 W, Type B.

The sessions of local vibrations (Tab.1) were distributed using the methodology (Fig.3) that has been developed together with professor V.Krausts.

Table 1

Scheme of local vibrations for athletes of Murjāņi Sport Gymansium

Week	Frequency of vibration	Amplitude of vibration	Time of vibration (minutes)	Vibration session per week
Week 1	100Hz	2mm	5min	2
Week 2	10Hz	2mm	5min	3
Week 3	100Hz	2mm	10min	2
Week 4	100Hz	2mm	10min	3
Week 5	100Hz	4mm	12min	2
Week 6	100Hz	4mm	12min	3
Week 7	100Hz	4mm	15min	2
Week 8	100Hz	4mm	15min	3
Week 9	100Hz	4mm	20min	2
Week 10	100Hz	4mm	20min	3
Week 11	100Hz	4mm	15min	3
Week 12	100Hz	4mm	15min	4

Stage 3. Tests with stationary CONCEPT-II ergometer and performance of electromyography form March 8, 2011 to March 11, 2011.

After 12 weeks of local vibration sessions the leading participants of CG and EG chose to continue the sessions because they were used to the positive effect they felt after the local vibration.

Local vibration (LV) as a training method was developed and appbrobated for the rowers of Murjāņi Sports gymnasium. (MSĢ). There were different manipulation carried out on muscles and sinews, based on a strategic structure developed for LV trainings that involved the changes of vibration parametres on a weekly basis: the amplitude of vibration from 2mm to 4mm, the time distribution of vibration from 5 to 20min and the impedance (pressure) on muscle. Though the frequency remained fixed (100Hz) for the whole 12 week period of local vibration trainings, that involved 2 to 4 trainings per week. The local vibration was applied on muscles in thr following order (Fig.4): Erector Spinae, Latissimus Dorsi, Teres Major, Teres Minor, Trapezius, Rhompoideus, Infraspinatus, Deltoideus, Splenius Capitis, Triceps Brachii, Gluteus Maximus, Semitendinosus, Biceps Femoris, Semimembranosus, Gastrocnemius, Achiles Tendom, Rectus Femoris, Vastus Lateralis, Tensor Fascia Latae, Vastus Medialis, Sartorius, Pattellae, Tibialis Anterior, Rectus Abdominis, Pectoralis Major un Biceps Brachii. The vibratode was applied to each muscle separately and the distance between the points of contact was 2-3 cm. The duration of contact between vibratode and muscle was 1 to 5 seconds for each point of contact.

Results

The results of anaerobic powers tests after 12 weeks of local vibration sessions for the rowers of experimental and control group were compared to the results of first test (fig. 4).

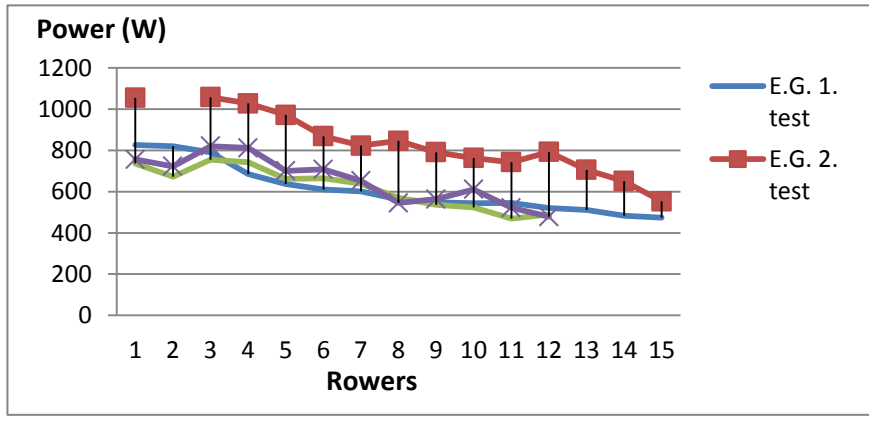

Figure 4. Arithmetic mean results of anaerobic capacity test for rowers of EG and CG

The average increase of results between first and second test for EG is 221,4W, but average increase for CG is 36,1W and that is considerably less than it is for EG.

Data were processed with SPSS 17 program to determine the credibility of difference of T-test.

Table 2

Anaerobic power first and second tests results of EG and CG

Rowers	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	E-11	E-12	E-13	E-14	E-15
W(1.test)	827	821	791	685	637	610	601	562	549	544	546	520	511	484	474
W(2.test)	1055		1058	1028	972	869	823	846	791	763	743	793	706	651	553
Rowers	K-1	K-2	K-3	K-4	K-5	K-6	K-7	K-8	K-9	K-10	K-11	K-12			
W(1.test)	737	672	755	743	662	665	639	570	536	523	470	489			
W(2.test)	756	723	821	812	701	708	653	545	564	611	522	478			

The best results in the experimental group for the first test was 826W for the participant E-1 and 821W for the participant E-2, but the weakest result was 474W for the participant E-15. The best results for the second test for the experimental group was 1058W for the rower E-3 and 1055W for the rower E-1, however the weakest result 478W was for rower E-15 but rower E-2 didn't participate in the second test. Participants of control group accomplished the second test with average increase in the group of 36W. The best result in control group was 755W for participant C-3 and the weakest result was 470W for participant C-11. The best result for the second test for the control group was 821W for rower C-3 and the weakest result was 478W for rower C-12. Data were processed with SPSS 17 program to determine the credibility of difference of T-test. In the first test the T-test p-value was 0,802 < 0,05. But after the second test the T-test p-value was 0,003 < 0,05. After the EMG was determined for the experimental group, we can see that the Triceps Brachii muscle biopotential has considerably increased both on right and on the left side (before the beginning of the movement and during the movement). However Latisimus Dorsi muscle biopotential haven't changed considerably neither on right nor on the left side (before the beginning of the movement and during the movement). Yet for the control group muscle biopotential hasn't changed considerably. In the most cases the p-value of muscle frequency and biopotential was < 0,05, which means the differences are considerable, but for the control group the differences have been observed only in few cases.

Discussion

Many scientists in their researches have used different vibration frequencies, amplitude and time of vibration to determine the immediate and short term effect. The scientist opinions on vibration frequency range varies

starting from 5Hz to 300Hz and more. But the amplitude is from 1mm to 10mm and more, as well as the time of vibration varies from 5 seconds to even 30 minutes. In the same way the number of repetitions varies from one single repetition to several months. A tonic vibration reflex is delivered when local vibration is applied on a specific muscle and only the muscle, on which the local vibration device has direct impact, receives the excitation (Cardinale, 2003) as the muscle spindles are innervated in a simultaneous manner in every vibration cycle (Issurin, 1996) and it leads to increased total activity of the muscle (Gilhodes, 1986; Park, 1994; Sarabon, 2004). However it is important to indicate that for the tonic vibration reflex a direct vibration impact on muscle or sinew with frequencies >100 Hz is required. For the purposes of the study of rowers the vibration device was set on 100Hz frequency, 2 – 4mm amplitude and the variable vibration time added in each session was 5 to 20 minutes for the total of 12 weeks with 2 to 3 vibration sessions per week. After the local vibration sessions for experimental group, the anaerobic test results prove considerable increase on the stationary rowing ergometer Concept - II. As for the control group, there were no considerable increase observed. EMG proves considerable Triceps Brachii muscle activity improvement for the experimental group, yet the activity improvement was not observed for the control group. Latisimus Dorsi muscle activity was uniform in both tests for both groups.

There were differences in results between groups in determing the anaerobic capacity ratio in wats (W), when EG has improved for 222,6W, but KG for 36,1W and p=0,003, therefore the repeated tests for anaerobic power for EG (experimental group) and for CG (control group) were performed and processed with t-test Independent Samples Test. After data for EG were processed with ANOVA, it revealed the difference in results in only one case, i.e., for the frequency (HZ) of innervations impulse of *Triceps Brachii* before the beginning of the movement p=0,002. When the percentage ratio between first and second test of EG rowers were determined, it revealed that the amplitude of *Triceps Brachii* impulse (mV) have increased both for the left and for the right side muscles, but as for the *Latisimus Dorsii* the results have slightly decreased, with exception for the muscles of right side before the beginning of the movement. Regarding the CG it was determined that the difference of percentage ratio between first and second test have increased for *Latisimus Dorsii* and for *Triceps Brachii* on the both sides of body.

Conclusions

After the local vibration sessions for experimental group, the anaerobic test results prove considerable increase on the stationary rowing

ergometer Concept - II. As for the control group, there was no considerable increase observed. EMG proves considerable Triceps Brachii muscle activity improvement for the experimental group, yet the activity improvement was not observed for the control group. Latisimus Dorsi muscle activity was uniform in both tests for both groups.

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ORIGINAL RESEARCH PAPER

WEARABLE PHOTOPLETHYSMOGRAPHY DEVICE FOR TELEMETRIC MONITORING OF PULSE WAVE PARAMETERS

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Abstract

At present efficient training requires a complex approach incorporating the control of the exercise intensity and observation of athlete physiological variables. The heart rate monitoring during training session has become a common procedure, while more extensive investigation requires expensive technology and experienced personnel. Photoplethysmography (PPG) may be one of the potentially promising, simple and inexpensive techniques for acquisition of physiological parameters related to cardiac and arterial-hemodynamic activity. The aim of the current study is development end evaluation of a digital, multi-sensing photo diode technology based PPG device for telemetric monitoring of pulse wave parameters. Six young and healthy volunteers (21-23 y.o.) participated in this study. PPG signal has been recorded from the skin over the temporal artery in rest conditions, during veloergometry test and recovery period. The data has been processed and statistically analyzed with custom developed PPG waveform analyses software, providing information on PPG waveform related parameters, such as systolic peak time, relative amplitude, pulse duration, time to maximal ejection velocity,

etc. A reliable, low noise PPG signal has been obtained from all the subjects. Computed PPG signal waveform parameter changes reflected different physiological conditions (rest period, exercise, post-exercise recovery period) and were consistent with the values reported in the literature. We concluded that digital multi-sensing photo diode PPG device demonstrated high accuracy and convenient use, which suggests potential application in exercise physiology and training.

Key words: *photoplethysmography, pulse wave, hemodynamic parameters, wearable sensor, biomedical garment.*

Introduction

At present efficient training requires a complex approach incorporating the control of the exercise intensity and observation of athlete physiological variables. On one hand, inefficient intensity may oppress the athlete performance; on the other hand, overtraining might cause exhaustion and other health related problems. Modern technologies are offering advantageous opportunities to improve athlete performance including telemetric monitoring and further analysis of physiological and kinematic parameters and high-performance sportswear and equipment (Shishoo et al., 2005). At the moment there are a wide range of commercially available products (Polar®, Zephyr® heart rate monitors etc.), however despite of technological achievements the most commonly assessed cardiovascular parameter during the training session still remains the heart rate (HR).

A more advanced modification of HR assessment method is heart rate variability (HRV) analysis, which may provide information on sympathetic and parasympathetic balance during the rest and recovery, and may serve as an indirect indicator of overtraining (Mourot et al., 2004). Hence, HRV analysis requires application of more advanced heart rate monitors with accurate beat-per-beat RR interval registration and special software incorporating real time spectral analyses.

Another significant parameter measured during exercise is arterial pressure (AP). However, continuous, beat-per-beat registration of such parameter requires expensive laboratory equipment (Finameter midi, FMS Inc.) and measurement precision can be affected by body movement during an exercise. Currently there are no commercially available technologies for assessment of hemodynamic variables during training affordable to a wider consumer range. Still, a potentially promising method, which may provide physiological information on cardiac and arterial-hemodynamic function, is photoplethysmography (PPG). Photoplethysmography is a non-invasive measuring technique based on optical detection of arterial pulse. The signal

consists of a slow component (DC) and alternating component (AC). AC component mainly reflects cardiac activity while DC tissue blood perfusion and slow vasomotions of the blood vessels (Allen, 2007). Quantitative analysis of PPG signal provides physiological information on cardiac and hemodynamic function. It comprises evaluation of parametric values of the pulse wave amplitude, its temporal features, e.g. of foot-to-foot interval time, time of pulse wave reflection etc. (Dupre et al., 2004). However, in order to get more detailed information on physiological processes, quantitative analysis of the pulse wave may be supplemented with qualitative evaluation of the signal waveform, which represents individual properties of blood circulation (Schmidt & Kurjak, 2005). Major clinical applications of PPG technology utilized in biomedical equipment are monitoring of blood oxygen saturation level, continuous measuring of beat-to-beat blood pressure and vascular diagnostics (Allen, 2007). Although there have been a few studies attempting to identify and quantify exercise related PPG waveform parameters (Poon et al., 2003; Sandberg et al., 2005; Zhang et al., 2001; Chellappan et al., 2008). It is well known that efficient post-exercise recovery requires simultaneous adjustment of both cardiac parameters and peripheral arterial stiffness (MacDonald, 2002; Hogan, 2009; Dimpka, 2009). Therefore on-line observation of hemodynamic processes during training might be of great interest to sport physicians and coaches. The aim of the current multi-disciplinary study is development and laboratory testing of a wireless wearable multiple-photo detector device integrated into textiles (head-bandage).

Materials and Methods

Design of wearable PPG system

The developed electronic setup consists of wire-connected PPG probe, electronic circuit and 240 mAh Li-ion accumulator (Fig.1, Fig.2). The multiple-PD probe contains one infrared LED in the centre of the probe and nine photodiodes, located around the LED (Fig.3). The device operates in the reflection mode, while most of the commercially available biomedical PPG devices operate in the transmission mode. In our design the preference is given to reflection mode, because it allows recording of PPG signal from various body sites, regardless of tissue thickness. Unlike transmission mode reflection mode is more appropriate in the research field and might expand applications of PPG devices in hemodynamic parameter assessment, e.g. telemetric monitoring of peripheral blood pressure during recovery period, non-invasive express method for artery stiffness evaluation for elderly and hypertensive patients etc.(Kaibe et al., 2002; Mackenzie et al., 2002). The operation types of the device- power mode, Bluetooth connection and

discharge levels of the Li-ion accumulator, - are indicated by two colour LEDs. Registered PPG signal is acquired with 1 ms resolution by a high speed microcontroller NXP LPC2148 ARM7, which operates at 48MHz clock frequency.

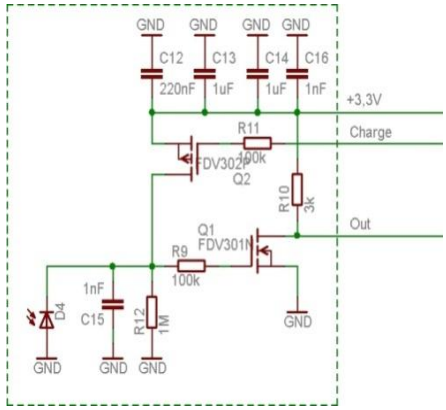

Figure1. Electronic circuit of the sensor probe (d=21 mm)

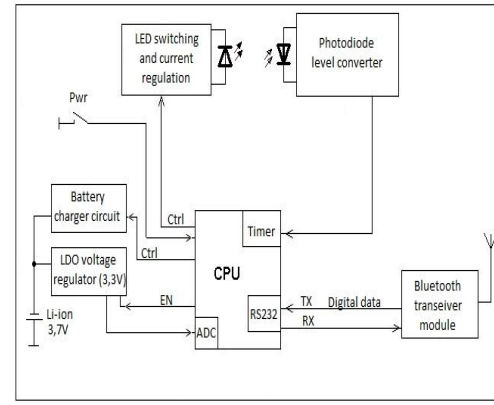

Figure 2. Block-diagram of the device (21x38x5 mm), see details in text

The substantial innovation of this device is digital acquisition of PPG signal based on photo diode (PD) discharge time detection. The capacitor discharge time is measured by a built-in 32-bit timer capture module (Fig.2). This method of PPG signal acquisition does not require application of analogue operation amplifiers and filters insuring less signal noise and reduced power consumption. Data transmission up to 10 meters distance is provided by Bluetooth module, which connects to a personal computer (PC) or Personal digital assistant (PDA) via a standard serial port (SSP).

Figure 3. The prototype of the head bandage with embedded PPG device; probe contains 1 emitter and 8 detectors

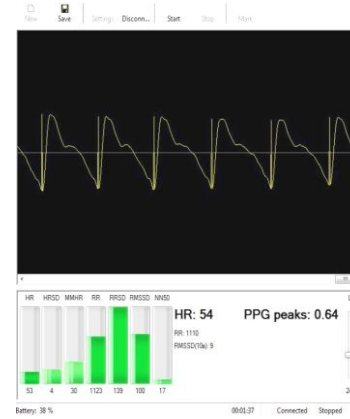

Figure 4. Software screenshot DataScope for PPG signal real-time monitoring, see details in text

The device and the probe have been designed to provide integration of the electronic system into different textile types (Fig.3). The technical parameters of PPG system have been previously evaluated in pilot study and described elsewhere (Grēve et al., 2011; Mečņika et al., 2012).

Recording of the physiological data obtained by the garment integrated PPG device has been accomplished by the custom developed software DataScope (LU ASI) for PPG signal acquisition and device operation in real time (Fig.4). This software is necessary for device setting changes, such as LED intensity, signal filtering and others. DataScope incorporates Pulse rate variability analyses module (PVR) which computes parameters from PPG signal: HR, foot-to-foot interval, systolic and diastolic peak ratio pulse rate variability parameters (PRSD – Pulse Rate Standard Deviation (n/min), MMPR – Max - Min Pulse rate Rate (n/min), FF– Pulse Width (ms), RRSD – Pulse Width Standard Deviation (ms), RMSSD – RMS Standard Deviation (ms), NN50 – Interval percentage, where Δ interval > 50 ms) however we excluded this analyses from current research (Fig.4).

Experiment procedure

To test PPG system operation during exercise and demonstrate potential of this innovation in sports physiology a pilot study has been performed. A PPG measurement has been taken from six sedentary normotensive female volunteers 19-27 year old, in rest condition, during cycling exercise and recovery period, that lasted 180s, 180s and 360 s. respectively. The subject inclusion criteria were absence of apparent arterial disease, physical abnormalities and medication. This study was approved by local ethics committee (LU EKMI). All experimental procedures were explained to the volunteers and informed consent obtained to participate in this study. The entire procedure has been carried out in laboratory settings in a well ventilated, temperature controlled room (23±1.5 °C). The physical load has been induced by veloergometer (Monark Ergomedic 894E Bike) at 120 W. During entire experiment PPG signal was acquired from the skin over the temporal artery *(a.temporalis)* by wireless PPG device integrated into a head bandage (see Fig.3). PPG device has been controlled by custom developed software DataScope (LU ASI), the off-line data analyses were performed by custom developed PPG waveform analyses software: *PPG_waveform analyses* (LU ASI) see fig. 7. The potentially important PPG waveform parameters were extracted from signal waveform and included in further analyses see figures 5 and 6. Figure 6 demonstrates the hemodynamic parameters obtained from the superficial temporal artery *(a.temporalis)*. Pulse duration (PP) is a time of interval between two successive feet (F_i, F_{i+1}), systolic peak amplitude (P_1) results from the direct

pressure wave travelling from the left ventricle to the recording site, and a diastolic peak (P_2) derives from reflections of the pressure wave by arterie (Qawqzeh et al., 2011). The time to dA/dt_MAX characterizes cardiac function (ref). The 2nd derivative of PPG consists of four peaks - e a, b, c and d waves see figure 5. (Kaibe et al., 2002; Hashimoto et al., 2005; Šimek et al., 2005)

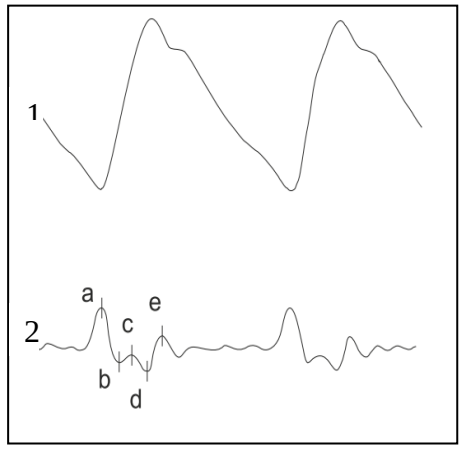

Figure 5. Initial PPG signal (1.) and second derivative of PPG signal: SDPPG (2.); signal deflection points are denoted: a - e

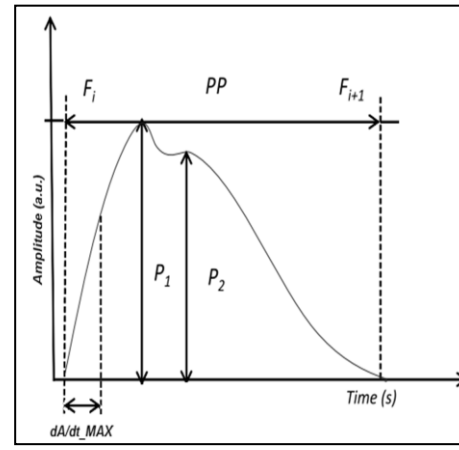

Figure 6. PPG waveform parameters computed by the PPG_waveform analyses software

The ratio between b and a peaks (b/a) is determined from the SDPPG signal and is related to distensibility of large conduit arteries. The average parameter values from aforementioned parameters were computed for all subjects in rest conditions (1 min before exercise) and during exercise (last minute of exercise), parameter changes during recovery were visually inspected by experienced expert.

Results

It was possible to obtain high quality, low noise PPG signal during rest, 120 W veloergometric exercise and recovery period from all six subjects. The subject movement during cycling produced minor artefacts which were successfully eliminated by DataScope real-time processing software. The larger sensor movement artefacts during cycling were reduced by "smart" bondage design preventing sensor floating on the skin and in the same time providing enough comfort for the subject.

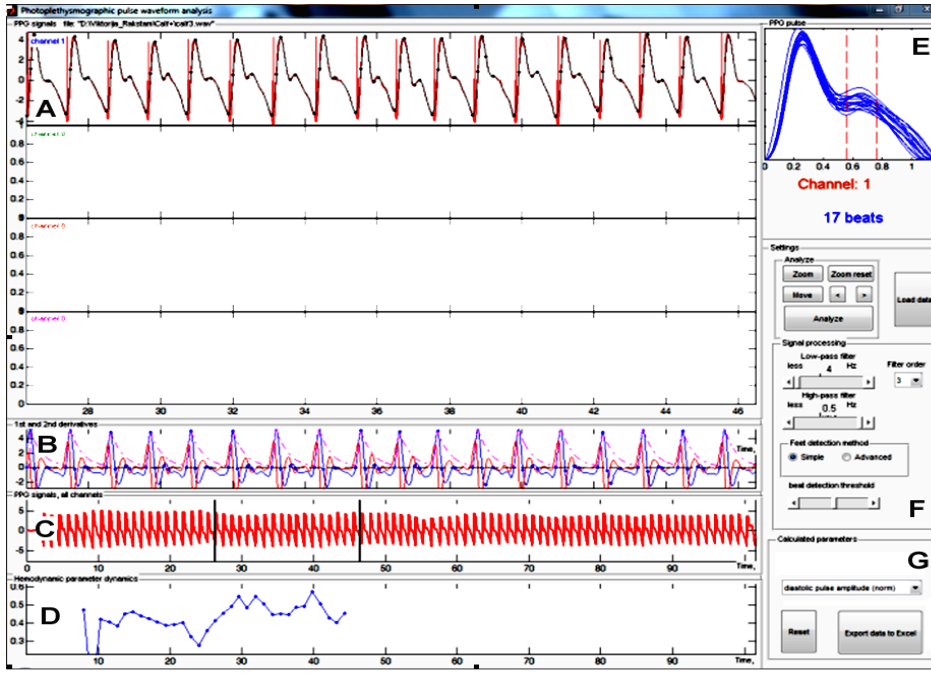

Figure 7. Software screenshot for PPG signal hemodynamic parameters analysis: A- PPG signal channel window; B- 1st derivative (blue line) and 2nd derivative (red line) of PPG signal; C- Signal window; D- Computed parameter window; E- Diastolic peak amplitude selector window; F- low-pass and high-pass filters settings; G- Selector for visualised PPG parameter (signal displays on D)

The incorporated multi diode PPG probe collected reflected light even in conditions when absorbance of the light has relatively high (dark skin colour, diverse tissue optical properties, low blood perfusion), thus insuring low noise, high amplitude signal. During resting conditions (baseline) all PPG signal components were relatively stable insuring accurate detection of waveform hemodynamic parameters. Although hemodynamic parameters vary across individuals it was feasible to calculate average values for the group: resting pulse duration was 0.74±0.14 sec., systolic peak amplitude 5.65±1.14 a.u., diastolic peak amplitude 4.11±0.9 a.u., time to dA/dt_MAX 0.056±0.005 sec., b/a ratio 0.69±0.09. In contrast to the rest conditions the onset of cycling exhibited abrupt changes of parameters. The general characteristics of the subjects and the summary of obtained PPG hemodynamic parameters during the last minute of veloergometric exercise are represented in table 1. The typical values of hemodynamic parameters during entire test protocol: rest, exercise and

recovery period are shown in Figure 8. Changes during recovery period were exponential, containing two or more phases; therefore application of descriptive statistic for post-exercise recovery data has been avoided. The inspection of data trend by experienced physicians revealed close relationship to the physiological conditions: as seen in the figure 8. the beat-per-beat dynamics reflect different phases of protocol.

Table 1

Individual characteristics and PPG hemodynamic parameters of the subjects during exercise

CODE	*BMI (KG/M^2)*	*PULSE DURATION (S)*	*TIME TO DA/DT_MAX (S)*	*SYSTOLIC PEAK AMPLITUDE (A.U.)*	*DIASTOLIC PEAK AMPLITUDE (A.U.)*	*B/A*
I.A.	22.5	0.433±0.013	0.049±0.006	3.337±0.297	2.097±0.223	0.518±0.089
J.M.	21.5	0.411±0.012	0.050±0.005	14.167±1.002	5.400±0.529	0.581±0.093
R.K.	19.1	0.345±0.005	0.056±0.003	12.633±1.079	4.210±0.872	0.431±0.097
C.I.	20.5	0.353±0.003	0.058±0.028	7.633±1.380	3.163±0.607	0.463±0.105
H.T.	21.0	0.368±0.009	0.053±0.013	2.036±0.192	0.964±0.085	0.528±0.114
O.R.	22.1	0.410±0.006	0.059±0.007	5.957±0.352	3.107±0.687	0.526±0.070

Table 1.Individual characteristics and hemodynamic parameters of the subjects (mean ± SD). Table indicate subject code, body mass index (BMI) and five PPG waveform derived hemodynamic parameters computed for the last minute of cycling test: pulse duration, time to dA/dt_MAX, systolic and diastolic pulse amplitudes and second derivative parameter- b/a.

Discussion

Recently an attractive though challenging approach is optical non-intrusive acquisition of hemodynamic parameters characterizing progress of training, such as peak parameter values during an exercise or dynamics of post-exercise recovery period. During past five years there have been many attempts to develop photoplethysmography methods for assessment of cardiovascular system of athletes. The main questions addressed in these papers were: development of multispectral PPG probes (Asare et al., 2011), improvement of signal processing algorithms, to suppress noise and artifacts during body movement (Yong-Sheng et al. 2005), and seeking for a new waveform derived indexes (Huotari et al., 2011).

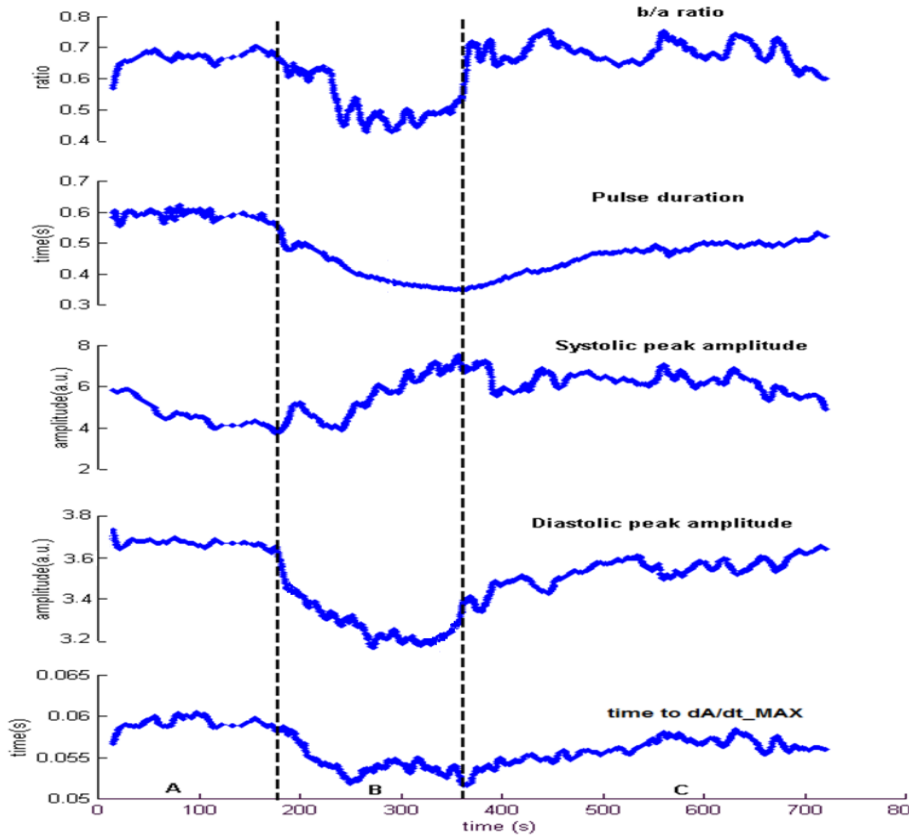

Figure 8. Representative example from one subject, showing typical beat-per-beat PPG waveform derived hemodynamic parameter changes during test procedure; A- hemodynamic parameters during rest conditions, B- cycling induced changes of hemodynamic parameters, C-oscillations of hemodynamic parameters during post exercise recovery period

Several studies described application of PPG in tissue blood flow assessment during an exercise incorporating multispectral approach in combination with unique geometry and position of photosensitive elements: the well-known paper published by Zhang and colleagues demonstrated potential of PPG in assessment of human anterior tibial muscle blood flow during arterial occlusion and isometric and concentric contractions (Zhang et al., 2001; Zhang et al., 2004). Later same group with Saundberg continued to develop this technique, and substantially improved muscle blood perfusion measurement technique. In his study the muscle perfusion was measured during exercise with a near-infrared light penetrated down to the vascular depth inside the muscle (Saundberg et al., 2005). One year later

Näslund and colleagues introduced and evaluated PPG technique to assess blood flow in bone tissue: measuring blood flow changes in human patellar bone (Näslund et al., 2006). The relatively few papers have been published that describe exercise induced PPG waveform parameter changes (Chellappan et al., 2008; Linder et al., 2008; Qureshi et al., 2002) and to the best of our knowledge there is almost no papers describing application of conduit artery PPG during an cycling exercise. Our technical design is based on utilization of special geometry and arrangement of light emitting and detecting elements in the probe, thus increasing sensitivity and reducing noise. Similarly study by Sandberg and colleagues confirmed the importance of distance and arrangement of detector and emitter elements for PPG signal recording from selected depth. Specially designed flexible Velcro straps compensated for the major movement artifacts during the exercise, while smaller signal distortions were eliminated by intelligent adaptive filtering. In the same way in the study by Lee B author emphasizes filtering procedure as a powerful tool to reduce artifacts in PPG signal (Lee et al., 2011). Application of novel -"digital" PPG registration principle yield device more robust against noise, reduced number of electronic components and substantially decreasing the size of device which was crucially important for successful integration in to textile. Our previous studies confirmed precision of similar digital PPG device in heart rate detection and heart rate variability studies in rest conditions: PPG signal was simultaneously recorded with a reference ECG signal from the group of healthy subjects. The reference devices were Polar® RS100 heart rate monitor and Contec Medical Systems TLC5000 12 Channel Holter (Grēve et al., 2011; Mečņika et al., 2012). In both case the prototype demonstrated high correlation with reference devices. The obtained PPG waveform derived hemodynamic parameters differ between the subjects although gender, body mass indexes (BMI) and age were similar. Such a difference was expected and could be partly explained by different fitness level (Rabbia et al., 2002) and psychological stress during recording procedure. Some subjects exhibit decreased pulse duration (0.6 sec), hence group average was slightly lower then normal, corresponding to approx. 81(beat per minute) bpm. Considering the fact that subjects were sedentary but healthy and normotensive this value is acceptable. PPG amplitude values were different because of distinctive tissue optical properties, however in all cases systolic peak amplitude was higher then diastolic. Similar findings regarding PPG amplitudes were reported by others(Allen, 2007; Korpas et al., 2009). Due to the limited calibration of PPG amplitude, more reliable and precise are PPG signal time based parameters, such as first, second or

third derivative or preferably their ratios. However is some cases detection of time changes in the inflection phases might be sophisticated due to artefacts and signal noise (Sukor et al., 2011). In our study in the resting conditions time to dA/dt_MAX was approximately 0.056 which is acceptable for such situation (Adler et al., 1996; Morimont, 2012). The average b/a ratio was 0.7 and confirming normal distensibility of large conduit arteries (Takazawa et al., 1998). In general resting data is acceptable and previous investigators have reported similar results. As expected the most prominent changes of parameters occurred during exercise and recovery period. The cycling produced well known adaptation of cardiovascular system to an exercise induced stress, as reported elsewhere (MacDonald, 2006; Rozanski et al., 2001; Wilkins et al., 2004; Ho et al., 1997). In respect to baseline (rest conditions) pulse duration decreased, indicating elevated heart rate, systolic amplitude raised pointing to an elevated arterial blood pressure, b/a ratio and diastolic amplitude diminished indicating decreased arterial stiffness and lowered peripheral resistance (Takazawa et al., 1998; Otsuka et al., 2007; Hashimoto et al., 2005). Time to dA/dt_MAX decreased indicating increased ventricular contractility during an exercise (Adler et al., 1996; Morimont, 2012). Caution should be used when interpreting alterations of PPG waveform derived parameters because the pulse waveform is determined by the complex interactions of different factors such as systemic circulatory parameters and properties of blood vessels, including pressure wave reflection and pulse wave propagation in the aorta and arteries and waveform may depend on recording site (Allen, 2007). Summarizing our results we can conclude that the main advantages of the wearable PPG device for application in sport are: 1)Stable signal recording- headband is situated on the most stable segment of human body. 2)Miniature and waterproof device hardware- can be easily embedded in another type of sport garment, such as swimming cap. 3) Hemodynamic parameters are recorded from conduit artery (temporal artery), site which is relatively least affected by the *swelling of the tissue during exercise. 4)Provided parameters are related to systemic hemodynamics, such as cardiac contractility, peripheral resistance and arterial pressure which can be used for evaluation of training.*

Conclusion

The custom developed wearable telemetric PPG system demonstrated potential in monitoring of hemodynamic parameters during exercise, thus providing non-intrusive on-line control of important physiological parameters during training.

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REVIEW PAPER

COMPETITION TECHNICAL MODEL FOR HIGH-CLASS JUDOKAS
(2003 – 2005 World Championships for Women)

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Abstract

All judo techniques fall into one of three categories, and each category is further subdivided. The three categories are: throwing techniques (nage waza), grappling techniques (katame waza), and striking techniques (atemi waza). The action of the hips is important in any tachi waza (standing techniques), but they are further classified as either te waza (hand techniques), koshi waza (hip techniques) or ashi waza (foot or leg techniques) depending on which part of the body plays the central role in executing the technique. The former involves taking a back-on-the-mat position, but sutemi waza (side sacrifice techniques) – side-on-the-mat position. In competition practice athletes use throws from all classification groups. In 2003 the most often applied techniques were from the arm technique group. The second was the shoulder technique, the third – the leg technique, the fourth – the hip technique, and the fifth – the risk group. In 2005 the techniques in the frequency remained the same. The differences were only in the leg and shoulder technique groups. The leg technique was ranked the second, but the shoulder technique – the third. The competition model changes in the studied time period between two world championships have been stated in all weight categories. The most significant changes were recorded in the medium and heavy weight categories. The percentage of throws decreased a lot in the shoulder technique (7%) and hip technique (6%) group, changes were the biggest in the heavy weight category. The applied hip technique increased (17%), but the arm technique decreased (16%).

Keywords: *classification of techniques, technical scope, technique, judo standing techniques.*

Introduction

Judo is a martial art of contact, strength and complicated coordination, performed in antagonically and dynamically changeable action. Techniques classified into three main categories – throwing

techniques (nagewaza), grappling techniques on the mat (katamewaza or newaza) and striking techniques (atemiwaza). Throwing techniques and grappling techniques on the mat are also called techniques for free practice (randoriwaza) and are used both in practice sessions and contests. Striking techniques are practiced only in controlled model techniques, what are called kata (Pimenovs, 2012).

In the Japanese language *judo* has very many meanings: *ju* – soft, gentle, polite; *do* – a way, correct path, conscience, morale, skill, as well as the principle "kindness wins evil and gentleness gains an advantage over rough strength". (Rudzitis, 1979)

It is the merit of Jigoro Kano that judo techniques became familiar not only in Japan, but all over the world. In 1964 judo was included in the program of Tokyo Olympic Games. (Shulica & Koblev, 2006; Pedro & Darbin, 2005; Rudzitis, 1979) Today the International Judo Federation involves 200 countries from the whole world. (Putin, Shestakov & Levicky, 2000)

In a judoka's preparation process it is possible to distinguish between technical, physical, tactical, psychological and intellectual preparation. All these directions are closely linked, however, each of them has own different features.

Technical preparation can be evaluated by movement preciseness, the ability to do maximally economic movements and the ability to purposefully rearrange technical elements according to the competition situation, maximally hampering the opponent's movements. Research on technical proficiency includes stating of the number of technical elements, effectiveness and proficiency level. [Putin, Shestakov & Levicky, 2000; Rudzitis, 1979)

The technical elements are characterized by the scope and variety of techniques, but the proficiency level by stability, steadiness, degree of preservation and automatization. Effectiveness depending on the criterion is evaluated as absolute, comparative and of realization. (Rudzitis, 1979)

According to the conception by Shulica (1988, 1994) the fighter's integral model consists of three determining blocks: technically-tactical movements, resultative characteristics and functional qualities (Putin, Shestakov & Levicky, 2000). In fighting practice empirical models are used now.

The modeling of technical movement is used to solve two basic questions: movement study and their teaching. (Dravnieks, Popovs & Paeglitis, 1997)

After the evaluation a judoka's indices of his competition action and the development tendencies of the sport the further high-class competition

perspective champion model is stated. A judoka's condition and difference between the total and individual model characteristics are stated from the same indices. (Putin, Shestakov & Levicky, 2000)

Having looked through the literature sources we concluded that practically there is no information about the tendencies of the technical element changes of high-class fighters in judo competitions. In the available literature sources we found little information about competition action model characteristics and their differences. The study of the techniques used in the competitions will help to state the "champion" model, which could be applicable when preparing to important international competitions to obtain better result.

Aim of research. Changes of a judoka's techniques model characteristics during the period – in 2003 and 2005 World Championships (for women).

Taking the research aim as the basis the following tasks were forwarded:

1. To state the throws applied in competitions according to the groups of classification.
2. To state a high-class female judoka's competition action model characterization according to the weight categories.
3. To state the difference characterization of the competition action model of high-class female judokas.

Materials and Methods

In the initial stage of the research we collected information concerning the amount and variety of judo standing throws (nage waza) and stated the total number of judo throws known. Next we grouped the amount of throws according to judo element classification features. Videos and DVDs were used in the research. Two world judo women championships (2003, 2005) were analyzed. Final, semi-final and satisfaction (gratification) fights for the third place was filmed on video and DVD material. 62 fights have been analyzed. The offence movements of high-class judokas taken down in worked-out protocols were studied. In the worked-out records judokas' name, surname, country they represent, the color of their kimono, which each fighter wears in a definite fight, weight category, fight duration were written and successful throws were depicted with special symbols in each minute (see Table 1). The assessment by judges (experts) was written next to each throw. For example, if a throw was assessed as „*Ippon*", then it was marked as 10 points and circled. The assessment „*Wazaari*" was 7 points, „*Juko*" – 5 points, and „*Koka*" – 3 points. This point system is accepted in judo competitions. The throws which were not assessed by judges but

usually are taken into account are called „Kinza" which in Japanese language means "attack" and in judo means as a real try of a throw. In our study we gave 2 or 1 point for them. If the opponent is thrown down on his stomach, the throw is marked as 2 points. If a fighter touches the tatami with his knee or hand, such a throw was marked as 1 point. The first three penalties were marked with the letter „S" – *Sido* and the penalty which caused the fighter to lose the fight as „h.m." – *Hansoku - make*. A frame was drawn around a Penalty symbol to see it better in the protocol.

With the help of mathematical statistics method we processed the obtained results and made the analysis of the statistical indices. The successful throws were stated in all championships, they were divided according the classification groups and the percentage was stated.

Results

The total number of the standing fight technique is stated by two internationally recognized institutions – the International Judo Federation (IJF) and the Judo Institute „Kodokan". In the official list of IJF there is 71 throw. In the list of „Kodokan" there are 65 throws. And the division according to classification groups is different: „Kodokan" divides the throws in five groups: the leg technique, hip technique, arm technique, throws with falling on the back and throws with falling on the side. IJF divides the throws in four groups: the leg technique, hip technique, arm technique and the throws when falling. The throw classification according to Kavaishi was used in our research: the leg technique – 15 throws, the hip technique – 15throws, the arm technique – 9 throws, the shoulder technique – 6 throws and the throws when falling –15.

In the research seven weight categories were analyzed, as well as the absolute weight category. 370 successful throws executed by 89 female judokas in 62 fights were fixed. Female judokas were divided in three subgroups of weight categories: light weight category (-48 kg; -52 kg), middle weight category (-57 kg; -63 kg) and heavy weight category (-70 kg; -78 kg; +78 kg; open).

In Figure 1 we see that in 2003 World Championship in the light weight category 55 throws were registered, including 26 or 46% the arm technique throws. Next were the throws of the shoulder technique, where 13 throws or 19% were fixed. In this championship the judokas of the light weight category had used the less throws from the risk group – 7%.

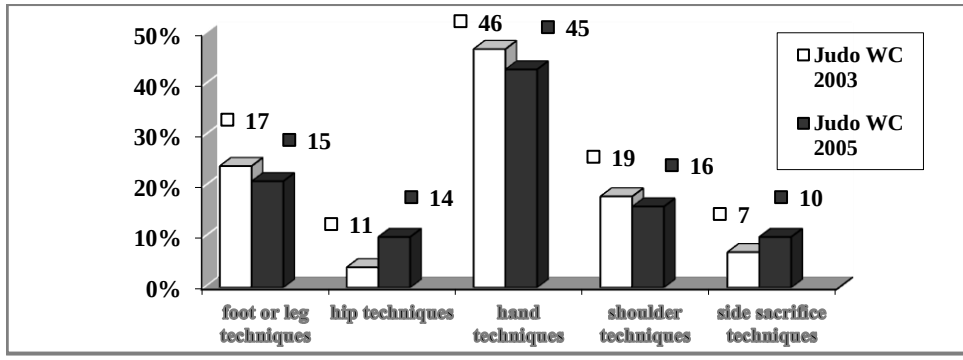

Figure 1. Mutual relation of the competition action model characterizations in the light weight category

The research showed that the division of the successful throws according the classification groups in the middle weight category differs a lot from the division of the used throws in the light weight category; therefore we can assume that there will be different competition action model characterization in each weight category. The research results show that the arm technique throws are used the most often – 28 throws or 48% from all the registered throws in this weight category. The risk group throws were registered the least, 4 throws or 6% were fixed as the throws when falling (Fig.2).

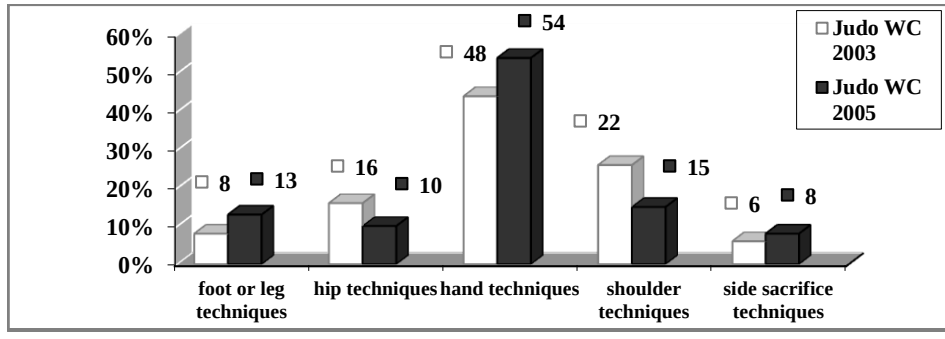

Figure 2. Mutual relation of the competition action model characterizations in the middle weight category

In figure 3 we see that also in the heavy weight category the arm and shoulder techniques dominate, accordingly 42 throws or 56% and 16 throws or 20% of all registered throws in this weight category in our research.
Also from the heavy weight category the judokas used the least throws from the risk group – 2 throws or 3% were fixed from this classification group.

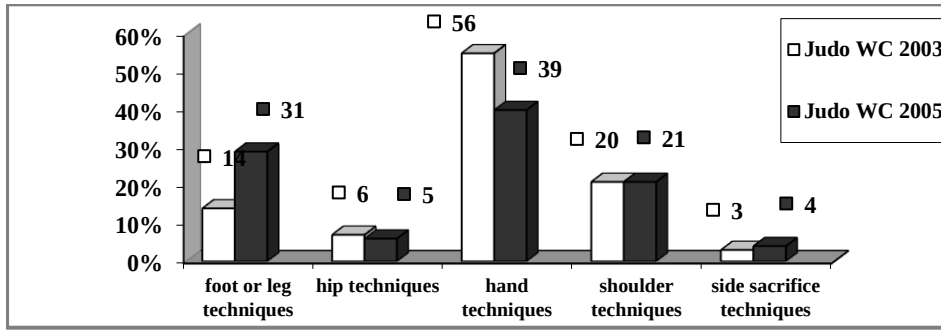

Figure 3. Mutual relation of the competition action model characterizations in the heavy weight category

Taking a look at the obtained results about the 2005 World Championship the following competition action model characterizations were seen in each weight category: in the light weight category the greatest number of the successful throws are the arm technique throws – 22 throws or 45%; from the hip technique 14% and from the risk group – the throws with falling on the back or side – 5 throws or 10% (see Fig.1).

In Figure 2 we can see that in the middle weight category in the 2005 World Championship 39 successful throws, including 21 throw or 54% of the arm technique were registered, and it is a high percentage, more than a half of all successful throws in this weight category. In the middle weight category the judokas also used the throws from the risk group the most seldom, such throws were registered 3 or 8% of the total number of throws.

In Figure 3 we can conclude that the most number of the successful throws in the heavy weight category are the arm technique – 34 throws or 39% from 85 registered throws in this weight category. The throws from the risk group when falling on the back or side was registered the least – 3 throws or 4%.

In our research in high-class competitions the arm technique took the first place according to successful application frequency and in the 2003 World Championship they composed 49% and in the 2005 World Championship – 44% of the total number of the applied throws in each championship or respectively 96 and 77 throws.

In our research the second place was taken by the throw group where basically leg technique (*Ashi-waza*) is used, and it includes various throws: weeps, wheels, reaping. These throws are executed also together with arm technique (combination).

In Figure 1 we see the competition action model characterization differences in the light weight category. In this weight category the first

place is taken by the throws from the arm technique – in the 2003 World Championship they composed almost a half of the total number of the registered throws (46%), in 2005 the number of the successful throws decreased up to 45%, still maintaining the first place as in the previous championship. In 2005 the number of the successful throws from the leg technique decreased per 2%, and we see that in 2003 it made 17%, but in 2005 – 15%. Similar situation is also in the shoulder technique where in the 2003 World Championship the female judokas applied 10 throws or 19% of all fixed throws in this weight category, in 2005 – 8 throws or 16%. From the hip technique the number of the successful throws increased from 11% up to 14%. In 2005 judokas applied also the throws from the risk group more often (10%), but in the previous world championship the throws from this classification group composed 7%.

In Figure 2 we see that the competition action model characterization differences in the middle weight category comparing two world female championships (2003 and 2005) are more significant than in the light weight category. Changes have taken place in all classification groups of throws, the smallest percentage is in the classification group throws with a fall. If in the 2003 World Championship they composed 6%, than in 2005 – 8%. The research results show that the biggest changes were in the application of the arm and hip technique, where the percentage of the successful throws decreased per 6%. In 2003 in this weight category 64 throws were registered, including 48% of the arm technique throws, but in 2005 they increased up to 54%, but the percentage of the hip technique in 2003 was 16%, but in 2005 –10%, what means that athletes and coaches in the preparation process between the world championships have more paid attention to exactly arm technique, but less to the hip technique, as well as the number of the successful throws has decreased.

Comparing two world women championships we can say that the biggest changes were in the application of the leg technique and arm technique. If in the 2003 World Championship 42 successful throws or 56% of the total throws registered in the heavy weight category were from the arm technique, but already after two years in 2005 34 throws or 39% were fixed. There is a different situation with the leg technique – the number of the successful throws in this classification group has increased up to 31% in the 2005 World Championship.

As we can see in Figure 3, in 2003 female judokas in high-class competitions applied 11 successful throws from the leg technique or 14% of all registered throws in the heavy weight category.

Discussion

From our research we can say that in nowadays' competition practice athletes apply throws from all classification groups, and the application frequency of the throws is different. In our research we registered 379 successful throws executed in two world championships, from which the most often used throws were from the leg technique, arm technique and shoulder technique groups, correspondingly in 2003 29 throws or 15%, 96 throws or 49% and 43 throws or 22%; in 2005 41 throws or 24%, 77 throws or 44% and 32 throws or 18%.

In our research we studied three weight categories: the light (-48 kg; -52 kg), middle (-57 kg; -63 kg) and heavy (-70 kg; -78 kg; +78 kg; open). In both world championships the female judokas from all weight categories applied the most often throws from the arm technique in the light weight category in 2003 – 26 throws or 46% and in 2005 – 22 throws or 45%, in the middle weight category in 2003 – 21 throws or 48% and in 2005 – 21 throw or 54% and in the heavy weight category in 2003 – 42 throws or 56% and in 2005 – 34 throws or 39%. The least percentage was from the group the throws when falling in the light weight category in 2003 – 4 throws or 7% and in 2005 – 5 throws or 10%, in the middle weight category in 2003 – 4 throws or 6% and in 2005 – 3 throws or 8% and in the heavy weight category in 2003 – 2 throws or 3% and in 2005 – 3 throws or 4%. The results of our research showed that the applied throw division according to classification groups, in percentage, is different, and it testifies that high-class female judoka's competition action model characterizations change according to the weight categories. Therefore it is necessary for each weight category to develop its own competition action model characterization.

The results of our research showed that bigger changes in the offensive action have been registered in two throw groups – in the leg technique and arm technique correspondingly from 29 throws or 15% the number of throws has increased up to 41 throw or 24%, and from 96 throws or 49% has decreased up to 77 throws or 44%.

The greatest changes have been registered in the middle and in heavy weight category. So, in the middle weight category the successful throws from the shoulder technique decreased per 7% (in 2003 – 22%, in 2005 – 15%). The hip technique also decreased per 6% (in 2003 – 16%, in 2005 – 10%). In the heavy weight category the leg technique increased per 17% (in2003 – 14%, in 2005 – 31%). In the arm technique the successful throws decreased per 17% (in 2003 – 56%, in 2005 – 39%).

Conclusions

1. We can conclude that in nowadays' competition practice athletes apply throws from all classification groups, and the application frequency of

the throws is different. From the registered 379 successful throws executed in two world championships the most often used throws were from the leg technique, arm technique and shoulder technique groups.

2. Bigger changes in the offensive action have been registered in two throw groups – in the leg technique and arm technique. The greatest changes have been registered in the middle and heavy weight category. So, in the middle weight category the successful throws from the shoulder technique decreased per 7% .The hip technique also decreased per 6%. In the heavy weight category the leg technique increased per 17%. In the arm technique the successful throws decreased per 17%.

3. In both world championships the female judokas from all weight categories applied the most often the throws from the arm technique. The results of our research showed that the applied throw division according to classification groups, in percentage, is different, and it testifies that high-class female judoka's competition action model characterizations change according to the weight categories. Therefore it is necessary for each weight category to develop its own competition action model characterization.

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REVIEW PAPER

THE IMPACT OF SPORTS ON THE ECONOMY

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Abstract

The significance of sports in the Latvian economy has not been evaluated sufficiently, although at the European Union (in further text EU) level, sports are increasingly recognized as of value not only in the context of physical health but also as contributing to the economy, which is rather varied. As noted by Stefan Kesenne, the economic influence of sports is twofold. The economic importance of sports can be calculated statistically as part of the benefit of a national economy's Gross Domestic Product (in further text GDP) – but these measurements do not comprise the added economic acquisitions generated by healthy physical activity which substantially diminishes health care and other associated costs. The assessment of these added gains to the economy is much more sophisticated.

Keywords: *Sports economics, globalization, major sports events, European Union*

Introduction

The authors of this study review the core available quantitative indicators constrained with the economic impact of sports in the EU, and make a reflection of assessment of the situation in Latvia based on currently available information and possible future trends.

The purpose of this study is to identify the implication of sports in the global economy, in the context of the EU, and to appraise the Latvian situation using publicly available quantitative data.

Objectives of the study:

1. Assess the historical aspect of the impact of sports on the economy.
2. Assess the impact of sports on the global and European Union economies.
3. Review the main global sporting events.
4. Assess the impact of sports on the Latvian economy.

Material and methods

The material and methods of the research included content analysis of international and national-level policy documents, conceptions, programs as well as analysis of theoretical literature.

Results and discussion

A review of the situation

The connection between sports (for the sake of clarity and simplicity, in this study authors are referring to the notion of "Sport" as it is defined by European Council, which states that Sport is all the occasional or specifically organized forms of physical activities, directed to the improvement of physical and mental shape and which creates social relations or on the ground of which, positive results are being achieved in the whole variety of competitions) and the economy can be identified as early as the Ancient Olympics, when athletes were remunerated with goods or gold. During the 19th century gambling on results of ongoing contest stimulated the development of professional sports. Various sporting activities and events in the early 20th century attracted the attention of the media and especially the press due to radio broadcasting of sport events; however, true globalization of the sports economy proceeded after the Second World War.

The impact of sports on the global and European Union economies

There are three key factors that assisted in creation of the globalization of the sports economy. The firs of them was the increase in the number of paid holidays for workers, which led to the rise of consumption of sport-related activities, incorporating sport practice, sporting newspapers and magazines, sport shows and other events. Secondly, the development of television broadcasting system of sporting events ensured the access of this particular media to any significant international sporting event. And finally, the vast progression and development of information technologies such as computers, internet, mobile phones, etc., has allowed the processing of photographic and video material of sport events to be momentarily sent or transmitted from anywhere of the Globe at any time, to every possible place in the World. And these are the key reason why the sport as an economic sector transformed itself in the last decades from, as Andreff and Staudohar (2002) called it, a traditional Spectators-Subsidies-Sponsors-Local (SSSL)-model to a more global Media-Corporations-Merchandising-Markets (MCMM)-model underlining the synergy between business and sports.

The "European Commission's "White Paper on Sport" [the strategic document elaborated by European Commission which determines procedures and guidelines in this particular field in European Union's scale, also considered as a contribution of European Commission in debates of the significance of sport in our daily life including economical approach (in further text, White Paper on Sport)] is the EU's fundamental document regarding policy of the sport in the EU. According to this document, sport is a dynamic and rapidly increasing sector of the economy, and its macroeconomic implication has not been sufficiently assessed. More importantly, in the context of the EU's Lisbon objectives, the sports sector can definitely encourage the economic and employment growth, as well as local and regional development. It is believed that sports and tourism have a synergy which could stimulate the modernization of the infrastructure and the advancement of new partnerships for financing in the field of sports and recreation.

As a result of the factors mentioned above, the proportion of sports economy as a part of the GDP has increased substantially. For example, France publishes a macroeconomic indicator called "gross domestic sports expenditure". It constitutes of national household and resident expenditures for sports materials and services, also comprising the national sports budget, local municipal sports budgets, sports sponsorship expenses and television broadcast fees set by sports event organizers. In 2005, gross domestic sports expenditure made up 1.77% of France GDP which was equivalent to 30.4 billion Euros (similar values of between 1% and 2% of GDP are found in all developed countries) (Andreff, 2008). At the year 2006 the study which was made during the Austrian Presidency of the EU established that the impact of sports on the economy of the EU in 2004 was determined at the amount of 407 billion Euros, which was equivalent to 3.7% of the EU GDP and that the sports sector employed 15 million people, which was equivalent to 5.4% of the EU's employees (White Paper on Sport).

Globalization of the sports economy

It should be certainly emphasized that the core market for many businesses associated with the sports economy is not the domestic one but most definitely the global World-wide market (Andreff & Staudohar, 2002) "European and US sports business models". (Barros, Ibrahimo & Szymanski) Unfortunately, it can be concluded that a fundamental accounting system of the global sport economy does not yet exist. The Economic indicators characterizing the influence of sports economy have been elaborated and summarized only in the most developed countries. The European Commission (in further text EC) in collaboration with EU member states is striving to work out a united European statistical method

for appraisal of the sports sector economy which could be used by EU member states for statistical analyses, thereby opportunely establishing so-called European satellite account for sports, which will serve as base of data collecting and processing system for all the member states. (White Paper on Sport) Most of the economic data related to sport and presented in the mass media are an approximation, so economists are looking for improvements to the compiling and systemizing of data related to the global sports economy.

Nevertheless, taking into account the above-mentioned lack of data, in 2004 the global sports goods and services market was evaluated to be between 550-650 billion Euros. Football, the so-called 'King of Sports', was estimated to be worth about 250 billion Euros globally. The total market of the sports products was determined to be worth about 150 billion Euros and for its part accumulated amount of funds for sporting event broadcast rights constituted of 60 billion Euros, while the overall sports sponsorship market was appraised to be 18 billion Euros. (Andreff, 2008) A 2006 study made during the Austrian Presidency of the EU found that the impact of sports on the economy of the EU in 2004 was valued at 407 billion euro, which was equivalent to 3.7% of EU GDP, and that the sport sector employed 15 million citizens which was equivalent to 5.4% of the labor force. (White Paper on Sport)

Taking into account all the above mentioned, two relevant conclusions can be made. Firstly, for the most part, the mass media greatly exaggerates its calculations related to the global sports economy and, more importantly, their information does not always reflect the actual situation. Secondly, the collection, compilation and systemization of data related to the global sports economy is primitive and acutely in need of improvement in order to reach the goals emphasized by the EC's "White Paper on Sport". (White Paper on Sport) Because of the scale of the direct investment that is budgeted by exploiting the multi-national companies associated with sports goods and services, it is extremely important that more accurate guidelines were established which would sufficiently reflect the nature of the global sports economy. A fundamental approach to the global sports economy itemization and displaying is still in the process of being elaborated. (Adreaff, 2006)

Global sports events

A review of the main characteristics of the globalized sports economy shows that today's sports events are shows as well as international global sporting events. A slight overview of the increasing number of large annual international sports events from 1977 until 2005 reveals that in 1977 there were 315 such events, in 1987 there were 660 and in 2005 there were

over 1000 large international events. (Andreff, 2008) This roughly corresponds to 3 large international sports events held daily. It should be noted that the enlarged sports event audience corresponds with an increased television broadcast capacity of the events. Taking into account that the combined existing and potential audience engaged with sports broadcasts which is about 6 billion persons, there is a possibility to study potential increases, stagnation or decreases in broadcast audience size. It should be emphasized that the first signs of declining sport broadcast audiences are already apparent. [An indicator that reflects a percentage of the total TV viewers who watch sports broadcasts], especially in the United States.

The Olympic Games and the World Football Championship are the two largest organized sporting events in the globalized sports economy. Today the economic significance of these important international events is fairly precisely known. (Andreff & Szymanski 2006; Kurscheidt, 2006; Preuss, 2008; Cheltenham, 2004) It should be underlined that economic or financial justification for hosting and organizing international sport events is greatly overrated, considering that countries use various methodologies to obtain data which is then used out of context to justify organizing an event which is presented as being of benefit and an investment for the hosting country. Unfortunately this ruse is also often associated with significant mistakes in data interpretation. It is generally acknowledged, and the media report the fact, that the costs of hosting the 2012 Summer Olympic Games in London are increasing constantly and have reached such a high level that it will not be possible for projected revenues to cover expenditures. (Barget & Gouget, 2007)

To touch again the subject of the economic benefits and their effects for countries hosting and organizing sporting events, it can be concluded that the calculations used in support of these events are not based on scientific methodologies or approached analytically, thus favoring the approval and financing of these events. (Adreaff & Cheltenham, 2006) Unfortunately, the information used in assessing projects such as the Olympic Games does not include the analysis of alternate investments. For example, simple consumer surveys could be made asking respondents how much they would be willing to spend for alternate events if the Olympic Games were not held in their country. An analysis of tourist flow shows that tourists usually tend to avoid large international events due to the inconvenience of traffic congestion, pollution, etc. The desire of the local population to take part and pay for the attendance of these events has not been fully studied yet. Countries organizing international sports events encounter the same inadequacies in methodology used in estimating the economic benefits of sports events. Each candidate state competing to host

global events expects studies providing the economic benefit of organizing such events, which helps in the acquisition process against competing candidates and justifies the organization of these events to the taxpayers. (Andreff & Szymanski, 2006; Kurscheidt, 2006; Preuss, 2004) Unfortunately, this can be attributed to all the countries and cities competing to host international sporting events. It also must be stated that all the consulting companies related to these events eagerly provide data which justifies the economic feasibility of the event, ignoring the possibility of financial losses. Invariably, after the event is finished, the negative impact of the losses becomes apparent, even though during the event the host country was at the epicenter of global media attention.The Albertville Winter Olympic Games in 1992, with a deficit of 150 billion French francs, was the only international global sporting event acknowledged to have had a negative economic effect for the country staging the event. (Andreff, 2008)

Methodologies used by sports economists, based on cost and benefit analyses, provide a more accurate reflection of economic impact of international sporting events. These analyses are more complex and sophisticated than the simple economic impact studies in current use, and are more precise. This type of methodology was first used to analyze the Rugby World Cup in France in 2007. (Barget & Gouget 2007)

The Situation in Latvia

Presently according to Latvia data about the sports economy is available only on the Central Statistics web page, and the data gives only a partial conception of the situation. The sports economy sector as part of total GDP is not analyzed. The only available data reflects the sports economy business sector profit/loss indicators. (Central Statistical Bureau) The data is shown in Table 1.

Table 1

Businesses related to sports activities, rest and recreation – profit or loss					
Year	2006	2007	2007	2009	2009
Lats (millions)	- 4.5	-3.4	-3.4	-8.2	-8.2
Busineses related to sport activities, rest and recreation - net turnover					
Year	2006	2007	2008	2009	2010
Lats (millions)	44.7	50.5	54.8	45.2	52.5

Conclusions

The sports economy is a rapidly-growing and developing sector of the economy and is closely connected to more traditional sectors, comprising tourism and recreation. The value of sports should not be

evaluated as merely a part of the GDP, but should also include the benefit of sports as related to health care and government expenditure reduction not only in this particular budget position but also social one – the more active people are, the greater the health benefits they obtain.

Global sporting events secure the greater portion and gains of the sports economy sector but their positive and negative influences have yet to be fully evaluated.

So far, a common methodology that evaluates the sport economy has not been developed. The lack of a unified methodology is related to the lack of accurate statistical data as exemplified by the Latvian situation.

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REVIEW PAPER

MANAGEMENT OF LANGUAGE POLICY AT A HIGHER EDUCATION INSTITUTION (A COMPARATIVE STUDY)

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Abstract

In the first decade of the 21st century to promote multilingualism and involve in the internationalization processes many universities in Europe (Free University Berlin and University of Freiburg in Germany, Jyväskylä University and University of Helsinki in Finland, University of Oslo in Norway, a.o.) have developed and are implementing language policy. The need for universities to provide students – future specialists – with opportunities to develop knowledge, skills and competences necessary for successful professional activity in the European labor market in accordance with today's requirements forms the basis of language policy. A wider language offer at universities is essential for students – future specialists of every field. The research about language policy at state institutions of higher education in Latvia involved 15 institutions and 319 students of different specialties, including sports teachers, physiotherapists and other specialists related to sport. In the previous stages of the research it was found out that only one state institution of higher education– the University of Latvia – has developed and accepted in its Senate a language policy document and is implementing language policy. The aim of the present study was to investigate the essence of the language policy strategy developed by the University of Latvia and its realization management process.

Key words: *foreign language, language offer, language policy, management of language policy.*

Introduction

Language policy is a guideline for language development process made by the developers of language policy about the status, functions and acquisition development of some language(s). Language policy is about the choice of language(s). Any person, a group of people can choose to use some language(s), and also a group of authoritative people can try to influence other people's language choice and its development in some conditions (Spolsky, 2005; Spolsky & Shohamy, 2000; Rahimi &Faravardin, 2009).

Language policy states the language status, its corpus, its acquisition and dissemination in other countries (Spolsky & Shohamy, 2000; Tollefson, 2008). Language policy plays a great role in education institutions such as universities as one of the main objectives is the development of language competence. Language policy deals with the questions how many and what languages should be studied, in what courses or programmes, by what part of students, what should be the number of classes and ECTS obtained (Spolsky & Shohamy, 2000).

The practical experience of such universities in Europe as Free University Berlin and University of Freiburg in Germany, *Jyväskylä* University and University of Helsinki in Finland, University of Oslo in Norway, a.o. in implementation of language policy, especially the language policy of the Scandinavian countries, shows that language policy is a developed and accepted strategy about the language usage, teaching and learning, and language competence development at university. The language competence includes one's first (state, native) language competence and the first foreign language, the second foreign language, etc. competence. The theoretical basis of the developed language policy is formed by the European Union and national recommendations on the facilitation of the language competence development. Language policy refers to students (of the home country, foreign countries), academic staff and researchers (of the home country, foreign countries), management and service personnel in multilingual and multicultural studies, research and work environment.

Language policy includes two directions: 1) learning of the first (native, state) language, the development and enriching of its competence; 2) the development of the first foreign language competence, learning of the second (third, etc) foreign language and enriching of its competence.

In the framework of the language policy universities should provide students with the opportunities to learn languages and develop the language competence, and universities should manage the language policy implementation process.

The essence of the education management is to achieve definite education aims and objectives. Management in general is a system that provides a successful functioning and development of an organization (Ukolovs et al., 2006). Management includes such processes as the development of the conception, aim and objectives, the development of the strategy, activity planning and organizing, its control and evaluation (Appannaiah & Ramanath, 2009; Nelson & Economy, 2005). Ramasamy (2010) defines management as a process where a group of people performs some task effectively using available recourses.

Education institutions work in certain political contexts that determine the processes of new strategy implementation that should be carried out under the management of the state and local leaders in order to increase achievements (Bell & Bolam, 2010). So, universities solve the questions of language policy in political context, as the aim of language policy is to develop the language competence of students and staff members – both academic and others. Universities should develop their own vision about how to implement the new strategy using their resources in correspondence with the general strategy of each university.

The aim of the research was to state the essence of the language policy developed by the University of Latvia and, based on this research, to work out recommendations for LASE language policy.

The tasks of the research were to study the language policy document developed by the University of Latvia and its correspondence to the language policy documents developed by the Scandinavian countries; to study the document *On Language Policy Implementation* accepted by the University of Latvia; to develop recommendations for language policy at the Latvian Academy of Sport Education.

Materials and methods

The study of the language policy document developed by the University of Latvia was carried out applying a qualitative research method – document content analysis. When applying content analysis and using the method of word analysis the researcher can obtain useful information about the text (Francozi 2004; Stemler 2001) which he/she interprets linking it to the theoretical conception. The analysis was made using the qualitative research data procession program AQUAD 6. The content of four materials about language policy at European universities (University of Helsinki in Finland, Göteborg University in Sweden, Copenhagen Business School (CBS) in Denmark and University of Oslo in Norway) and the language policy document of the University of Latvia were administered and organized in the environment of the AQUAD 6 program. The frequencies of

the words (content) were analyzed and data were interpreted. The content of the document *On Language Policy Implementation* by the University of Latvia was also analyzed.

The catalogue of the criteria – language policy key words – was worked out. It included the words that characterize:

1. Language policy document (policy, document, strategy, plan);
2. Language policy context (international, employability, competitiveness, labor, market);
3. Languages (English, native, foreign, state, first, second, other, Finnish, Swedish, Norwegian, Danish, Latvian, language, bilingual);
4. Language aspects (competence, skills, knowledge, professional, intercultural, writing, speaking, listening, reading, terminology, communication);
5. Target groups (student, foreign, staff, researchers, scientists, teachers, exchange and service);
6. Forms of language realization (offer, courses, information, publishing, articles, summary, home, page, teach, learn);
7. Environment (university, science, studies, multicultural, environment, plurilingual, variety);
8. Language policy realization activities (use, increase, promote, facilitate, encourage, develop, improve, support, provide, acquire);
9. Desirable standards of language usage (high, clear, correct, standard, quality).

To avoid subjectivity the data were processed using the program of qualitative data analysis AQUAD 6. The texts were put into the AQUAD 6 environment accordingly with the program requirements. Then the data were processed and the frequencies were stated.

Results and discussion

The frequencies were analyzed in all four materials about the language policy of the Scandinavian universities and the one of the University of Latvia. The results were summed up in the table 1. Having analyzed word frequency in all materials it can be said that the word *language* is the most often used word in the materials of all universities, as it refers to the language policy document itself and to languages – state languages and foreign languages.

Table 1

The most often used words in language policy descriptions

University, country	Total number of words	Most often used words (times)
University of Oslo, Norway	77	1) language (16) 2) university (9) 3) teaching (5); students (5); foreign (5); use (5); 4) another (4) 5) policy (3); International (3); skills (3)
Göteborg University, Sweden	360	1) language (68) 2) university (27) 3) another (25) 4) students (21) 5) research (15)
Copenhagen Business School, D	598	1) language (113) 2) students (78) 3) International (28) 4) competence (27) 5) staff (25)
University of Helsinki, Finland	602	1) language (123) 2) university (98) 3) policy (31) 4) teaching (28) 5) another (23)
University of Latvia, Latvia	205	1) language (43) 2) Latvian(23), university (23) 3) studies (15) 4) English(8) 5) students (6)

For four universities (Oslo, Göteborg, Helsinki and the University of Latvia) the second most often used word is *university*, and it characterizes the institution where language policy is realized. In the document of the University of Latvia the second most often used word is also *Latvian*, and that characterizes one direction of language policy – the development of the Latvian language. The word *student* is often used, and it characterizes the main target group of the language policy implementation. In the material about the language policy in the Copenhagen Business School the word *staff* is frequently used. Staff is another target group of the language policy implementation. The word *another* is used many times, and in language

policy documents it may mean *another language*, although this word may be used together with other nouns. The words *teaching* and *studies* appear frequently, and they characterize the form of language policy implementation. In the language policy document of the University of Latvia the word *English* is often used, and it shows that the development of the English language competence is stressed in the language policy of the University of Latvia. The words *policy, competence, skills, foreign* (foreign language, foreign students), *use* which describe the main notions in language policy appear often, as well.

The most frequently used words characterize the main notions (Stemler, 2001). In the analyzed materials the most often used words characterize the main thing in language policy – the development of a language competence by university studies.

Having analyzed word frequency it was stated whether all word groups which correspond to language policy (see above mentioned criteria) appear in the frequencies. Having analyzed the language policy document of the University of Latvia it was stated that:

1. From the first group which characterizes the language policy document all criteria words (*policy, document, strategy, plan*) appear.

2. From the second group which characterizes the language policy context (*international, employability, competitiveness, labor, market*) there are only the words *international* and *competitiveness*, but this may be due the fact that the document is quite short and concrete in comparison with the other ones.

3. From the third group which characterizes languages (*English, native, foreign, state, first, second, other, Latvian, language, bilingual*) there are words *state, native, English* and *foreign*, it means that the language policy of the University of Latvia envisages to develop both native and foreign language.

4. From the fourth group which characterizes language aspects (*competence, skills, knowledge, professional, intercultural, writing, speaking, listening, reading, terminology, communication*) the word *knowledge* does not appear. There is *competence* which involves knowledge, skills and attitude, there is no word *professional* (language) as professional foreign language is already included in the study programmes of the University of Latvia. There is no word *intercultural*, but *culture* appears what may express the same – studying culture of a country, the language skills *writing, speaking, listening, reading* are not mentioned, but *communication* appears.

5. From the fifth group which characterizes target groups (*student, foreign, staff, researchers, scientists, teachers, exchange, service*) the word

teachers does not appear, but there is *staff*, meaning teachers, there is no word *exchange* (mobility), but there is *foreign* that may mean foreign (mobility) students or teachers, there is no word *service*, which may mean that the language policy of the University of Latvia does not envisage to develop the language competence of service staff.

6. From the sixth group which characterizes the form of language implementation (*offer, courses, information, publishing, articles, summary, home, page, teach, learn*) there is no word *articles*, but there is *publishing*, which may mean the same, there are no words *home, page*, but there is *information*, the words *teach, learn* do not appear, but there are words *acquiring, acquire* what actually mean the same.

7. From the seventh group which characterizes environment (*university, science, studies, multicultural, environment, plurilingual, and variety*) the words *plurilingual* and *variety* do not appear, but *multilingualism* is mentioned, plurilingualism and multilingualism contain the same notion – the use of many languages.

8. From the eighth group which characterizes activities of language policy implementation (*use, increase, promote, facilitate, encourage, develop, improve, support, provide, acquire*) the word *improve* does not appear, but there is *develop* what may be the synonym of *improve*.

9. From the ninth group which characterizes the desirable standards of language usage (*high, clear, correct, standard, quality*) none of the words appear what may mean the standards of language usage are not given in the language policy document of the University of Latvia.

The first stage of the management process is the development of a strategy, then the planning and organizing of its realization follow. The study of the implementation document *On Language Policy Implementation* by the University of Latvia was also analyzed applying content analysis. Lexical units were separated and the data were interpreted.

The analyzed document shows that the language policy of the University of Latvia is a two year event until 2013. It envisages the implementation of:

1. a study course in English and other foreign languages to be offered in the optional part (C) of the study programme;

2. a study course in English and other foreign languages to be offered in the limited choice part (B) of the study programme;

3. the development of an electronic dictionary of the main terms used in the study courses of the field in English and in other foreign languages;

4. the development of the requirements of the Latvian language skills and foreign language skills in the study results of the programme according to the programme level and specifics and the European language skill level classification;

5. the provision of the possibilities for students to choose study courses in English and in other foreign languages when students register for the study courses, as well as the provision of the necessary information in Latvian and English on the University portal.

Conclusions

Having analyzed the language policy document developed and accepted by the University of Latvia and having compared it to the theory of language policy it can be concluded that the language policy of the University of Latvia includes the main aspects of language policy:

– the development of the language competence (state (native, first) language, the first foreign, the second foreign, etc., language competence) at the university, including the acquiring of the terminology of the academic field;

– it refers to the following target groups: students (of home country, foreign country), academic staff and researchers (of home country, foreign country), but does not envisage the language competence development of the managing and service personnel;

– the language policy is implemented in multilingual and multicultural study, research and work environment.

For the following two study years in the implementation of language policy the University of Latvia envisages the implementation of study courses in foreign languages, mostly in English, but also in others, the development of the Latvian language, as well as working out of the field terms in foreign languages. The target group is students, but the implementers are both academic staff and other staff.

The following processes can be distinguished in the implementation of the language policy of the University of Latvia:

– the development and acceptance of a language policy strategy (the study year 2009/2010);

– the development and planning of language policy events (the study year 2010/2011);

– the implementation and control of language policy events (the study years 2011/2012 and 2012/2013).

Recommendations

Taking the theoretical and empirical research cognitions about the language policy as the basis, recommendations for the language policy at the Latvian Academy of Sport Education (LASE) have been developed:

The language policy at LASE should include the following steps:

1. Meetings of LASE language policy strategy developers – the Academy authorities, programme directors, language specialists – to work out the strategy of language policy at LASE.

2. Acceptance of the language policy at LASE strategy document at the Senate.

3. Meetings of LASE language policy strategy developers – the Academy authorities, programme directors, language specialists – to plan the language policy implementation.

4. Implementation, control and evaluation of the language policy at LASE.

The language policy at LASE strategy should envisage:

1. the facilitation of LASE staff and students' skills of the Latvian language;

2. the facilitation of LASE staff and students' use of adequate Latvian language including adequate terminology in studies, research and communication;

3. the facilitation of the Latvian language learning by foreign students;

4. the facilitation of LASE staff and students' skills of the English language by:

- providing separate study courses or modules taught in English,
- developing joint study programmes with foreign universities;
- providing LASE staff with the possibility to supplement or learn English;

5. the facilitation of LASE staff and students' use of adequate English language including adequate terminology in studies, research and communication;

6. the facilitation of LASE staff and students' skills of at least one more EU language.

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REVIEW PAPER

SHOOTERS' PRE-START PSYCHOLOGICAL CONDITIONS AND METHODS OF THEIR SELF-REGULATION

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Abstract

The aim of the study is to assess the Latvian sport shooters' readiness for competitions – to analyze the pre-start psychological conditions and the shooters' self-regulation skills. As methods of study were used literature analysis and surveys which involved 32 high-class athletes from Latvia. In the first study of this kind shooters gave the self-assessment of their psychological preparedness. The questionnaire included 13 questions about shooters' pre-start conditions, ways of anxiety, ability to overcome it, and psychologically to tune in both the exercises and performing a single shot. The results of the study show that shooters' psychological preparation in Latvia is insufficient. Conclusions: it is necessary to elaborate an appropriate pattern of psychological training for Latvian shooters. For this pattern to be operational, in the field of psychological training the first thing to do is to educate shooting coaches by organizing seminars. There also has to be compiled and published the specialized literature which is insufficient in Latvia.

Keywords: *shooting sport, pre-start conditions, psychological preparedness.*

Introduction

High sports achievements are associated with athlete's ability to psychologically prepare for showing one's highest result directly in competition. One's readiness and skill level of sports activities each athlete demonstrates in competition where one of emotionally hardest moments is the start at the beginning of competition day (Ābele, 2009).

A training program is composed of preparation, competition and transition period (Blumenstein et al., 2007). Each period includes technical, physical, mental and tactical elements. All four elements are linked and

influences each other (Blumenstein et al., 2010), and should be carefully planned and taken into consideration in different parts of the season. It is very important for athletes and coaches to carefully plan athletes' preparation in order to achieve their peak performances and top results at the most important competitions of the season (Šašek et al., 2011).

Psychological preparedness plays a particularly important role in shooting sport. Pre-start anxiety and stress during the competition affect shooters much more than any other sports representatives. Most of the technical errors are made due to insufficient psychological training. Even very experienced shooters' results are subject to emotional condition impact. However, high class shooters stand out with their ability to control this situation and show the best shot directly in competitions (Yuryev, 1973; Zhilina, 1986).

Optimization of psycho-emotional position can be performed by a coach or psychologist (hetero-regulation) as well as the athlete oneself, if he or she has acquired appropriate skills and competences (self-regulation) (Ābele, 2009). One of the most effective methods of helping people control their stress and anxiety is to assist them in developing their confidence. Highly confident people, who believe in their abilities, experience less anxiety (Weinberg & Gould, 2005).

Assessing athlete's psycho-emotional state just before the start, several pre-start conditions are described:

- state of readiness;
- pre-start fever;
- pre-start apathy;
- pre-start self-complacency;
- psychosomatic crisis, which may occur throughout the event.

Each high-class athlete has experienced these emotional states in serious, or less marked manner (Ābele, 2009). Shooter's most representative pre-start conditions are state of readiness and pre-start fever. Pre-start fever is more typical of young, inexperienced athletes. It is due to a desire to achieve good results, but, at the same time, the athlete is not sufficiently prepared for the competition. Some physiological changes are pre-start fever symptoms: loss of appetite, high blood pressure, increased heart rate and breathing, sweating, dry mouth. Athlete experiences sleep disorders before the competition, he is careless and difficult to concentrate and his logical thinking ability and coordination are reduced during the competition (Ilyin, 2011). Insufficient knowledge about expressions of pre-start conditions and their self-regulation techniques is the cause of unsuccessful participation in international competitions for Latvian shooters.

The aim of research: to assess the Latvian sport shooters' readiness for competitions – to analyze the pre-start psychological conditions and the shooters' self-regulation skills.

Material and methods

The material and methods of the research included content analysis of literature sources and questionnaire as a pilot research.

In order to learn about the pre-start conditions and self-regulation skills of Latvian shooters there was made a survey of answers given by 32 athletes aged 12 to 52, with shooting experience 3 – 38 years. From the total number of respondents 59% are rifle shooters, 41 % - pistol shooters. 50 % of respondents are women, 50 % - men. From total of 32 respondents there are 13 sports master candidates, 15 are sports masters and 4 are international class masters of sports.

In order to make a survey there was used a self-prepared questionnaire. It contained 13 questions about the pre-start conditions and self-regulation skills. There were distributed 44 questionnaires and received 32 of them. The survey was performed during the period between competitions.

Results

Most shooters - 79% – feel anxiety before competition, 12% of shooters do not feel anxiety, but for 9% of athletes it is difficult to answer this question (Fig.1).

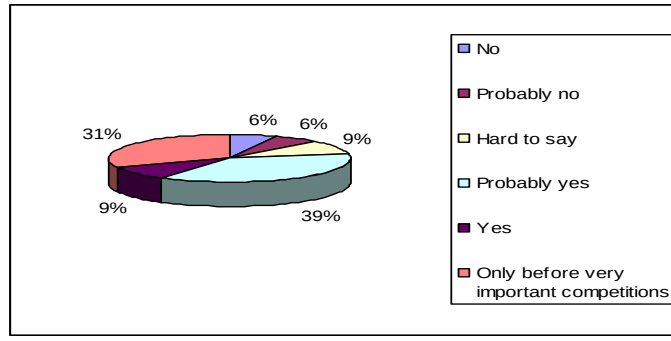

Figure 1. Feeling anxiety before competition

Figure 2 shows that most of shooters – 89% – feel pre-start fever symptoms – palpitation, nervousness, chaotic thoughts, sleep disorders, poor appetite, inability to concentrate and body trembling. Only 7% feel other symptoms and for 4% it is difficult to answer this question.

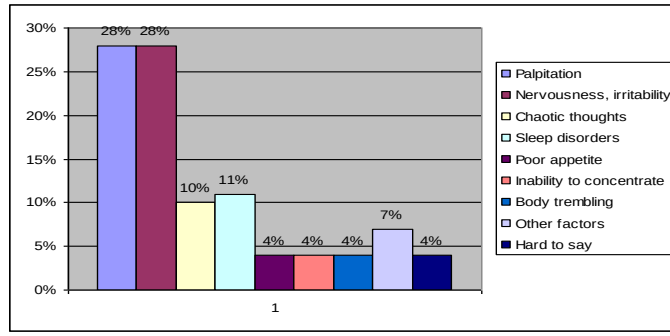

Figure 2. Most typical pre-start fever symptoms

One of emotionally hardest moments is the start at the beginning of competition. In 29% of cases anxiety appears in the morning of competition day. In most – 67% – of cases it becomes apparent directly before the start (figure 3).

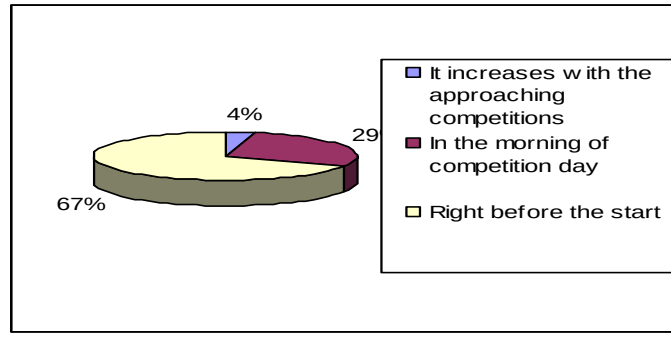

Figure 3. Starting point of anxiety

Shooter's anxiety may continue up to the end of the competition - until performing the last shot. Typically there is less anxiety during the sighting shots, but it will increase when competition shots start. Anxiety decreases if the first competition shots are performed successfully (Fig.4).

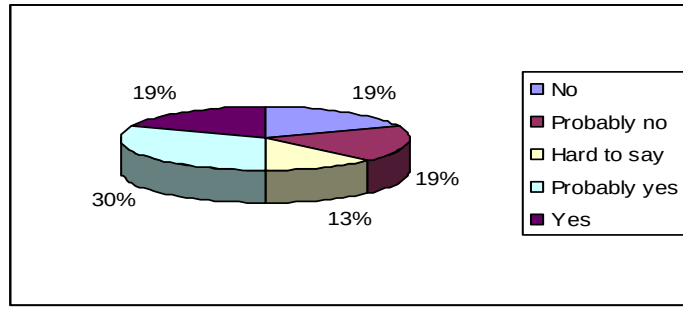

Figure 4. Anxiety decreases after first successful shots

Various conditions may cause its increase – unsuccessfully performed shot, weather changes, etc. Similarly shooter feels more anxiety participating in finals, than participating in qualifying competition. Figure 5 shows that for 88% of shooters anxiety are bigger during finals.

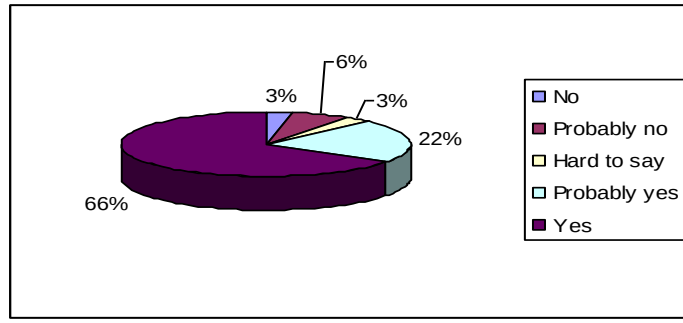

Figure 5. Anxiety increases during finals

Figure 6 shows different techniques which shooters use to perform self-tuning before the competition. Unfortunately 19% of shooters do not use any techniques.

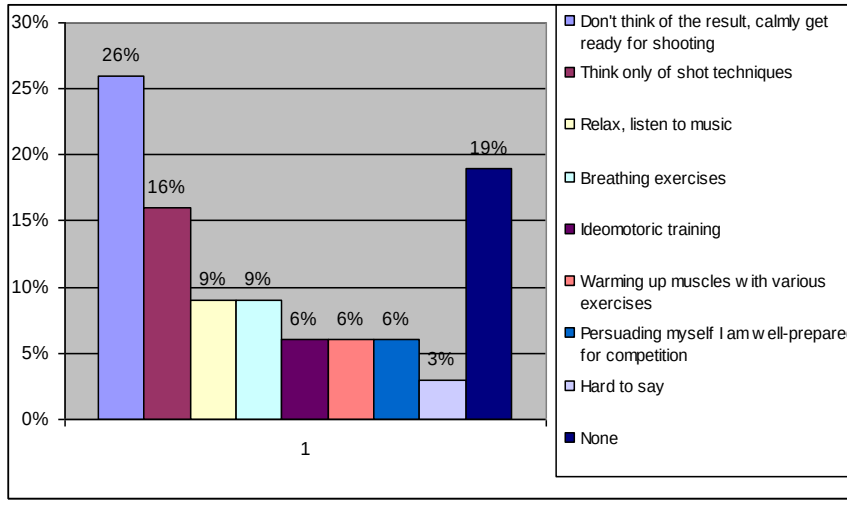

Figure 6. Techniques used to perform self-tuning before competitions

During the shooting exercise, shooters have to tune themselves before each single shot. There are many different techniques used by shooters, but 13% do not use any techniques (Fig.7).

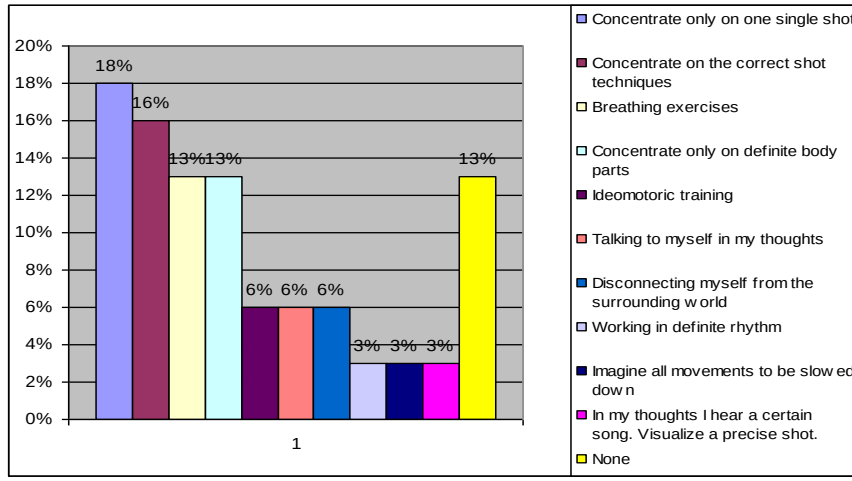

Figure 7. Techniques used to perform self-tuning before single shot

Each shooter regulates one's psychological condition in a different way, but they all lack the knowledge of self-regulation methods as only some of the athletes have been informed by the coach or they have read specialized literature. A survey of shooters showed that 49% of shooters know nothing of such methods (Fig.8).

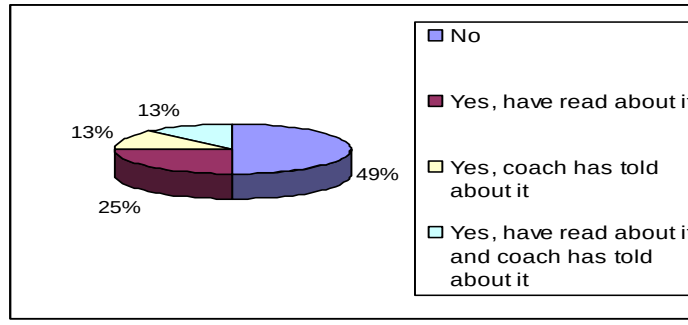

Figure 8. Answers to the question if shooters have information about self-regulation methods

Discussion

We can conclude that Latvian top level shooters and coaches do not work according to recommendations given in sport and scientific literature. Taking this fact into consideration, they have more refined knowledge which allows them to remain more aware of the importance of the mental training element in the competition period (Šašek et al., 2011).

Following literature sources, most of world's top shooters use different techniques to tune themselves before competition and before each

single shot. Analysis of research results shows, that Latvian shooters, who get disposed psychologically, mostly use similar or uniform methods like concentration on the technical execution of a shot, concentration on a certain part of body as well as breathing exercises.

Conclusions

Conducting theoretical and empirical investigation the authors made the following conclusions:

1. The most characteristic pre-start condition for Latvian athletes is pre-start fever.
2. Every shooter regulates one's psychological condition in a different way, but there is insufficient knowledge of self-regulation methods as only some of athletes have been informed about them by their coach or they have read about them in the specialized literary sources.
3. Shooting coaches in Latvia have to be educated in the sphere of psychological preparedness. There is an urgent need for seminars as well as arranging and publishing specialized literature which is available in small amounts.

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REVIEW PAPER

GUIDELINES AND CHALLENGES FOR SPORTS TEACHER LIFELONG LEARNING

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Abstract

One of the reasons that hinder the improvement of competence is that many teachers lack adequate didactic preparedness and their overload, as well as school inadequate infrastructure. Therefore many teachers conduct simplified, routine lessons, not including innovative solutions in lesson content and assessment. The aim: analyze conceptual issues of the development of sports teachers' professional and pedagogical competences and skills renewal in pedagogue professional development. The research was organized in the courses of the development of sports teacher professional and pedagogic competencies. Sports teachers' professional and pedagogical skills improvement: at the basis of the developed program is competence approach. This module in Latvian is relatively new; competencies are human abilities, knowledge and skills, which competence researchers (Bader, 1994; Boitmane, 2006) have divided into four basic groups: personality competences, managerial competences, communication and social competences, cognitive competences. In teacher training program under development are includes six modules, which are directed to the development of a core group of competencies, divided into smaller structural elements.Assessing the program of the courses, the teachers were asked 12 questions (answers were provided in 6 point Likert scale) about the topicality of the themes, the balance between theory and practical tasks, study forms and methods, control works, as well as about creative attitude to work and the introduction of innovation in it. The survey involved 204 teachers from nine course groups, who attended the courses in study year 2011/2012. The answers obtained show that the content of the course is formed according to education topicalities in today's school. Teachers'

responses indicate that the prevalence of the examples of good practice is essential for increasing the quality of the courses. Quality education process in sports lessons should serve sustainable development of society and the nation's health.Teachers should continue their professional development and throughout their careers should be available high-quality continuing professional development and training. EL believes that teachers need to maintain high professional standards, and they should be responsible to the public.

Key words: *sport teacher, lifelong learning, the quality of education in sport lessons, teacher training*

Introduction

Education in Europe nowadays is viewed in relation to the diversity of society, people's economic and social rights, human rights, equality and gender equality. Also, the education processes are not comprehended unambiguously. Education today is not only teaching and learning, but also includes lifelong learning, mobility, training, self-assessment and the final results achieved. Forming the area of democratic education in Europe, is necessary public responsibility, social cohesion, the ability to change and improve, which is not possible without the assurance of the qualitative of the continuous education process.

Physical activities have become especially topical now, when human lifestyle has dramatically changed. Modern life does not require physical effort and the strain, and it harms our health and shortens our lives. Without physical activities it is not possible to be healthy. In present situation adequate could be saying “Motion can replace medicine but no medicine can replace movements”.

Latvian National Development Plan (from 2007 to 2013) emphasizes that health is one of basic human values; it is the basis for the quality of life, personal and family well-being. Each individual's health is also influenced by habits, characterizing the lifestyle. To pave the way for good health throughout life, it is necessary to build such public opinion, in which healthy lifestyle is a value. To form citizens' understanding of health as a value, it is essential to involve people from an early age in maintaining their health and physical activities and raise their awareness about the necessity to pursue physical activities. In the Plan is put forward a specific task: "To promote the population, particularly children and young people, active participation in sport classes". One of the key goals of “Education Development Guidelines for 2007 - 2013" is the improvement of general level of knowledge and the development of skills. The development of basic

skills is included in study subject Standards for basic and secondary general education and in samples of general education subject curricula, including transition from information acquisition to the development of the skills.

In its turn, one of the goals of "Youth Policy Guidelines for 2009 – 2018" is to provide young people the opportunity to engage in physical activity, developing physical and mental talents and wholesome development, as well as raising awareness about active, healthy lifestyle.

Investigation methods:

1. Theoretical: analysis of literature and information resources.
2. Empiricial: condition a questionnaire and statistic processing of its results.

Theoretical guidelines:

Main task of the National Development Plan for 2014 – 2020: promote an approach of creativity-oriented and participation inspiring education, as well as define the necessary changes and to set clear objectives for action. It is essential that in its successful development and implementation participate all stakeholders - students, pedagogues, parents, representatives of the sphere of education.

A crucial role in promoting quality plays qualitative learning process in sport lessons. Today should be reached a common understanding of the issue: *a sport lesson first is meant for maintaining and improving student health.* Unfortunately, such an understanding does not prevail among neither among sport teachers and coaches, nor among sports functionaries. Perhaps we should think about changing the title of the subject of *Sport*, as in many European schools lessons in the name of physical education, physical education, physical activity. In the society of Latvia prevails the view that the word "sport" is concerned only with the results and there is no difference between the goals and objectives of the sport lesson and sport school workout group. European Sports Charter provides that all young people have an opportunity to obtain physical education and basic skills in sports, and everyone has an opportunity to participate in sport and physical rest in safe and healthy environment (White Paper on Sport, 2007).

The guidelines of Latvian current general education standard reflect health-oriented sport education. Essential are the ways of implementing the standard into life; the proportions in which the students acquire knowledge, develop skills; what psychological climate prevails in the lessons, how the students are motivated to participate in sports activities, to what extent are encouraged of self-expression skills, how study process influences student self-esteem and self assessment, to what extent helps to restore mental work capacities for the long study day.

In sport education can be set different priorities, but the main objective of the study subject "Sport" is and remains the promotion of student physical development and physical competence, consequently the promotion of student health.

In the study subject of "Sports", in its turn, main tasks are to create for students opportunities: engage in systematic physical activity according to the learner's condition of health, strengthening and improving health, developing physical abilities, promoting harmonious physical and mental development; raise awareness about the interaction between health, physical abilities, the environment and the exercise of the particular sport.

Along with the introduction of new standards in sport education in Latvia has been accomplished a move from the normative pedagogy to human pedagogy, which means that in center of the learning process is the student. In the new approach the primary focus in the development of skills and physical abilities is not on definite norms, but on student competition with him or her. Such high-quality learning process can be implemented only by competent sport pedagogue.

In the world today topical is an issue of quality education in the future. In the sixth congress World Education Workers Union (Education International), experts from 154 countries in Africa, Asia, Caribbean, Europe and America adopted a resolution on qualitative education for future (Cape Town, South Africa, July 2011).

General guidelines for resolutions about quality education in the future are as follows: Every citizen in any country has the right to quality education. The provision of qualitative education, taking care of students' abilities and needs, will be the main challenge for lifelong learning, from pre-school to further education and higher education. The quality of education is defined as to its contribution (student preparedness, teacher qualification), the *educational process* (teaching, learning), and *anticipated result* (individual, social and environmental needs).

State institutions must ensure that the schools have broad and balanced range of programs, which apply the same rights and responsibilities to all students; this framework should be flexible enough to allow schools to apply it considering student needs; educational institutions themselves should be responsible for adjusting the framework to the needs of society. All assessment forms must be *formative* rather than *punitive, repressive*. EI believes that the widespread incorrect use of the concept of quality to justify the use of standardized assessment forms is doing harms to the whole system of education, because teaching and learning process is reduced and placed into quantitative indicators. EL argues against

standardization and one-dimensional approach to the assessment of study process. It does not encourage innovation and creativity. Repressive, 'high stakes' requirements in assessment reduce the effectiveness of educational institutions and belief in them. All education level teachers should be adequately prepared and qualified.

Teachers should continue their professional development and throughout their careers should be available high-quality continuing professional development and training. EL believes that teachers need to maintain high professional standards, and they should be responsible to the public. The results of empirical studies show that according to expert assessment of high-quality standards characterized competent sport pedagogue scope of activity with the help of the following indicators. (Fig.1)

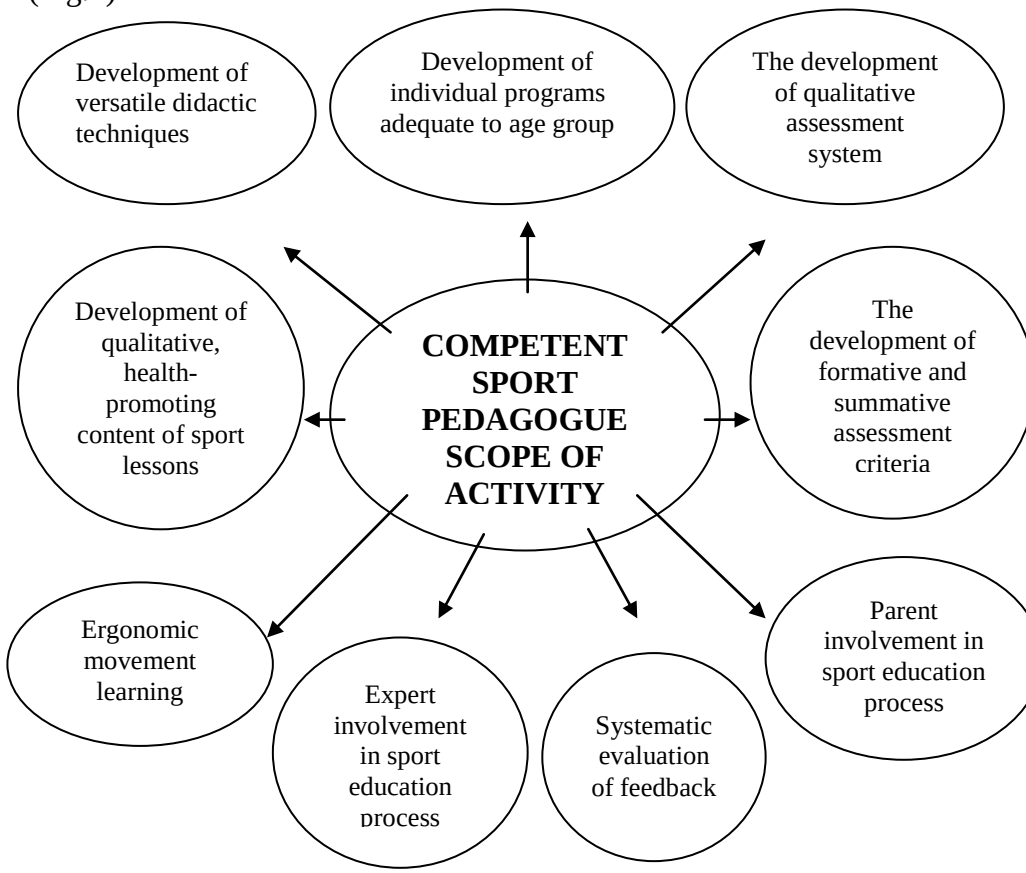

Figure 1. Competent sport pedagogue scope of activity

Results and discussions

The problem lifelong learning sport: one of the reasons that hinder the improvement of competence is that many teachers lack adequate didactic preparedness and their overload, as well as school inadequate infrastructure. Therefore many teachers conduct simplified, routine lessons, not including innovative solutions in lesson content and assessment.

*The aim***:** analyze conceptual issues of the development of sports teachers' professional and pedagogical competences and skills renewal in pedagogue professional development.

The research was organized in the courses of the development of sports teacher professional and pedagogic competencies.

Lifelong learning courses annotation

In the framework of the Program of Continuing education teachers will have improved their competence as a person's ability and preparedness to work in professional situations, make individual plans and take social responsibility, make solutions based on knowledge, experience and creative ideas, thus developing their operational abilities in open and student friendly sport lesson.

Lifelong learning courses objectives

1. Acquire knowledge about and skills in the use of innovative exercises and the latest techniques in sports lessons outdoors.
2. Acquire the development and use of didactic materials at school sport lessons study component "Knowledge and understandings in sport".
3. Acquire the skills to select and apply a variety of means (drills and exercises) for the improvement of the content of sports lesson.
4. Acquire the skills of interactive planning in the subject of sports.
5. Introduce and raise awareness about the shift of paradigms in assessment system in the subject of Sport.

Expected results

Teachers, who have successfully acquired continuing education program, will have:

- *refreshed the knowledge* of the content of the subject of sport in basic and secondary education Standard;
- *improved understanding* about the working out of the planning documentation and the conditions of use in student friendly sport lesson;
- *acquired and formed* innovative assessment system in the subject of sport;
- *mastered the content and evaluated* the role of the development of physical abilities in health promotion;

- *evaluated* the content and amount of sport lessons in connection with physical activities in social and natural environment;
- *improved the skills* to use a variety of resources (physical exercises) for the implementation of the content included in the standard;
- *considered the regularities* of forming the dialogue with students.

Sports teachers' professional and pedagogical skills improvement: at the basis of the developed program is competence approach. This module in Latvian is relatively new; competencies are human abilities, knowledge and skills, which competence researchers (Bader, 1994; Boitmane, 2006) have divided into four basic groups: personality competences, managerial competences, communication and social competences, cognitive competences. In teacher training program under development are includes six modules, which are directed to the development of a core group of competencies, divided into smaller structural elements.

Assessing the program of the courses, the teachers were asked 12 questions (answers were provided in 6 point Likert scale) about the topicality of the themes, the balance between theory and practical tasks, study forms and methods, control works, as well as about creative attitude to work and the introduction of innovation in it.

The survey involved 204 teachers from nine course groups, who attended the courses in study year 2011/2012.

During the study process teacher and students make experiments, solve different motion learning tasks, search for information, and complement exercises with added value. Such as education environment has multidimensional feedback.

Teachers were questioned about the course content and theme topicality. The answers obtained show that the content of the course is formed according to education topicalities in today's school. (Fig.2)

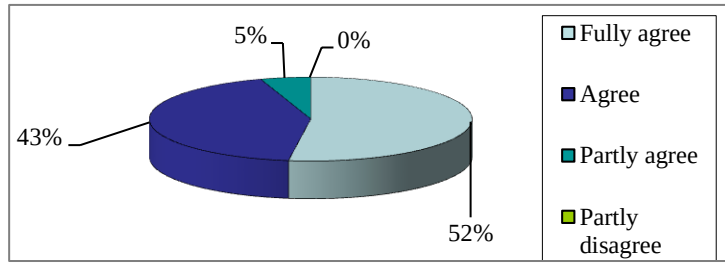

Figure 2. The topicality of the themes studied

Teachers' responses indicate that the prevalence of the examples of good practice is essential for increasing the quality of the courses. (Fig. 3, Fig.4, Fig.5)

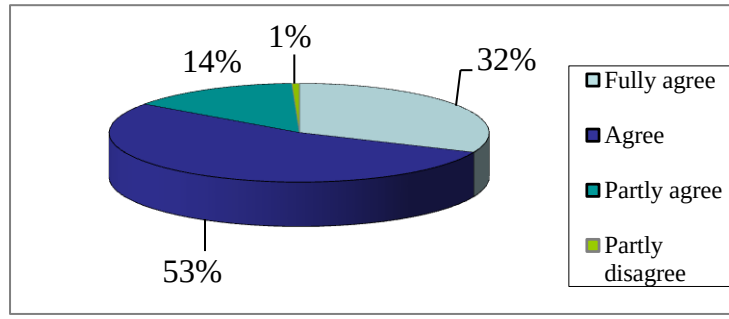

Figure 3. Balance between theory and practical tasks

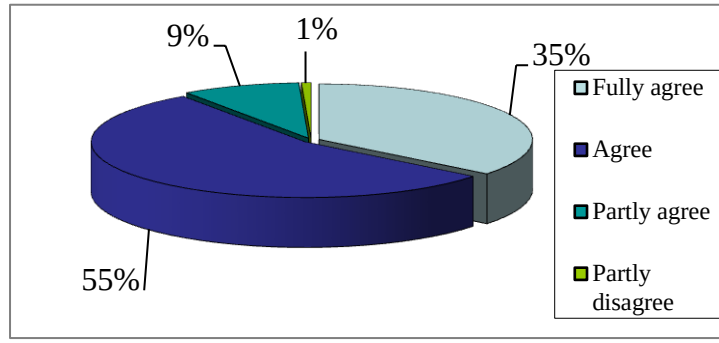

Figure 4.Direction of the content of the module to innovations

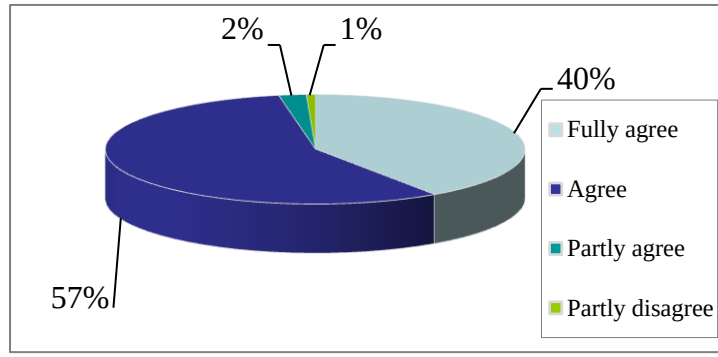

Figure 5. Direction of the content of the module to creativity

Teacher user comments (answers posted unchanged) (Fig.6).
More practical work.

- I gained the understanding of Sport standard.
- I understood that in the lesson should be provided nothing more than the Standard.
- Working out unified norms, program, and thematic plan.
- Encouraged more creative work.

- With personal positive attitude can improve students' attitudes to activities.
- Strengthened the basic idea that the student should be prepared for life, not only for sport results.
- I understood the importance of formative assessment; I will work on developing individual criteria.
- How to develop physical abilities for strengthening health the importance of health in Sports lessons and children everyday life.
- That sport affects health.
- Many new exercises and group work.
- New ideas for conducting sport classes.
- The knowledge gained I will be able to use it to introduce innovations in my work.

Teachers' answers to the question: What are the benefits of the program “Improvement of sports teachers' professional and pedagogical competence".

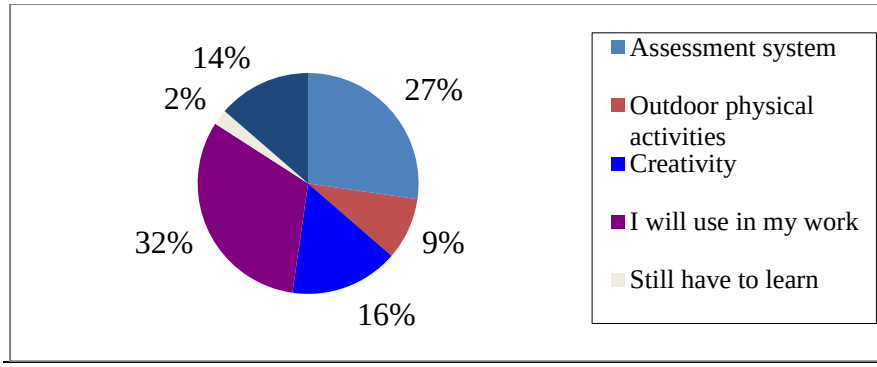

Figure 6. Teacher gains in developing competence

Quality education process in sports lessons should serve sustainable development of society and the nation's health.

The overall conclusions

- Themes studied at teachers' professional and pedagogical skills development courses are topical.
- Teaching and learning environment of the courses should be improved by a greater number of practical tasks.
- In the courses should be included examples of good practice: sports lesson simulation and analysis.

Forms of assessment of practical tasks should be to be formative, offering constructive suggestions.

- Teachers should be encouraged to develop flexible learning, adequate to school and students' needs, focused on creativity and inspiring participation in education.

Participation encouraging further education, because "the need to link young people's interests, current issues and classical knowledge is not only for show to in order to attract to school children spoilt by the modern world. These conditions are dictated by the prevailing capitalism around us, in which the necessary level of competence in the labor market jumps forward gallop, but the school seems to be dragging back like as a lame 15-year-old basset.

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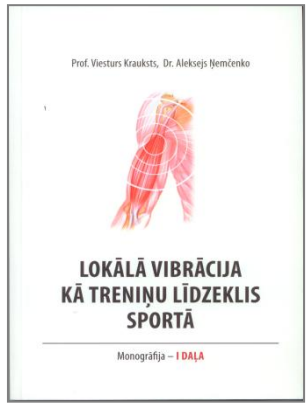
Submitted: April 20, 2012
Accepted: June 14, 2012

SHORT COMMUNICATION

Review of Viesturs Krauksts, Aleksejs Ņemčenko book **"LOCAL VIBRATION AS TRAINING MEANS IN SPORT"**



The problem of the research – finding alternative training methods of affecting an athlete's body – is very perspective, and in the course of time it will become even more essential and topical due to regular tightening control of the use of prohibited medical substances (doping) or prohibited methods of stimulation the body in sport. It is becoming more and more difficult for professional top athletes to hide the use of doping, and the risk of being caught and suspended is increasing. Besides, in recent years social evaluation of the use of the prohibited stimulators has changed.

Sport has changed from simple exercising to highly prestigious field of human activity, attracting close attention of all layers of the social environment. It is not surprising that on the state, as well as simple supporters' level people want to see fair sports competition that is not overshadowed by scandals. An important factor which proves this social demand is that in the criminal code doping is regarded as equal to drugs. All these conditions make sports society all over the world to search and develop legal means to find out and increase functional reserves of the body. One of such means is vibration training. The substantiation of effectiveness of the vibration training from the point of biology and pedagogy is especially emphasized in this book.

The topicality of the book is determined by theoretical and practical value of problems of affecting an athlete's body by proportioned (in frequency, amplitude, time and localisation) mechanical vibration influence on the muscle fibres.

It is known that vibration exercises, necessary for the body in the training, do not raise additional psychic tensions caused by maximal loads, coordination difficulty, and the danger of having injury. The authors of the monograph Professor V. Krauksts and Doctor A. Nemcenko mention such advantages of the vibration training as its short duration and simple application.

The priority of the vibro-stimulation method as the means of physiotherapy is that it is not widely spread. The analysis of the problem testifies that vibro-stimulation has great perspectives in its practical application in sport.

The authors of the monograph offer their ways of the vibration training, based on systematic application of vibration waves of proportioned frequency, amplitude and localisation to the muscles. Local vibration as a means of training process in sport allows use vibration frequency in the range of 10 – 120 Hz with

the amplitude 2 – 8 mm, and it is naturally-biological basis of training systems in sport.

The question of improving training systems for athlete preparation has always been essential in sport. One of the most important problems is optimisation of training process, involving manipulations using available training means and methods, meant to change an athlete's condition, primarily physical condition. Therefore, the creation and implementation of such pedagogical, medically-biological and technical developments which provide constant increase of sport result are really topical.

Unusual for the body training effects are effective means of overcoming adaptation barriers. They include also local vibration that allows stimulate biological activity of the body.

There is not much research about the effectiveness of vibration range of frequency and amplitude for the increase of sport result. So, it can be stated that quantity and quality of the knowledge about the character of functional changes in the body during the process of local vibration do not correspond to growing requirements in sport. The detailed development and application of highly effective alternative methods of affecting the body allows us break methodological limitedness of traditional approach towards problem solving in sport trainings and opens broader possibilities in training process.

In sport practice those methods and devices have proved themselves the most perspective which allow generate vibration waves directed to the muscle fibres. A distinctive property of these methods is that localisation of the influence is applied by special methodological means during vibration and after it. The vibration device on the one hand and the man on the other hand are active factors of this process of interaction.

The question of detailed studying of the functional status of the body during local vibration still remains topical.

While researching the affect of the proportional local vibration the authors of the monograph have stated minimal necessary doses of vibro-load in a separate session and optimal doses of vibro-load in the system of trainings.

In the research the authors based on the fact that the application of optimal doses of vibro-effect can cause predictable changes in the body functions, leading to more intensive development of an athlete's physical qualities comparing to equivalent traditional exercises. To prove this sufficient amount of research data have been collected in the framework of theoretical and practical research.

The book can be of great value for sport physicians, coaches, university teaching staff, as well as a wide range of specialists of the field involving medically-biological and pedagogical means aimed at increasing potential of the human body.

Leonīds Čupriks
PhD, Professor
Latvian Academy of Sport Education

CURRENT NEWS

Latvijas Sporta pedagoģijas akadēmija

Latvian Academy of Sport Education

LASE 5th PhD and Master Student Scientific Conference
"Theory and Practice in Sport Science"
14 March, 2013 Riga, Latvia

LASE 65th Student Scientific Conference
4 April, 2013 Riga, Latvia

6th Baltic Sport Science Conference
23-25 April, 2013 Riga, Latvia

The official languages of the Conference are Latvian and English for oral and poster presentations. The information is placed on the website: www.lspa.lv

OSRESS 2012

Outdoor Sports and Recreation Education Summer School 2012
Recreation sports in multicultural environment in Latvia
Setember 5-12, 2012 Madona, Latvia

Organizers: Latvian Academy of Sport Education and Latvian Association of Outdoor Education and Recreation **in collaboration with** Jozef Pilsudski University of Physical Education in Warsaw, Faculty of PE in Biala Podlaska, Poland, State College of Computer Science and Business Administration in Lomza, Poland, Swedish School of Sport and Health Science, Sweden and University of Malaga, Spain.

The information is placed on the website: www.lspa.lv

CONGRATULATION

We congratulate ***Māris Lesčinskis***, the student of doctoral studies at the Latvian Academy of Sport Education, to have defended his thesis "Individualization of Overall, Special Endurance and Forearm Muscles Development in Kettlebell Sport" (Sport Science) at the Latvian Academy of Sport Education on January 17, 2012. Supervisor Prof. L. Čupriks.

PhD Māris Lesčinskis is lecturer in the Department of Heavy Athletics, Boxing and Wrestling in Latvian Academy of Sport Education.

We congratulate ***Sergejs Saulīte***, the student of doctoral studies at the Latvian Academy of Sport Education, to have defended his thesis "Improvement and Control of Special Speed and Technical Preparation of Taekwon-Do ITF Sportsmen" (Sport Science) at the Latvian Academy of Sport Education on February 14, 2012. Supervisor Prof. L. Čupriks.

PhD Sergejs Saulite is lecturer in the Department of Heavy Athletics, Boxing and Wrestling in Latvian Academy of Sport Education.

We congratulate ***Ingrīda Smukā***, the student of doctoral studies at the Latvian Academy of Sport Education, to have defended his thesis "Pedagogical Interaction and Students' Physical Activity" (Sport Science) at the Latvian Academy of Sport Education on February 14, 2012. Supervisor Prof. D.Krauksta.

PhD Ingrīda Smukā is lecturer in the Department of Skiing, Shooting, Orientation, Tourism and Recreation in Latvian Academy of Sport Education.

GUIDELINES FOR CONTRIBUTORS

Instruction to Authors

The **LASE Journal of Sport Science** is a journal of published manuscripts in English from various fields of sport science. It covers the following types of papers:

- ✓ *original research papers* (maximum 12 standard pages of typescript, including tables, figures, references and abstract),
- ✓ *review papers* commissioned by the Editor (maximum 20 standard pages of typescript, including documentation),
- ✓ *short communications* (maximum 3 standard pages of typescript plus two table or figure and up to 5 references),
- ✓ *letters to the Editor* delivering an opinion or a comment to published manuscripts (maximum 2 standard pages of typescripts),
- ✓ *current news* (information on conference, abstracts of PhD. theses and Post-Doc. theses, book reviews, biographical notes),
- ✓ *advertisements* that may be covered on separate pages of the journal (prices are subjects to individual negotiations).

Papers must be accompanied by the following submission letter (form available at journal's website), signed by all Authors: "The undersigned Authors transfer the ownership of copyright to the **LASE Journal of sport science** should their work be published in this journal. Authors state that the article is original, has not been submitted for publication in other journals and has not already been published except in abstract form, preliminary report or thesis. Authors state that they are responsible for the research that they have carried out and designed; that they have participated in drafting and revising the manuscript submitted, which they approve in its contents. Authors also state that the reported article (if it involves human experiments) has been approved by the appropriate ethical committee and was undertaken in compliance with The Helsinki Declaration."

Research papers and short communications will be sent anonymously to two reviewers. Depending on the reviewers' opinion, the Editors will make a decision on their acceptance or rejection. The Editors' decision is ultimate.

Manuscript specification

Articles must be submitted in English and only to the **LASE Journal of Sport Science.**

Authors should observe the ethics of manuscript preparation (avoiding duplicate publication, inaccuracy of citations, fraudulent publication, plagiarism and self-plagiarism).

Copyright will be owned by the publisher: **LASE Journal of Sport Science**. A properly completed Transfer of Copyright Agreement must be provided for each submitted manuscript. A form is available at journal website.

Authors are responsible for the factual accuracy of their papers, for obtaining permission to reproduce text or illustrations from other publications and for an ethical attitude regarding the persons mentioned in the manuscript.

Format

Document format – Microsoft Word 97-2003 or 2007.

Page format – 210x297 mm (A4).Text – single column (font Times New Roman, letter size 12 pt), line spacing – Single, paragraph alignment – Justified, left margin – 20mm, right margin – 20mm, bottom margin – 25mm.

Style

Papers must be written in a clear, concise style appropriate to an international readership. Familiar technical terms may be used without explanation. Acronyms and abbreviations are likely to need full presentation at least once.

Content

Research or project reports, case studies of practice, action research reports, and reports on teaching practice or techniques will be accepted.

Research reports should include a description of the practical application(s) of the ideas tested, while reports of teaching practice or techniques should contain an explanation of the theoretical foundation underlying the practice or technique in question.

Material in the form of illustrations or photos is welcomed. This material should be accompanied by text clearly setting out its philosophical or practical origins or implications. All material should be clearly referenced to its sources.

The manuscripts should be arranged as follows: title page, abstract and body text

Title page should contain: title of the paper, first and last names of authors with affiliation, first and last name of corresponding authors with postal address, telephone, fax and e-mail.

Abstract (up to 250 words) consisting of the following sections: justification and aim of the study, material and methods, results, conclusions, as well as 3-6 key words, should be provided before the body text.

Body text should be sectioned into: Introduction, Material and Methods, Results, Discussion, Conclusions, Acknowledgements (If necessary) and References. In articles of others types, the text should follow in a logical sequence and headings of its particular sections should reflect issues discussed therein.

Introduction – should be short and concise; it should introduce readers into research problems addressed in the study as well justify undertaking the research and specify its aim.

Material and methods – should describe the subject of the study (in the case of human subjects data should include their number, age, sex and any other typical characteristics) and methods applied in a sufficiently exhaustive way to enable readers to repeat the experiments or observations. For generally known methods only references should be given, whereas detailed descriptions are to be provided for new or substantially modified methods.

Results – should be presented in a logical sequence in the text, tables and figures. Data collated in table and figures should not be repeated in the text which should summarize the most important observations.

Discussion – should emphasize new or important aspects of experimental results and discuss their implications. Results of own studies are to be compared with findings described in the respective domestic and international references used by the Authors.

Conclusions – should be started in points or descriptively and should be logically connected with objectives stated in the *Introduction*. Statements and conclusions not derived from own observations should be avoided.

References – following instructions for Authors on References (APA style).

Citing in-text

Following artificial text shows different types of in-text citation:

Claessens (2010) found evidence that attention will be given to multi-compartment models, such as the 3-water, 3-mineral and 4-compartment models, to assess percentage of body fat. However, Raslanas, Petkus and Griškonis (2010) noted that Aerobic physical load of low intensity got 35.1 % of total trainings time. Research on physical loading also focused on identifying the basis of many years' research of physical activity (Bytniewski et al. 2010). According to Ezerskis (2010), "… heavy physical loads had the undulating character

depending on the dynamics of workloads…" (p. 71) yet girls are more ascertained that the Track & Field training helps to develop courage.

Instructions for Authors on References (APA style)

This document describes standards for preparing the references in the APA style. The following sections give detailed instructions on citing books, journal articles, newspaper articles, conference papers, theses, web pages and others.

Please provide all the required elements in the references to your paper. Please pay particular attention to spelling, capitalization and punctuation. Accuracy and completeness of references are the responsibilities of the author. Before submitting your article, please ensure you have checked your paper for any relevant references you may have missed.

A complete reference should give the reader enough information to find the relevant article. If the article/book has DOI number, the author should include it in the references. And most importantly, complete and correct references may allow automatic creation of active links by the MetaPress technology that we use for making the electronic version of our journal. Active reference linking is regarded as the greatest benefit of electronic publishing and it adds a lot of value to your publication.

Additional information about APA style writing is found on LASE web page: http://www.lspa.lv/ .

Tables – should be prepared on separate pages (saved in separate files) and numbered using subsequent Arabic letters. They should be provided with titles (above). Every column in a table should have a brief heading and more extensive explanation should be given under the table, e.g. statistical measures of variability.

Figures – should be prepared in an electronic form and saved in separate files. A separate page should be provided with legends to figures, authors' names, manuscript's title, and consecutive number of figure with "*bottom*" or "*top*" identification. Photographs or other illustrative materials may be submitted in an electronic form (*.tif, *.jpg, image resolution: 300 or 600 dpi) or any other form suitable for final technical typesetting by the Editorial Office. In the appropriate places in the text consecutive numbers of tables or figures should be provided in parentheses, e.g. (Tab. 1) or (Fig. 1). Places of insertion of the illustrative material should be marked with pencil on the margin of the typescript.

General principles – the Editorial Office reserves for itself the right to correct stylistic errors and to make necessary changes (abridgements) in the text without Author's knowledge. Articles not accepted for publication are not returned. Manuscripts not prepared following *Instruction to Authors* will be sent back to Authors for revision. Galley proofs of manuscripts will be sent to Authors for proofreading. It is the Author's responsibility to return the proof within one week. Each Author will receive free-of-charge one copy of the issue in which their work appears.

Submission of manuscripts

The articles should be sent to:

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