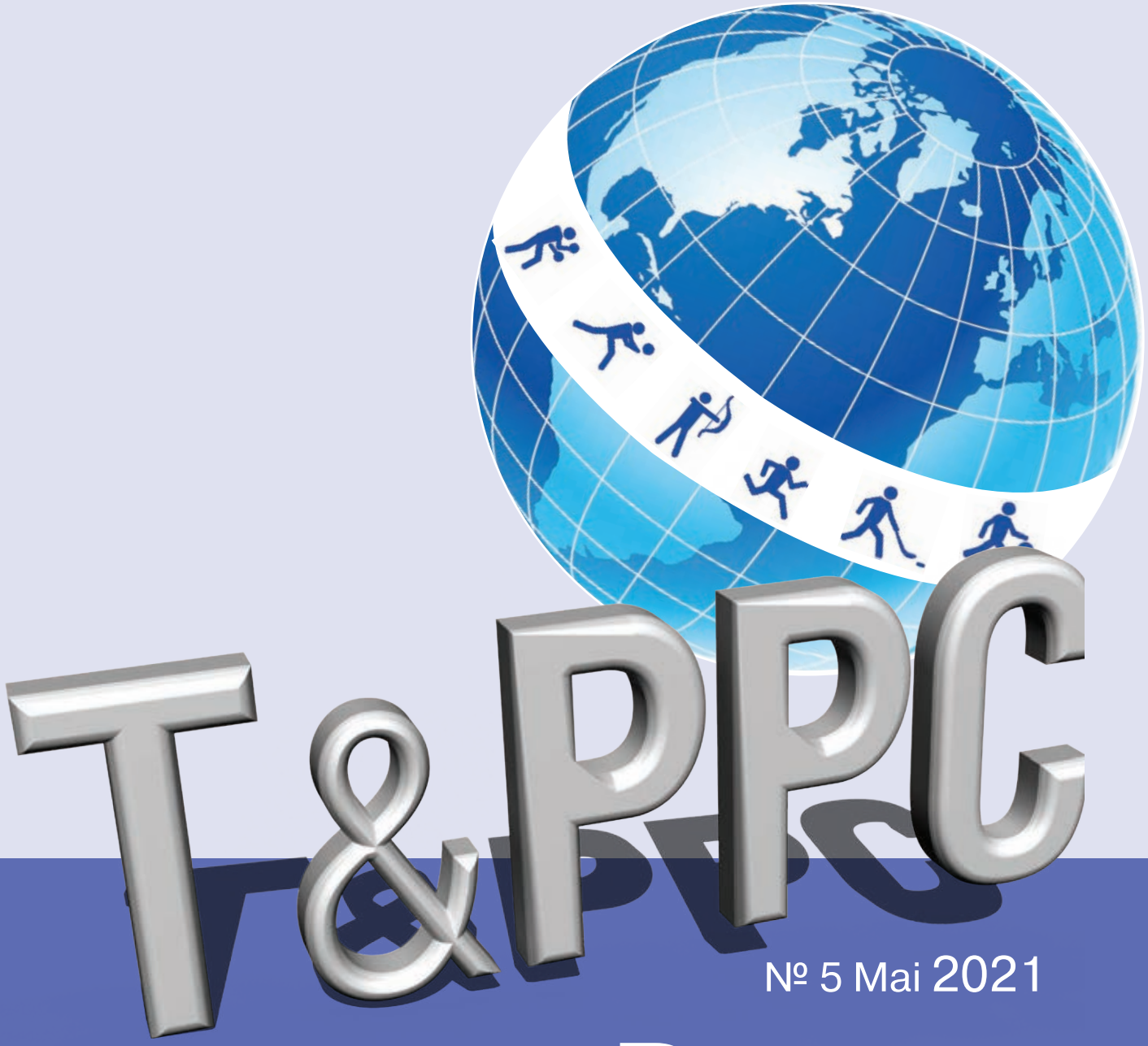

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Theory & Practice of Physical Culture

Athletic training | Sport psychology | Academic physical education | Sport physiology

Key issues of the modern sports science for discussion

Sports nutrition: from the request of practice to scientific and theoretical substantiation

Today, sports nutrition is one of the young and developing field of sports science. Sometimes ideas about the effective drug, biologically active supplement can radically change within one year. A classification of biologically active additives (BAS) according to the degree of effect achieved has already been created and generally accepted by specialists: certainly effective (class A), probably effective (class B), insufficiently studied additives (class C), certainly ineffective (class D).

This classification of supplements forces practitioners to use sports nutrition drugs with particular caution. However, it is probably also not worth completely refusing to use them, since extreme loads, especially in the sport of higher achievements, require the athlete to quickly restore performance. Although everyone knows that sports nutrition is not a drug, it allows you to restore the balance of trace elements, saturate the body with the necessary number of calories spent during the most difficult training and competitive loads.

Trainers and athletes need to approach the choice of drugs from a clear representation of the goals that are set at one stage or another of the training process. At the same time, their quality and reputation should be carefully monitored.

During training and competitive activities, a wide range of sports food products is used: protein, gainer, complex amino acids, arginine, glutamine, creatine, testosterone boosters, vitamin-mineral complex, omega-3, pre-training complexes, fat igniters, joint and ligament preparations.

Sports nutrition belongs to the category of supplements and is an addition to the main diet, consisting of ordinary products. The commercial orientation of the distribution of dietary supplements requires scientists to develop new methods for assessing the quality of drugs, conducting studies that could confirm the effectiveness, feasibility and usefulness of sports nutrition as an alternative to the use of doping in order to increase the sports result.

Chief editor of TPPC,
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Theory and Practice of Physical Culture

Contents

Development of athletes' psychophysiological condition monitoring system based on cloud technologies

UDC 796.01:159.9

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Abstract

Presented a description of the principles of operations of a system for monitoring the psychophysiological condition of athletes on the basis of cloud technologies developed in SPbRIPC. The system is based on the method of gas-discharge visualization included in the list of FMBA devices for monitoring the psychophysiological condition of athletes. The software is implemented on the server, which provides an opportunity to work in any conditions, both in the training hall and in the field, automatic storage of the received information, access to the database only for authorized users and high security of the database. The developed system allows working with the database from any computer or mobile phone connected to the Internet. Experience of 5 years of operation of the system has shown that it has a high degree of reliability, speed, convenience for users, and for all this time there have been no cases of information leakage or loss.

The psychophysiological condition of athletes is measured in the morning and evening. This allows monitoring the circadian rhythm and taking into account the adaptation of the athlete's body to changes in the environmental conditions and training loads. The process of measuring and analyzing data is so simple that it can be done by the coach or by the athletes themselves directly during the training process. Athletes have different psychophysiological parameters, so the focus is on the dynamics of these parameters over time. Particularly important is the positive dynamics of the parameters during the preparation for competitions. The high degree of correlation between the values of gas-discharge visualization parameters and the success of competitive activity during performances was shown. In the process of working with the Russian Olympic and Paralympic teams the method has earned high appreciation from the coaches and athletes due to its non-invasive, simple, and informative nature. Application of the developed method in sports gives a convenient tool for athletes and coaches to analyze and correct the training process and competitive activity.

Keywords: *psychophysiological condition, cloud technology, gas-discharge visualization*

Introduction. One of the objectives of the "Strategy for the Development of the Information Society of the Russian Federation for 2017-2030" is the creation of Russian information and communication technologies to obtain new technological advantages, use and processing of information, access to it, obtaining knowledge, creating new markets and providing leadership in them [1]. Under these conditions, sport science and practice, aimed at improving the efficiency of the training process and ensuring the highest achievements, should also be transformed by adhering to modern "digital trends".

Monitoring the psychophysiological condition of athletes in the training process and during competitions is an important task for sports of the highest achievements. At the same time, athletes, as a rule, do not have time and desire to conduct long, complex tests. Therefore, the use of methods of rapid assess-

ment of the psychophysiological state that an athlete or trainer can conduct independently is a modern necessity. The practice of work with Olympic and Paralympic teams shows that such tests must meet certain criteria:

1. Noninvasive.
2. Ease of use.
3. Easy interpretation of the results obtained.
4. Ability to be carried out in all conditions, both in the training hall and outdoors, in various weather conditions.
5. Automatic saving of the received information.
6. Restriction of access to stored information.

Small-size devices based on cloud technology, including those using a mobile phone, have become increasingly common recently. In the process of scientific and methodological support of the national teams they are used to assess and analyze the functional state of athletes, biomechanical analysis of the athlete's movement technique, psychological state, designing thematic schemes of wrestling, assessment of adaptive capacity, etc [2]. The greatest share of data in physical culture and sports is functional diagnostics. Practically all sportsmen use in their training activity the devices of Polar company that transmit to mobile devices or computer the information about the functional state of the sportsman in the state of rest and load.

This paper describes the technology developed in SPbRIPC.

Research objective. The gas-discharge visualization method imaging (GDV) is widely used in the world to study the psychophysiological state of a person in medicine and psychology. (An overview of the main publications for 10 years can be found in [3]). For many years researchers of the SPbRIPC under the auspices of the Ministry of Sport of the Russian Federation have been developing a method of applying the GDV method in sport. Based on the research results dozens of articles [4] and two monographs [5, 6] have been published. The Federal Research and Clinical Center for Sports Medicine and Rehabilitation of the Federal Medical and Biological Agency has published "Methodological recommendations for the use of the method of Gas-Discharge Visualization in the non-invasive diagnosis of functional status, psychophysiological status and health status of athletes of national teams of the Russian Federation" under the editorship of the head of the FMBA Professor V.V. Uiba [7].

The basis of the GDV method is the computer registration of the glow of athlete's fingers in a high-intensity electromagnetic field. Generated current at the microAmp level and a shooting time of about 5 microseconds make this method completely non-invasive. Developed on the basis of many years of research, the method of analysis of athletes consists of collecting information from the two ring fingers of both hands with the help of the GDV device. The whole process takes about 10 seconds, which makes it possible to perform the analysis morning and evening. The measurement results are sent to a server, where the information is processed and the user receives the processed data almost instantly [8, 9]. For athletes, the obtained parameters are stress level and energy level. Numerous experiments have shown a high degree of correlation of these parameters with data from psychological analysis and other instrumental methods.

The server program has a network architecture built on a three-level principle, where services within the "Internet cloud" organized in three large categories: database storage, data processing, and communication with the user. Such architecture, in particular, provides a high degree of database security: hackers' intrusion is possible on the first level, unlikely on the second, and fundamentally impossible on the third. All data is copied daily on an external medium, which ensures its safety in the event of a system failure. The application server and the database server are physically on the same server running CentOS with the Apache and PHP5.X web server installed. Due to the fact that the calculation of parameters is computationally difficult enough, the modules implementing this task require maximum performance. On this basis, the modules are written in standard C++ language and are built into executable files. Positioning computational modules on a powerful server computer allows us to use a relatively small application on the user's device that is used to capture data and interact with the server.

The developed system allows authorized users to work with their database from any computer or mobile phone connected to the Internet. Experience of 5 years of operation of the system has shown that it has a high degree of reliability, speed, convenience for users, and for all this time there have been no cases of information leakage or loss.

Results. As noted, the psychophysiological condition of athletes is measured in the morning and evening. This allows monitoring the circadian rhythm and taking into account the adaptation of the athlete's body to the changes of the environmental conditions and training loads [6]. The process of measuring and analyzing data is so simple that it can be done by the trainer or by the

athletes themselves during the training process. Athletes have different psychophysiological parameters, so the focus is on the dynamics of their parameters over time. Particularly important is the positive dynamics of the parameters during the preparation for competitions. The high degree of correlation between the values of GDV parameters and the success of competitive activity during the performances was shown [10]. In the process of work with the Russian Olympic and Paralympic teams the method has earned high appreciation from coaches and athletes due to its non-invasive, simple, and informative nature.

The latest generation of GDV devices is battery-operated and communicates with mobile phones via Bluetooth.

Discussion. The modern trend of "home medicine" development is to create devices for individual use that collect certain physiological data and inform the user about the parameters beyond the physiological norm. Systems of health status monitoring or physical activity indicators are gaining popularity every year. The latest generation of devices works over the Internet using a mobile phone, which allows you to save a database in the cloud and consult with a specialist if necessary. The application of these ideas in sports provides a convenient tool for athletes and coaches to analyze and adjust the training process and competitive activities. The technology and method developed in SPbRIPC for application of the Internet-based method for analysis of sports activity has been tested for a number of years during the survey of sportsmen of the Russian Olympic and Paralympic teams and has shown high efficiency combined with ease of use and interpretation of data. The next stage is a wide implementation of this method in the practice of Russian sports.

Conclusions

The presented materials testify to the prospect of further wide introduction of the method of GDV in Russian sport. The transition to Internet technology is a logical stage in the development of modern society, and sports science and practice are working successfully in this direction.

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Acute effects of running over different height mini-hurdles on sprint kinematics in athletes

UDC 796.012

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Abstract

Objective of this study was to examine the influence of the height of mini-hurdles on the kinematics of sprinting in sprinters and jumpers. Twelve male athletes (mean ± SD, age: 21.5 ± 1.9 years, height 178.4 ± 5.1 cm, body mass 74.6 ± 6.4 kg) ran maximal flying sprint under 3 different conditions: with flat, medium and high mini-hurdles (0.5, 13 and 20 cm high, respectively). The obstacles were set from 20 to 40 m. The Optojump Next (Microgate, Italy) was used to assess running velocity, stride length, stride frequency, contact time and flying time. The analysis revealed that running velocity and stride frequency were significantly greater ($p < 0.05$) in the flat mini-hurdles condition compared to the high mini-hurdles condition. Stride length significantly increased ($p < 0.05$) in the high mini-hurdles condition when compared with the flat mini-hurdles conditions. There were no significant differences ($p > 0.05$) between the medium condition and the other conditions for all sprint kinematics. We suggest that coaches and practitioners should adjust the height of sprinting obstacle depending on training needs.

Keywords: *sprint training method, hurdles, stride length, stride frequency.*

Introduction. Straight-line sprint running is an essential factor to many sports, including athletics, football, or rugby. Based on the kinematics model, effectiveness of sprint running is determined by stride length and stride frequency [1]. An increase in one parameter without decrease in the second one results in an improvement in the running velocity. However, an increase in stride length often leads to a decrease in stride frequency and conversely, an increase in stride frequency reduces the length of stride. Because only the optimal values of stride length and frequency make sprinting at the fast speed possible, researchers try to find training methods that can be used to manipulate these kinematics. One of the most common ways used to lengthen running stride is resisted sprinting (e.g. pulling a sled, tire, running uphill or with resisted bands) [2]. In turn, research showed that assisted sprinting (e.g. towing using a harness or stretch elastic tubing) is an effective method to induced changes in stride frequency [3].

However, we have little information on the third popular method to improve sprint performance through the use of sticks, marks or mini-hurdles to regulate stride kinematics. Using this method, coaches may directly influence the length and frequency of running stride. The key factor is the distance of the markers. Research by Makaruk et al. [4] demonstrated that sprint training with a lengthened distance between sticks resulted in an improvement in running velocity by an increase in stride length. On the other hand, when the distance between sticks was shortened, increasing running velocity was accompanied by an increase in stride frequency.

Objective of the study. Because the height of the training obstacle also could be a way of manipulating stride kinematics, the purpose of this study was to identify the differences in stride kinematics between sprints with increasing the height of the hurdles in sprinters and jumpers.

Research methods and structure. Twelve male athletes (mean ± SD, age: 21.5 ± 1.9 years, height 178.4 ± 5.1 cm, body mass 74.6 ± 6.4 kg) volunteered to participate in this study. All subjects were informed about the nature of this study. Six of the 12 athletes are sprinters, 4 long jumpers and 2 high jumpers. All the procedures were approved by the Ethics Commission for Scientific Research of the University of Physical Education in Warsaw.

The testing session consisted of general warm-up (5-minute jog, 8-minute dynamic stretching) and 2 x 20 m knee lifts and heel kicks, 1 x 40 m submaximal-intensity sprint. After the warm-up, each participant performed three 20-m flying sprints [5] in a random order in the following conditions: with flat, medium and high mini-hurdles (0.5, 13 and 20 cm high, respectively). The obstacles were set from 20 to 40 m and with a 220 cm distance between mini-hurdles. The participants were asked to perform the sprint at maximum speed. The Optojump Next (Microgate, Italy) was used to assess stride kinematics. This device consists of two pairs of measurement bars (1-m length transmitters and receivers) placed parallel to each other on the sprint track and connected to a computer via a USB port. The system detected all interruptions in communication between the bars with a timing accuracy of 1 ms. Contact time was measured as the time from footstrike to toe-off of the same foot, flight time was measured as the time from foot toe-off to footstrike of the opposite foot, stride length was determined as the distance from the tip of the spike-shoe at toe-off to the tip of the opposite leg's spike-shoe at toe-off, while mean step velocity was determined as the ratio between stride length and the sum of the contact time of the pushing leg and flight time during this stride.

Descriptive statistics are presented as means ± SD. The Shapiro-Wilk test was used to confirm whether the variables were normally distributed. A one-way analysis of variance (ANOVA) with repeated measures was used to determine if any significant differences existed between three sprint conditions. When significant effects were observed, Tukey post-hoc tests were applied. Statistical significance was set at $p < 0.05$. Statistica v. 13.0 software was used for all statistical calculations.

Results. Mean ± SD values of kinematic parameters are demonstrated in Table 1. The analysis revealed that running velocity and stride frequency were significantly greater ($p < 0.05$) in the flat mini-hurdles condition compared to the high mini-hurdles condition. Stride length significantly increased ($p < 0.05$) in the high mini-hurdles condition when compared with the flat mini-hurdles conditions. There were no significant differences ($p > 0.05$) between the conditions for contact time and flight time. There were also no significant differences ($p > 0.05$) between the medium condition and the other conditions for all parameters.

Discussion. Sprint running over sticks or low obstacles is a method often used by coaches and athletes attempting to improve stride kinematics. However, there is little in the way of scientific evidence to support this practice. Therefore, the purpose of this study was to examine how manipulation of the height of mini-hurdles influence kinematics of sprinting. The main findings of the study showed that an increased height of obstacles during sprint may lead to a change kinematic parameters. We found that running velocity and stride frequency decreased when the height of mini-hurdles increased from flat mini-hurdles to high mini-hurdles, but stride length increased. Additionally, our research revealed that using the medium mini-hurdles, did not change significantly running velocity, stride length and frequency, when compared to the flat mini-hurdles condition.

Table 1. *Acute effects of sprint running training on sprint kinematics (mean± SD) through mini-hurdles with different height**

Kinematics	Flat mini-hurdles	Medium mini-hurdles	High mini-hurdles
Running velocity ($m \cdot s^{-1}$)	8.69±0.43	8.61±0.39	8.50±0.54#
Stride length(m)	2.19±0.07	2.20±0.06	2.23±0.06#
Stride frequency (HZ)	3.98±0.23	3.91±0.22	3.82±0.37#
Ground contact time (s)	0.121±0.008	0.122±0.006	0.124±0.009
Flight time ($m \cdot s^{-1}$)	0.131±0.016	0.134±0.012	0.138±0.017

#Significantly different ($p<0.05$) from run over flat mini-hurdles.

The previous studies only reported the effects of distance between markers on stride kinematics [4,6]. According to our knowledge, this is the first research that compares the effects of mini-hurdles with different heights on the stride kinematics in athletics athletes. The results of this study showed that running speed significantly reduced with a 19.5 cm increase of mini-hurdles (from 0.5 to 20 cm, but did not significantly change when an increase was 12.5 cm (from 0.5 to 13 cm). In examining the possible mechanism for these observations, it is logical to suggest that decreasing running speed were produced by a decrease in stride frequency resulted from an increase in stride length [4]. We assume that an increase in stride length was due to athletes raised the knees higher to overcome the higher obstacles. Thus, for coaches wishing to increase stride length, it appears that relatively high obstacles may be effective to achieve this training goal. However, it is necessary to monitor changes in the other kinematic parameters before the implementation of the higher mini-hurdles. Although contact time and flight time showed little change between all of the conditions, longer stride may demonstrate the potentially negative effect. For example, the longer horizontal distance from the centre of mass to the foot at touchdown as the result of elongated stride may implicate an increase in the braking forces and increased hamstring injury [7].

We found that using the medium height of mini-hurdles did not significantly change the stride kinematics relative to flat condition, however, there was a trend towards an increase in stride length and decrease stride frequency. It can therefore be concluded that this condition did not significantly alter the athletes' running technique and may be recommended for athletes during training periods when movement pattern should not be dramatically changed [8]. Further research is needed to examine the longer-term effects of running over mini-hurdles and other sprint training methods on sprint kinematics [9].

Practical applications. Using mini-hurdles in running sprints may change some of an athlete's stride kinematics according to training needs. It needs to be highlighted that the implementation of high mini-hurdles requires carefully monitored training loads, especially during the competitive season. The current research has shown that high mini-hurdles (20 cm) may lead to unstable locomotor patterns and thus adversely affect running velocity by decreasing stride frequency and increasing stride length. Therefore, the coaches should use training obstacles for skill acquisition such as starting with sprints over flat markers or sticks, then implement a gradual increase of obstacles height.

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Comparative characteristics of special strength fitness rates in armwrestlers of different weight categories and skill levels

UDC 796.015

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Abstract

Objective of the study was to identify differences between special strength fitness levels of armwrestlers of the middle (80-85 kg) and heavy (up to 110 kg and over 110 kg) weight categories.

Methods and structure of the study. Sampled for the study were 24 armwrestlers aged 18-42 years who were divided into 2 weight categories and 2 groups depending on their skill levels. Group I (n=12) included the athletes with the sports titles "World Class Master of Sport" and "Master of Sport of Russia". Group II (n=12) was made of the athletes with the sports qualifications of Class I athletes and Candidate Masters of Sport. Group A (middle weight category) included the athletes (n=12) with the body mass of 78 to 85 kg, Group B (heavy weight category) - 105 kg and over (n=12). The subjects' special strength abilities were assessed using the tensodynamometry method.

Results and conclusions. The skilled armwrestlers and athletes of the heavy weight category (up to 110 kg and over 110 kg) were found to have significantly higher special strength fitness rates as compared to those of the middle weight category (80-85 kg.). The greatest differences between the mean strength values were found in the muscles involved in the forearm pronation, shoulder pronation, and wrist abduction ($p<0.01$). The smallest differences were found in the strength of the finger flexor muscles, forearm flexor muscles in the supine position, and wrist flexor muscles ($p<0.05$). The armwrestlers of the heavy weight category left those of the middle weight category behind in all the control tests.

Keywords: *armwrestling, strength fitness, weight categories, strength topography.*

Background. Armwrestling is a sport that demands higher standards of strength qualities. Research suggests that highly-skilled athletes have an advantage in both the anthropometric (forearm length, hand length and width, shoulder and forearm circumferences [3, 4]) and strength parameters (hand and fingers flexion [2, 5, 6], shoulder pronation: forearm supination and pronation, hand abduction, forearm flexion [1, 2]). This is evidenced by the results of competitions in the absolute (open-weight) weight category. They are common for Russian and international tournaments, in particular, commercial tournaments. At times, the difference in the athletes' body mass is up to 30-50 kg or even more. It is not uncommon for an athlete of a lighter weight class to beat a heavier athlete.

Objective of the study was to identify differences between special strength fitness levels of armwrestlers of the middle (80-85 kg) and heavy (up to 110 kg and over 110 kg) weight categories.

Methods and structure of the study. Sampled for the study were 24 armwrestlers aged 18-42 years who were divided into 2 weight categories and 2 groups depending on their skill levels. Group I (n=12) included the athletes with the sports titles "World Class Master of Sport" and "Master of Sport of Russia". Group II (n=12) was made of the athletes with the

Table 1. *Comparative characteristics of special strength fitness rates in highly-skilled armwrestlers (MS and WCMS)*

Control tests	Group A 80-85 kg, M±m	Group B 105+ kg, M±m	Difference, kg	Difference, %	T	P
Side	36.22±2.37	50.16±3.58	13.94	38.49	3.25	<0.01
Hand	63.31±4.65	79.80±3.09	16.49	26.05	2.95	<0.05
Abduction	23.17±1.80	36.12±2.49	12.95	55.89	4.21	<0.01
Supination	38.98±6.17	55.5±4.81	16.52	42.38	2.20	<0.05
Radius	39.26±1.18	52.89±3.96	13.63	34.72	3.30	<0.01
Back	74.44±5.92	108.11±2.72	33.67	45.23	5.17	<0.01
Biceps	40.35±2.24	50.79±2.13	10.44	25.87	2.38	<0.05
Pronation	37.03±4.09	63.23±5.62	26.20	70.75	3.77	<0.01
Fingers	80.10±6.08	98.37±5.67	18.27	22.81	2.20	<0.05

sports qualifications of Class I athletes and Candidate Masters of Sport. Group A (middle weight category) included the athletes (n=12) with the body mass of 78 to 85 kg, Group B (heavy weight category) - 105 kg and over (n=12).

The subjects' special strength abilities were assessed using the tensodynamometry method [2]. After the warm-up, the subjects were given two attempts for every test, where only the best attempt was recorded.

The athletes' maximum effort was registered in the following 9 main anatomical points of strength topography: shoulder pronator, hand flexors, hand abductor muscles, forearm supinators, neutral-point forearm flexors, shoulder extensors, supine forearm flexors, forearm pronators, and finger flexors, with every test applied to the relevant strength focusing point.

The statistical analysis of the data obtained was carried out using the license application program package "Excel". The method of descriptive statistics was applied to analyze the following indicators: arithmetic mean, standard deviation, and error of the mean. The statistical significance of differences in the groups was determined by the parametric Student's t-test.

The study was carried out on the basis of the armwrestling section of the Bauman Moscow State Technical University.

Results and discussion. Given in Table 1 are the indicators of special strength fitness of the armwrestlers with the sports titles.

Legend. Side – shoulder pronation, hand – hand flexion, abduction – hand abduction, supination – forearm supination, radius – neutral-point forearm flexion, back – shoulder extension, biceps – supine forearm flexion, pronation – forearm pronation, fingers – finger flexion.

The statistical analysis revealed significant differences between the middle and heavy weigh cat-

Table 2. *Comparative characteristics of special strength fitness rates in armwrestlers of senior categories (CMS)*

Control tests	Group A 78-85 kg, M±m	Group B 105+ kg, M±m	Difference, kg	Difference, %	t	p
Side	32.02±2.07	45.14±2.61	13.12	40.97	3.94	<0.01
Hand	53.75±0.47	70.79±4.56	17.04	31.70	3.72	<0.01
Abduction	19.83±1.53	30.64±1.14	10.81	54.51	5.67	<0.01
Supination	34.67±2.59	45.87±4.33	11.2	32.30	2.22	<0.05
Radius	37.03±0.89	49.64±2.55	12.61	34.05	4.67	<0.01
Back	74.42±5.13	104.39±7.36	29.97	40.27	3.34	<0.01
Biceps	36.29±2.90	50.23±3.76	13.94	38.41	2.94	<0.05
Pronation	32.92±1.67	56.11±2.49	23.19	70.44	7.73	<0.01
Fingers	65.39±1.67	85.38±3.91	19.99	30.57	4.70	<0.01

egory groups in terms of all test rates. The greatest difference between the mean strength values, above 50%, was found in the forearm pronators and hand abductors ($p<0.01$); the smallest, below 30% - in the finger flexors, supine forearm flexors, and hand flexors ($p<0.05$). At the same time, the mean body mass value in Group A was 83.3 kg, while in Group B - 122.6 kg - 32% difference.

Similar results were obtained in the comparative analysis of the armwrestlers with the 1st senior category and title of Candidate Master of Sports (Table 2). The armwrestlers of the senior categories from Group B left the highly-skilled armwrestlers of Group A behind in all the control tests.

As may be supposed, occasional wins of the armwrestlers of the middle weight category over those of the heavy weight one were due to the better developed speed qualities and special endurance of the former, which indicated a higher integral training level.

Conclusions. The skilled armwrestlers and athletes of the heavy weight category (up to 110 kg and over 110 kg) were found to have significantly higher special strength fitness rates as compared to those of the middle weight category (80-85 kg.). The largest differences between the mean strength values were found in the muscles involved in the forearm pronation, shoulder pronation, and wrist abduction ($p<0.01$). The smallest differences were found in the strength of the finger flexor muscles, forearm flexor muscles in the supine position, and wrist flexor muscles ($p<0.05$). The armwrestlers of the heavy weight category left those of the middle weight category behind in all the control tests.

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Parameters of strength fitness in athletes from various team sports

UDC 796.33

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Abstract

Objective of the study was to identify the parameters of strength fitness of athletes of different skill levels from various team sports and conduct a comparative analysis of the data obtained.

Methods and structure of the study. The following research methods were applied: theoretical analysis; testing; mathematical statistics. Sampled for the study were 117 handball players, 118 volleyball players, 114 basketball players, and 127 football players (qualified from Class III to Masters of Sports). The relative strength rates in the subjects' muscle groups were determined using the generally accepted method of B.M. Rybalko and B.M. Abalakov's test (dynamometry).

Results and conclusions. The experimental research under the supervision of Professor G.N. Maksimenko and further comparative analysis of the data obtained revealed the relative strength indices in different muscle groups of volleyball, handball, basketball, and football players with sports qualifications from Class III to Masters of Sports. The sports progress from Class III to Masters of Sports in the studied groups was accompanied by a statistically significant increase in the athletes' relative strength rates (and hence, absolute strength rates). The highest aggregate values of relative strength in the 5 leg muscle groups were recorded in the Masters of Sport in football (6.04±0.04 kg).

Simultaneously with the identification of the parameters of development of strength qualities of various muscle groups, we conducted a comparative analysis of the data obtained in the athletes from various team sports with sports qualifications from Class III to Masters of Sports. The findings conform to the modern scientific idea that sports progress and improvement of competitive performance in team sports largely depends on the level of development of strength qualities of individual muscle groups [3, 4]. The growth of sports skills is accompanied by a statistically significant increase in the strength of particular muscle groups.

Keywords: *relative strength, muscle groups, team sports.*

Background. Current scientific studies indicate the relevance of the issue of enhancement of athletic training in various team sports [1-4]. Most of the studies [2, 4] do not provide answers to the questions concerning the optimal strength value for each team sport, the muscle groups to be developed in athletes depending on their sports specialization, and the strength fitness parameters to be taken into account when planning the process of training of athletes qualified from Class III to Masters of Sports.

Objective of the study was to identify the parameters of strength fitness of athletes of different skill levels from various team sports and conduct a comparative analysis of the data obtained.

Methods and structure of the study. The following research methods were applied: theoretical analysis; testing; mathematical statistics. Sampled for the study were 117 handball players, 118 volleyball players, 114 basketball players, and 127 football players (qualified from Class III to Masters of Sports). The relative strength rates in the subjects' muscle groups were determined using the generally accepted method of B.M. Rybalko and B.M. Abalakov's test (dynamometry) [1, 2].

Results and discussion. As the Table shows, with the growth of sports mastery of the handball players, the relative strength rates in the studied muscle groups increased, which reached their maximum values in the Masters of Sport. This was especially noticeable in the aggregate strength values of 5 and 8 muscle groups. It should be noted that the relative strength rates in the handball players increased with the increase of their body mass in the process of building sports mastery from Class III to Masters of Sports. A total of 118 volleyball players with different skill levels were tested for the strength of the same muscle groups as the handball players. Besides, we tested the strength level of the trunk flexors. Thus, we detected the improvement of relative strength rates in the volleyball players accompanied by the growth of their sports skills. At the same time, as with the handball players, the most pronounced increase in the strength rates was observed in the aggregate values of strength of the 5 and 10 muscle groups. The testing of 114 basketball players with different sports qualifications showed a high level of correlation between their sports mastery level and relative strength of the following muscle groups: hip flexor and extensor muscles, ankle flexor and extensor muscles, plantarflexor, shoulder flexor and extensor muscles, forearm extensor, wrist flexor; adductor muscles of the shoulder, and trunk flexor and extensor muscles. The correlation "sports result - relative strength development level" was especially noticeable in the dynamics of the aggregate values. The muscle group strength test rates in 127 football players were found to have a similar tendency to increase. In the football players, the most informative and reliable indicators were obtained in the hip flexor and extensor muscles, ankle flexor and extensor muscles, and plantarflexor.

Conclusions. The study has made it possible to determine the parameters of development of strength qualities of various muscle groups of athletes from various team sports with diriment sports

Table 1. *Relative strength rates in handball players with different sports qualifications*

Muscle group strength rates (kg)	Sport qualification						
	Master of Sport		Class I		Class II		Class III
	$\bar{X} \pm m$	p	$\bar{X} \pm m$	p	$\bar{X} \pm m$	p	$\bar{X} \pm m$
Aggregate values of relative strength: hip flexor hip extensor ankle flexor ankle extensor plantarflexor	0.54±0.01 1.81±0.02 0.42±0.01 0.72±0.01 2.23±0.03	<0.01 <0.01 <0.01 >0.05 >0.05	0.38±0.02 2.04±0.03 0.31±0.02 0.75±0.04 2.14±0.05	<0.01 >0.05 >0.05 >0.05 <0.05	0.32±0.02 1.69±0.04 0.26±0.01 0.66±0.03 1.95±0.05	<0.01 >0.05 <0.05 >0.05 <0.05	0.4±0.02 1.5±0.05 0.35±0.02 0.64±0.03 1.62±0.05
Aggregate values of relative strength in the leg muscle groups	5.73±0.09	>0.05	5.65±0.08	<0.01	4.94±0.11	<0.05	4.60±0.1
Aggregate values of relative strength: adductor muscles of the shoulder shoulder extensors forearm extensors	0.8±0.01 0.8±0.01 0.39±0.01	>0.05 >0.05 >0.05	0.76±0.01 0.78±0.02 0.35±0.01	<0.01 <0.01 <0.01	0.6±0.02 0.61±0.02 0.22±0.01	>0.05 >0.05 >0.05	0.62±0.03 0.65±0.02 0.23±0.01
Aggregate values of relative strength in the 3 arm muscle groups	2.00±0.03	>0.05	1.90±0.06	<0.01	1.44±0.04	>0.05	1.51±0.06
Aggregate values of relative strength in the 8 muscle groups	7.73±0.11	>0.05	7.55±0.12	<0.01	6.38±0.11	>0.05	6.11±0.15

qualifications: from Class III to Masters of Sports. The data obtained were subjected to a comparative analysis. The findings conform to the modern scientific idea that the growth of sports mastery and improvement of competitive performance in team sports largely depends on the level of development of strength qualities of individual muscle groups [3, 4]. The growth of sports mastery from Class III to Masters of Sports in the studied team sports was accompanied by a statistically significant increase in the athletes' relative strength rates (and hence, absolute strength rates). For example, the highest aggregate values of relative strength in the 5 leg muscle groups were recorded in the Masters of Sport in football (6.04 0.04 kg).

The study data and findings can be used as benchmarks for monitoring the level of development of strength qualities of athletes of different skill levels from various team sports, which will ensure that such principles are put into practice thus focusing on the achievement of elite sportsmanship and proportionality in the development of the basic motor skills. The prospects for further scientific research may be based on the need to study the contribution of each of the motor qualities parameters to sports results in various team sports.

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Digital model of martial artist

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Abstract

Objective of the study was to offer a theoretical and practical framework for digital modeling of the martial artist's performance, with judo taken for the case study.

Methods of the study. The researchers used a set of the relevant theoretical and mathematical tools to formalize the theoretical and practical training process.

Results and discussion. The judoka's digital model includes (1) Basic individual data: above 10 specifications; (2) General physical fitness: 24 test rates; (3) Special physical fitness: 33 test rates; (4) Morphology and functionality: 20 test rates; (5) Medical and biological data: above 10 indicators; (6) Social standing: above 10 indicators; (7) Psychophysical state: above 10 test rates; (8) Technical and tactical skills: dimensionless points; and (9) Sports track record.

The above test data make it possible to analyze the aerobic performance, muscular endurance, flexibility, speed, coordination, neural-psychic stress tolerance, adaptability, and the physique type and harmony. The authors believe that further progress in the global elite sports will increasingly depend on sports digitalization service based on a profound knowledgebase developed by the modern sports physiology and psychology.

The athlete's digital model offered and analyzed herein may provide solutions for the urgent problems of the theoretical and practical training and competitive processes since its offers to athletes and coaches reasonably limited test data arrays with analysis and timely progress recommendations. The new digital model was developed using modern IT tools and includes a database, knowledgebase and special customizable mathematical toolkit for digital modeling service.

Keywords: *sport digitalization, digital model, judo.*

Background. Modern elite sports may be defined as the ultimate competitive domain that requires every individual resource being mobilized for success; and this success can be achieved any more only by intensive physical trainings and advanced theoretical and practical training system design and management tools. Nowadays progress in modern elite sports is secured by joint efforts of athletes, coaches, researchers, physicians and technical personnel service for success in the training and competitive phases. The sports communities increasingly understand that high quality theoretical and practical training analysis and situational express analysis in competitions cannot be made "on the edge of the field" by single coaches or coaching teams. It is the modern digital technologies that increasingly contribute to the coaching service in every sport including martial arts [1-6, 9], although the latter are still in need of special software products for the theoretical and practical training system design and management purposes.

Objective of the study was to offer a theoretical and practical framework for digital modeling of a mar-

tial artist's performance, with judo taken for the case study.

Methods of the study. We used a set of the relevant theoretical and mathematical tools to formalize the theoretical and practical training process.

Results and discussion. Formally, an athlete's digital model may be represented as a finite set of quantitative and qualitative test rates to describe variations in the physiological, psychological and cognitive processes with account of the personal behavioral models [4]. Therefore, the digital model design process requires thorough, repeated and prolonged tests to generate reliable performance test data [1-3]. The performance rating for every martial art requires rather painstaking and difficult work, and therefore we limited our digital model by elite judo taken for the case study. The proposed basic classification may be applied, when needed, to similar sport disciplines, with some adjustments to the set of the key performance tests. For judo, the test set includes: (1) Basic individual data: above 10 specifications; (2) General physical fitness: 24 test rates; (3) Special physical fitness: 33 test rates; (4) Morphology and functionality: 20 test rates; (5) Medical and biological data: above 10 indicators; (6) Social standing: above 10 indicators; (7) Psychophysical state: above 10 test rates; (8) Technical and tactical skills rated by points; and (9) Sports track record.

The above test data makes it possible to analyze the aerobic performance, muscular endurance, flexibility, speed, coordination, neural/ psychic stress tolerance, adaptability, and physique type and harmony. The individual digital model provides an individual performance matrix to produce progress recommendations on the following: (1) Frequency and duration of trainings; (2) Training process intensity management; (3) Energy costs; (4) Physical training tools; and (5) Training system design.

An athlete's digital model was formed by around 120 parameters, including both the discrete and continuous ones, and this is why the key task in the digital model design process is to effectively limit the data dimensions with no significant loss for the quality of the data array.

The resulting model *s* describes the athlete' state at specific time point by an array of continuous indicators (including the primary ones) with the following systems of nonlinear differential and integral-differential equations: $f^{(w)}$

$$, \ s \in S, \ s^{(w)}(f,x,z,t) = \frac{\partial f^{(w)}(x,z,}{\partial t}$$

$$x \in R, z \in Z, w \in \Omega, t > 0,$$

where $f = \{f(w)\}$ – unknown vector function describing one of the indicators of the resulting model, $x \in R$ – integer indicators, $x \in R$ – continuous indicators; and, $w \in \Omega$ –resultant indicator.

The array of indicators *M* for the digital model is defined as:

$$M = \{Un, Ph, Sp, M f, Mb, Soc, Ps, T, L\}.$$

$$Un = [u_1, u_2, \ldots, u_n], n=10,$$

where $u_1, u_2, \ldots, u_n$ – are the integer basic individual specifications.

$$Ph = [u_1, u_2, \ldots, u_n, \vartheta_1, \vartheta_2, \ldots \vartheta_m], n=8, m=16,$$

where $u_1, u_2, \ldots, u_n$ и $\vartheta_1, \vartheta_2, \ldots \vartheta_m$ – are the integer continuous general physical fitness test rates.

$$Sp = [u_1, u_2, \ldots, u_n, \vartheta_1, \vartheta_2, \ldots \vartheta_m], n=4, m=29,$$

where $u_1, u_2, \ldots, u_n$ и $\vartheta_1, \vartheta_2, \ldots \vartheta_m$ и – are the integer continuous special physical fitness test rates.

$$Mf = \{u_1, u_2, \ldots, u_n, \vartheta_1, \vartheta_2, \ldots \vartheta_m\} n=12, m=8,$$

where $u_1, u_2, \ldots, u_n$ и $\vartheta_1, \vartheta_2, \ldots, \vartheta_m$ – are the integer continuous values of the athlete's morphology and functionality.

$$Mb = [u_1, u_2, \ldots, u_n, \vartheta_1, \vartheta_2, \ldots \vartheta_m], n=4, m=6,$$

where $u_1, u_2, \ldots, u_n$ и $\vartheta_1, \vartheta_2, \ldots \vartheta_m$ – are the integer continuous medical and biological test rates.

$$Soc = [u_1, u_2, \ldots, u_n], n=10,$$

where $u_1, u_2, \ldots, u_n$ и $\vartheta_1, \vartheta_2, \ldots \vartheta_m$ – are the integer continuous social standing test rates.

$$Ps = [u_1, u_2, \ldots, u_n], n=10,$$

where $u_1, u_2, \ldots, u_n$ и $\vartheta_1, \vartheta_2, \ldots \vartheta_m$ – are the integer continuous psychophysical state test rates.

$$T = [h_1, h_2, \ldots, h_n], n \to N,$$

where $h_1, h_2, \ldots, h_n$ – are the technical and tactical skills metering points, and *N* – limiting number.

$$L = [l_1, l_2, \ldots, l_n], n \to N,$$

where $l_1, l_2, \ldots, l_n$ – are the athlete's track record stage rating points, and N – limiting number.

Each of the above test data arrays *M* has its own test specifics. Moreover, each indicator in each array requires its own specific tests. For example, a 30m sprint test needs to be standardized based on some principles; whilst an athlete's stress tolerance may be tested by a few options including, e.g., the Luscher color test.

Most of the above test rates may be easily formalized to a degree and described by very specific methods. The situation is complicated when such methods are still underdeveloped or non-existing. For example, the tactical and technical skills are rather difficult for

formalization process that needs a special mathematical toolkit. The same applies to the individual track record specifications. It is also clear that the individual competitive accomplishments are characteristic of the athlete's psychophysical state, albeit further detailed formalization of a track record requires an extensive set of criteria to describe the athlete's state in every time point and, hence, again requires its own mathematical toolkit.

The digital model design process is further complicated by the time flow, with every function being time-dependent. Time is accounted as the function time, but it is not specific and separate for every x or z indicator. Every indicator, in fact, requires its own timeframe not necessarily matching with the times of other indicators.

$$\forall(x_i(t), x_j(t`))\ t \neq t`$$

It should be noted that the test time differences $\Delta t = t - t`$ may be measured in months and even years. Some test rates are generated simultaneously to cause no generally negative effects on the model, but some parameters (for example, muscle mass), should be rated with Δt close to 0 for the modeling process accuracy:

$$s_{opt}: \Delta t \to 0.$$

To design a digital model for an athlete with a five-year track record, we may need as many as 600 test rates to analyze the present performance and progress options, conditional on the tests run every year (and even more often, in fact). Note that correlations of the test rates – even when we consider only the meaningful ones – are multiple times higher. Therefore, classifications of the current performance and progress options are extremely difficult and achievable only for the modern cutting-edge IT systems.

It may be pertinent to mention that the similar modeling systems are developed by research teams in Chelyabinsk [1], Minsk [3], Spain and Brazil [5, 7]. We believe that further progress in the global elite sports will increasingly depend on sports digitalization service based on a profound knowledgebase developed by the modern sports physiology and psychology.

Conclusion. The athlete's digital model offered and analyzed herein may provide solutions for the urgent problems of the theoretical and practical training and competitive processes since its offers to athletes and coaches reasonably limited test data arrays with analyses and timely progress recommendations. The new digital model was developed using modern IT tools and includes a database, knowledgebase and special customizable mathematical toolkit for digital modeling service.

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Innovative approaches to analysis of parameters of shooting skills of biathletes using wireless optical sensor SCATT MX-W2

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Abstract

The article presents the data of testing the shooting skills of biathletes of the Russian national team, obtained with the help of the SCATT MX-W2 wireless optical sensor and the analysis program. The analysis of the shooting parameters obtained using the SCATT MX-W2 wireless optical sensor makes it possible to develop an algorithm for managing the improvement of the shooting training of biathletes when firing ammunition. The examples of individual analysis of graphic and digital parameters of the technique of performing a series of shots are shown, which makes it possible to identify errors, develop individual programs for shooting training and recommending ways to eliminate the identified deficiencies.

Keywords: *shooting in biathlon, biathletes of the Russian national team, analysis of parameters of shooting skills, wireless optical sensor SCATT MX-W2.*

Introduction. Shooting simulators SCATT are widely used in the training of shooters and biathletes [1, 2]. This simulator allows you to get an objective assessment of the athletes' shooting fitness. Misses in the conditions of training and competitive activity can be caused by many factors, the main of which are insufficiently good fit of the rifle stock, errors in aiming and handling the trigger [1, 2, 3, 4]. Without the use of technical means, it is difficult for a coach to give an objective assessment of shooting skills and to identify the reasons for mistakes. With the advent of new approaches to the design of shooting simulators, a decrease in their weight and dimensions, it became possible to use them widely during idle training and firing with cartridges. The possibility of wireless data transmission during aiming and firing a shot has largely changed the methodological approaches to the use of SCATT MX-W2 in the shooting training of athletes. This is relevant in biathlon, where the athlete makes a lot of manipulations with the weapon during the preparation and shooting at five targets. Especially valuable for biathlon is the fact that an athlete can perform complex training, moving along a distance with a weapon with a wireless sensor attached to it, and perform a series of rounds of live ammunition in a shooting range at five targets, taking into account the specifics of shooting in biathlon.

Objective of the study was to analyze the results of a series of shots, expressed in graphic and digital format, obtained with the help of the SCATT MX-W2 wireless optical sensor in highly qualified biathletes.

Research methods and structure. The study involved 25 biathletes of the Russian national team of the main and reserve teams with qualifications of

masters of sports, international masters of sports, Honored masters of sports, aged 20-30 years. The total number of recorded training sessions was 154, with the number of shots in one training being from 50 to 150. After zeroing in the weapon, the athletes fired in a series of five shots at the installations in the conditions of the shooting range with live ammunition with a wireless sensor attached to the barrel at rest and after physical exertion (fig. 1).

When shooting with the use of SCATT MX-W2, the work is based on feedback, the athlete and the coach can immediately assess the ammunition firing performance on the computer screen and compare these indicators with their inner feelings [1, 2].

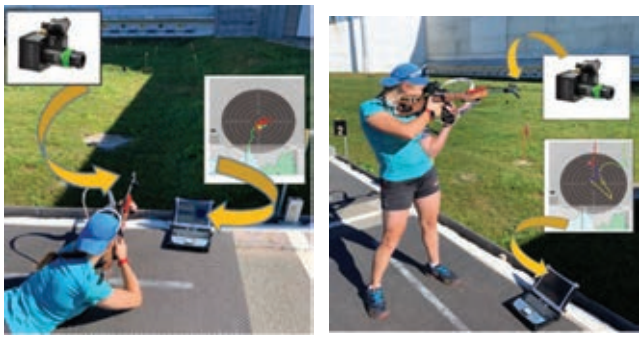


Figure 1. *Fragment of shooting training using a wireless optical sensor SCATT MX-W2 at biathlete international masters of sports*

Results and discussion. The testing made it possible to obtain objective and detailed information about the microstructure of the technique of a series of shots individually for each spotter, to identify errors made in the process of aiming and handling the trigger.

The program allows you to analyze several informative graphs and many statistical parameters. The SCATT MX-W2 shooting simulator makes it possible to receive and analyze a large amount of information about the shot in digital and graphic format during idle training and firing live ammunition. Figure 2 and Table 1 show a graphical and digital display of the technique of shots from a prone and standing position at biathlete international masters of sports using the SCATT MX-W2 wireless optical sensor when firing ammunition.

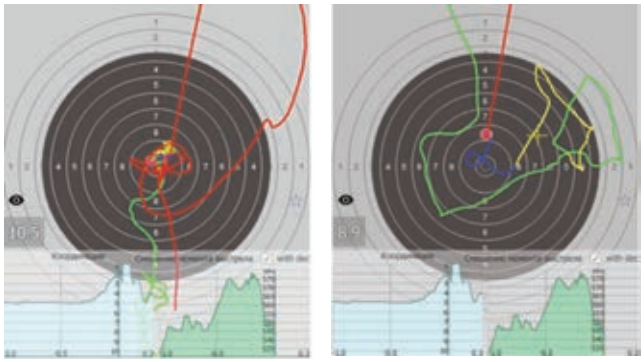
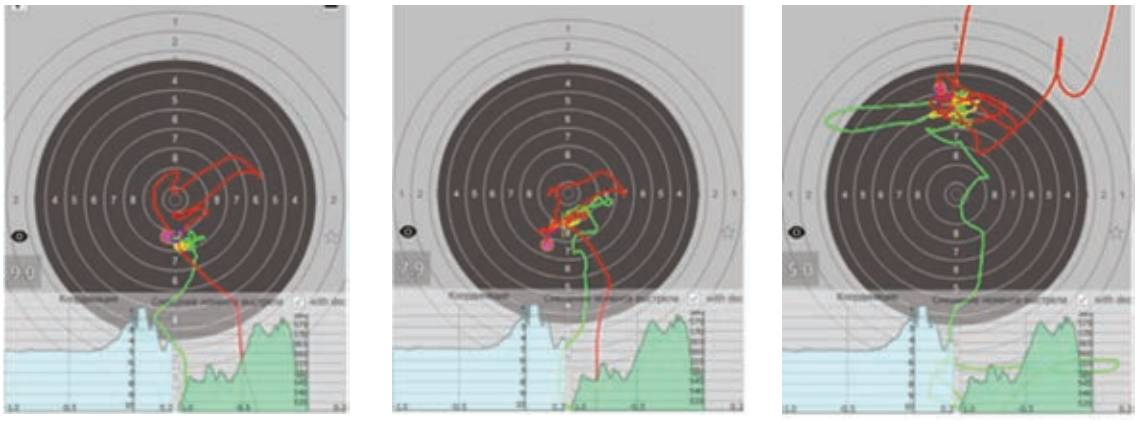


Figure 2. *Graphic display of the technique for performing shots from a prone position and standing at rest using a wireless optical sensor SCATT MX-W2 at biathlete international masters of sports*

Note: R is the result of the shot, T is the time of execution of the shot, 6a0 is the retention inside the dimension "6" (74.4 mm) relative to the STP 1 s before the shot, 9a0 is the retention inside the dimension "9" (26.4 mm) relative to STP 1 s before the shot, 10.0 - holding inside the "10" (10.4 mm) dimension relative to the center of the target 1 s before the shot, 10.5 - holding inside the "10.5" (5.4 mm) dimension relative to the target center for 1 s before the shot, 10a0 - holding inside the "10" dimension relative to the STP 1 s before the shot, 10a5

Table 1. *Results of a series of shots, expressed in digital format, obtained using a wireless optical sensor SCATT MX-W2 at biathlete international masters of sports*

№	R,	T, s	6a0, %	9a0, %	10.0, %	10.5, %	10a0, %	10a5, %	S1,mm	S2, mm	DA, mm
Shooting without physical load											
Prone	9,74 ± 0,5	5,46 ± 2,8	100 ± 0,0	100 ± 0,0	50,8 ± 27,8	15,4 ± 15,9	97,6 ± 2,6	54,4 ± 11,9	70,8 ± 5,0	59,8 ± 13,6	6,86 ± 3,0
Stand	6,76 ± 1,4	2,16 ± 1,0	95 ± 7,1	36,6 ± 7,8	6,6 ± 9,8	0,8 ± 1,8	10,2 ± 7,2	1,4 ± 2,2	180 ± 21,6	157,4 ± 48,3	18,32 ± 12,2
Shooting after exertion (heart rate about 180 bpm)											
Prone	8,7 ± 1,4	1,28 ± 0,6	83,0 ± 23,9	40,8 ± 33,1	19,2 ± 11,1	3,2 ± 2,8	10,4 ± 6,6	2,8 ± 1,3	154 ± 49	110 ± 33	24,0 ± 9,3
Stand	5,52 ± 2,0	0,98 ± 0,6	40,6 ± 30,9	7,6 ± 11,8	0,6 ± 1,3	0 ± 0,0	1 ± 2,2	0,2 ± 0,4	351 ± 28	303 ± 132	55,1 ± 21,4



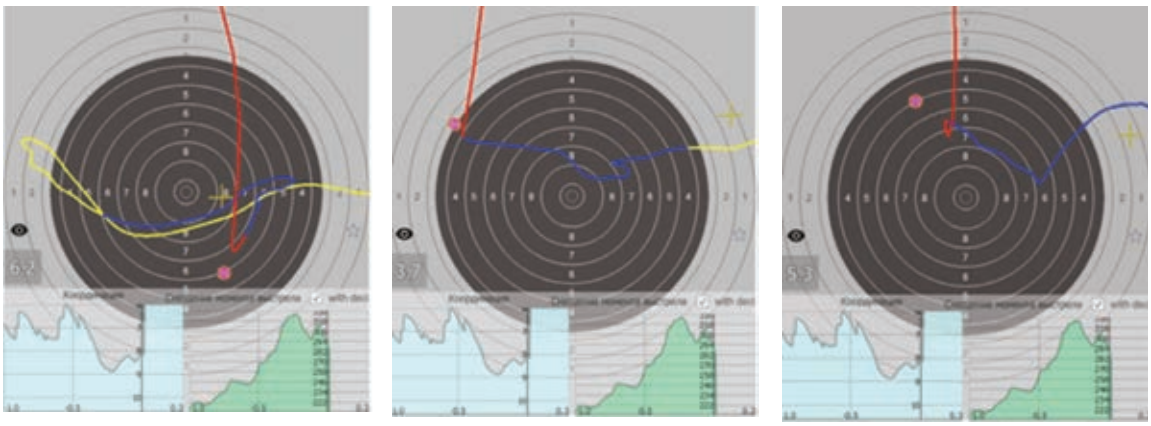
А Б В

Figure 3. *Examples of errors in the aiming technique and the execution of a shot when firing live ammunition from a prone position without physical exertion using the SCATT MX-W2 wireless optical sensor at biathlete masters of sports*

- holding inside the "10.5" dimension relative to the STP 1 second before the shot, S1 - the speed of the aiming trajectory 1 second before the shot, S2 - trajectory speed aiming 250 ms before the shot, DA is the distance between the center of the target and the center of the hole.

Shooting with ammunition after physical exertion is characterized by a significant decrease in the level of stability of the "athlete - weapon" system in relation to shooting without physical exertion (Fig. 2 and Table 1). The sum of points per shot is reduced from 9.74 ± 0.5 to 8.7 ± 1.4 points. The stability of weapons in the 10a0 size decreases both in shooting from a prone position and when standing. Graphical analysis showed that the curve of coordination and mixing of the moment of the shot leaves the aiming line 0.2 s before the shot, which indicates the loss of control over the aiming line at the moment of firing the shot. This may be due to the displacement of the middle point at the last moment of the shot, which is due to a number of errors at the final stage of the production of the shot. Figures 3 and 4 show typical mistakes when shooting from prone and standing positions using SCATT MX-W2.

When firing ammunition from a prone position, biathletes most often encountered loss of control over the lumen of concentric rings when aiming and firing shots (A), twitching with the index finger



А Б В

Figure 4. *Examples of errors in aiming technique and execution of a shot when firing live ammunition from a standing position without physical exertion using the SCATT MX-W2 wireless optical sensor at biathlete masters of sports*

during triggering (B), involuntary contraction of the muscles of the hand holding the weapon (the long green line deviates to the left beyond the size of the black target apple) (B).

The most typical mistakes when firing ammunition from a standing position among biathletes include instability when firing a shot (A), shooting "on the wire" (the weapon does not stop at the target) (B), shooting "to catch" the target (C).

Conclusions. The analysis of the shooting parameters obtained using the SCATT MX-W2 wireless optical sensor makes it possible to develop an algorithm for controlling the improvement of the shooting training of biathletes when firing ammunition in the conditions of training activity. The analysis of graphic and digital parameters of the technique of performing a series of shots allows to identify errors and develop individual programs for shooting training, recommend ways to eliminate the identified shortcomings. Based on the analysis of the dynamics of changes in the graphic and digital parameters of the series of shots in the conditions of complex training, the trainer has the ability to predict the athlete' fitness as accurately as possible.

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Physiological features of mechanisms to compensate for metabolic shifts in skilled orienteering athletes under competitive loads

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Abstract

Objective of the study was to identify the physiological features of the mechanisms to compensate for the shifts in the acid-base balance and cation-anion homeostasis in skilled orienteering athletes under competitive loads.

Methods and structure of the study. The in vivo and in vitro tests included the measurements of the main functional parameters of the skilled orienteering athletes (heart rate, maximum oxygen consumption), as well as the biochemical indicators of the acid-base balance and ion concentration of the blood (lactate and creatinine rates, concentrations of the hydrogen, chlorine, carbonic acid, sodium, potassium, and calcium ions). The study was conducted with the use of the hardware and software complex for gas analysis of the exhaled air, Epoc reader and Epoc host blood analysis systems, and lactate analyzer. Also, the integral indicators (anionic gaps) were calculated and the Davenport nomogram was constructed.

Results and conclusions. The study found that competitive loads lead to the development of increased-anion gap metabolic acidosis in skilled orienteering athletes, with respiratory alkalosis being the main compensatory mechanism. Moreover, the base excess (BE-ecf, BE-b) and anion gap (Agap, AgapK) rates serve as the informative markers of shifts in the acid-base balance both in the cluster and individual analyses. The pH rates obtained during the cluster analysis had a low informative value.

Keywords: *physiological features, compensatory processes, metabolic shifts, acid-base balance, blood ion concentration, competitive loads, skilled orienteering athletes.*

Background. Within the unit of biochemical reserves providing for metabolism under the influence of physical loads, the leading role is assigned to the markers of the acid-base balance and cation-anion contents [3], namely, lactate and creatinine rates, partial pressure of carbon dioxide and oxygen in the mixed venous blood, concentrations of the chlorine, carbonic acid, sodium, potassium, calcium, and hydrogen ions, capacity of buffer bases [4, 5]. The study of the above markers in the orienteering athletes under high-intensity competitive loads becomes highly topical and acquires practical importance in terms of the biochemical monitoring and diagnostics of fatigue at the level of the shifts in the acid-base and ionic homeostasis. In turn, the analysis of the metabolic shifts in the orienteering athletes in the field makes it possible to predict compensatory reserves, adjust the volume and intensity of physical loads to improve their functional fitness in the competitive periods of the year-round training [1, 2].

Objective of the study was to identify the physiological features of the mechanisms to compensate

for the shifts in the acid-base balance and cation-anion homeostasis in skilled orienteering athletes under competitive loads.

Methods and structure of the study. Sampled for the study were 8 skilled orienteering athletes (Masters of Sport in foot orienteering) who gave their voluntary written informed consent to participate in the experiment. Oxygen consumption (VO_2) rates at the competitive stages were determined on a calculated basis. For this purpose, prior to the field studies, the athletes were subjected to a PWC_{170} cycle ergometer test, in which the maximum oxygen consumption (VO_2max, ml^3 min^{-1}), relative VO_2max ($ml \cdot min^{-1}/kg$), and maximum HR (HR_{max}, bpm^{-1}) were determined using the Biopack (USA) hardware-software complex for gas analysis of the exhaled air. Further on, actual VO_2 and % VO_2max at the competitive distance were determined based on their percentage ratio of individual VO_2max and HR_{max}. The economical efficiency of the circulatory system was evaluated b calculating the oxygen pulse rate (OP, $ml \cdot beats^{-1}$ $=VO_2/HR$) [6]. The blood lactate content at the competitive distance was measured in the finger prick test using the lactometer Lactate Plus (USA) and Lactate Plus - Test Strips (USA), and disposable lancets Safety (Austria). The biochemical blood parameters were recorded using Epoc reader and Epoc host (Canada). Mixed venous blood samples were taken from the finger using the specialized capillary tube Epoc (Canada) 3 minutes before the start of the competition and immediately after passing the competitive distance (4.7 km, 16 control points, total ascent - 225 m, average speed of passing the distance (V, m/s) - 9.09 1.02 m/s, average time of passing the distance: group of athletes - 43.02±0.06 min, leader - 38.13 min). The blood biochemical data was registered with the use of the Epoc reader and Epoc host blood analysis systems (Canada). The blood sample was entered into a special test card 30 seconds after the draw. The following blood parameters were measured: creatinine content (Crea, mg/dL), chlorine ion concentration (Cl^-, mmol/L), carbonic acid ion concentration ($cHCO_3^-$, AB, mmol/L), sodium ion concentration (N^+, mmol/L), potassium ion concentration (K^+, mmol/L), calcium ion concentration (Ca^{++}, mmol/L), hydrogen ion concentration (pH), buffer base capacity (BE-ecf, BE-b, mmol/L), partial pressure of carbon dioxide and oxygen in the mixed venous blood (pCO_2 and pO_2, mmHg, respectively). The anion gap (mmol/L) was calculated by the formula (Agap=[Na+]-([HCO3-]+[Cl-]), the anion gap with potassium (mmol/L) – (AgapK=([Na+]+[K+]) ([HCO3-]+[Cl-]). The obtained numerical data were processed using the STATISTICA 10.0 software package. We calculated the mean value and error o arithmetic mean. The study was supported by Grant No. AAAA-A20-120012090164-8 from FSAEI HE V.I. Vernadsky Crimean Federal University.

Results and discussion. The study found that under competitive loads, HR, VO_2, VO_2max, La, and OP ($p<0.05$) in the orienteering athletes increased statistically significantly as early as at the first stage of the distance, and slightly increased at the second and third stages ($p<0.05$), which indicated a high adaptation level of the body, realization of its functional reserves under high-intensity physical loads, as confirmed by the stable speed of running when passing the distance. The study showed that at the end of the distance, pCO_2 in venous blood decreased from 41.3±0.83 mmHg (baseline) to 37.2±1.81 mmHg, $p<0.01$, and apO_2 increased from 71.7±2.46 mmHg (baseline) to 82.1±2.16 mmHg, $p<0.05$.

The analysis of the ion concentrations after the competition revealed that Cl^- and HCO_3^- changed statistically significantly. Thus, the concentration of Cl^- increased from 105.1±0.53 (baseline) to 108.2±0.66 mmol/L ($p<0.05$) and that of $cHCO_3^-$ decreased from

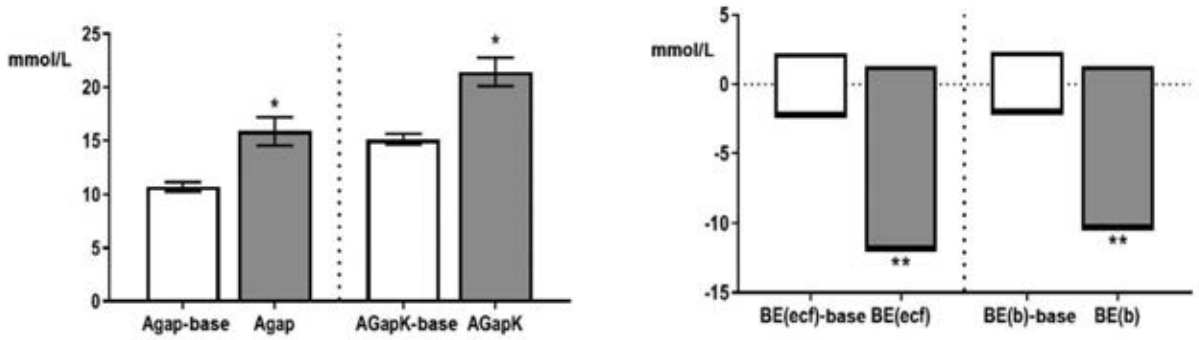

Fig. 1. *Changes in base excess (deficiency) and anion gap rates before (base) and after competitive loads*

25.4±0.42 (baseline) to 21.2±1.53 mmol/L ($p<0.05$). Besides, after the competition, the N^+ concentration increased from 141.5±0.68 (baseline) to 143.1±0.5 mmol/L ($p<0.05$) and that of K^+ increased even more significantly - from 4.4±0.19 (baseline) to 5.7±0.27 mmol/L ($p<0.05$). The integrative indicators of the cation-anion ratio are Agap and AgapK (Fig. 1). At the end of the competitive distance, Agap increased from 10.7±0.26 (baseline) to 15.8±1.33 mmol/L ($p<0.05$) and AgapK increased from 15.1±0.43 (baseline) to 21.4±1.32 mmol/L ($p<0.05$).

According to the data obtained earlier [6], the normal range for Agap is 7-14 mmol/L, for AgapK - 10-18 mmol/L, hence, there takes place an increase in the anion gap and overrange in both cases. In addition, the most important integrative indicators of the acid-base balance are the standard (BE-ecf) and actual (BE-b) base excess (deficiency). In was found that BE-ecf and BE-b shifted towards the negative value at the end of the competitive distance: BE-ecf shifted from the extreme value – 2.3 – +2.2 to the range – 11.9 – +1.3 mmol/L, $p<0.01$, and BE-b - from – 2.1–+2.3 to -10,4 – +1,27 mmol/L, $p<0.01$.

Therefore, the athletes' pCO_2 and pO_2 were within the normal range of the compensated values at the end of the competitive distance. While the changes in base excess and anion gap indicated the development of increased-anion gap metabolic acidosis.

Taking into account the physiological features of changes in the acid-base balance parameters, the identified acidosis was deemed metabolic and resultant from a buildup of lactic acid, though it manifested itself in 3 examined athletes only. In this view, it should be emphasized that it is precisely these athletes who were found to have the maximum negative shifts in BE-ecf and BE-b and the greatest anion gap; they underperformed at the competitive distance. Therefore, the analysis of the shifts in the acid-base balance and blood ion concentrations before and after the competition using H.W. Davenport nomogram [4], their association with the functional parameters in the field are of high practical importance in determining the vector of the compensatory processes providing for metabolic shifts, forecasting physiological features and competitive performance of skilled orienteering athletes.

Conclusions. The study found that competitive loads lead to the development of increased-anion gap metabolic acidosis in skilled orienteering athletes, with respiratory alkalosis being the main compensatory mechanism. Moreover, the base excess (BE-ecf, BE-b) and anion gap (Agap, AgapK) rates serve as the informative markers of shifts in the acid-base balance both in the cluster and individual analyses. The pH rates obtained during the cluster analysis had a low informative value.

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Benefits of eeg theta rhythm analyses for athletic training and competitive progress systems

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Abstract

Objective of the study was to analyze benefits of the EEG theta rhythm tests for competitive performance rating purposes in some sports disciplines, with the EEG theta-activity rates applicable as the competitive progress biomarkers.

Results and conclusion. Subject to the study was a correlation of the EEG theta rhythm amplitude with the individual attention control; plus a clear correlation between the frontal-medial theta rhythm amplitude and competitive progress found by a few studies. Some studies found the theta rhythm amplitudes for the sports professionals and beginners showing expressed differences that may be interpreted as indicative of the skills levels, with the theta rhythm rates applicable for the skill set rating purposes. Of special interest were analyses of the theta rhythm amplitude fluctuation profiles as biomarkers of the skill difficulty levels and state anxiety in sports.

Subject to the studies were also transcranial magnetic stimulation (with the theta packing protocols) methods used to correct the psycho-emotional control, optimize attention and motor memorizing mechanisms for a faster progress in the athletic skills mastering and excellence process. Of special importance in this context was the finding that transcranial magnetic stimulation of motor cortex improves the anaerobic performance. It should be emphasized, however, that the fast progress of the transcranial magnetic stimulation methods is associated with some risks as steps up the pre-competitive mental and physical fitness and, hence, may be interpreted as a sort of "neural doping". The study data and analyses give the grounds to conclude that the theta-rhythm-harmonized frequencies may be beneficial for precompetitive mental conditioning, with the EEG theta rhythm amplitude applicable as promising biomarkers for the training system improvements and competitive progress.

Keywords: *theta rhythm, EEG, sport, competitive progress.*

Background. Competitive accomplishments in modern sports require the individual resources being efficiently and completely mobilized for success, with the modern developments in neurophysiology being potentially beneficial for the relevant sports applications. Electroencephalography is ranked among the most informative and accessible non-invasive methods yielding important data on the brain activity in variable functional states. Modern technologies with their artifacts removal algorithms make it possible to obtain the EEG logs in quiescent state and on the move, with special benefits for the training and competitive performance rating and analyzing purposes.

It should be mentioned that all rhythms in the oscillatory activity of neurons are inextricably connected and representing some specific aspects of neurophysiological processes. Nevertheless, modern research classifies them into a few rhythm ranges, with their individual characteristics applicable as prognostic biomarkers of the nervous system activity on the

whole and for competitive performance improvement purposes in particular.

One of the most promising prognostic criteria in this context are the EEG theta rhythm amplitude varying in the 4-7Hz range [5]. Thus P.K. Anokhin believes that a theta rhythm amplitude growth may be indicative of an individual fitness for a specific operational stress [1]. The theta rhythm amplitude was demonstrated to grow in response to cognitive stresses including such unspecific factors as the attention control levels [7], task difficulty levels and task solving effectiveness [14]. In addition, a few studies found correlations of the theta rhythm amplitude with the individual typological characteristics including the trait anxiety and stress tolerance [2]. The above individual psycho-physiological qualities ratable, among other things, by the EEG theta-activity tests are rather important for competitive progress in many sport disciplines.

Objective of the study was to analyze benefits of the EEG theta rhythm tests for competitive performance rating purposes in some sports disciplines, with the EEG theta-activity rates applicable as the competitive progress biomarkers.

Results and discussion. Theta rhythm oscillations are fixed in many brain structures including hippocampus, parietal and prefrontal cortex and sensory areas of the cortex. Of special interest for research is the so-called frontal-medial theta rhythm (FM-theta rhythm) commonly associated with the attention controls. For example, a theta rhythm study of a basketball sample found the FM-theta rhythm being more stable prior to successful throws. Moreover, the theta-2 range amplitude was found to grow to 6-8 Hz in aiming phase of a successful throw due to a special attention balancing phase, as believed by the analysts [6].

The FM-theta amplitude with competitive success correlation may be sport- and skill-level specific. For example, a study of the FM-theta amplitudes in golf found them being lower in cases of accurate shots versus the inaccurate ones – indicative, as the authors believe, of the pre-success attention control being optimally focused; whilst excessive attention (with the related FM-theta amplitude growth) was found detrimental to the shooting accuracy [13]. It is believed that the FM-theta amplitude growth is negatively correlated with success for a wide range of visual-motor skills. This may be explained by the task-specific theta rhythm amplitude being negatively correlated with the skill 'automation' level – i.e. the high is the skill level in many cases, the higher is the success expectancy [8].

Correlation of the theta rhythm amplitude with the skill level was supported by a few studies of athletes grouped by the skill levels – to demonstrate the beginners and professionals being rather different in the theta rhythm test rates. Thus, a professional shooting sample was tested with the FM-theta amplitude growth prior to a shot – in contrast to the beginner shooters [10]. It was concluded that a successful competitor must develop a high motor skill level plus special attention control skills to timely concentrate on the key performance aspects, with such special concentration detectable by the FM theta patterns.

It is commonly believed that the theta rhythm amplitude growth is indicative, on the one hand, of the motor task difficulty level and, on the other hand, of the growing fatigue under long physical stress associated with the growing mental efforts to control attention and performance. These correlations were found by a few studies including the competitive performance analyzing ones [3]. Most of them have demonstrated a clear direct correlation of fatigue with the FM-theta rates [17].

Furthermore, the theta activity rates have been found correlated with emotions on the whole and sports-specific anxiety in particular [15]. A few experimental studies have found that stimulation of the anterior cingulate cortex by the theta-rhythm-matching frequencies helps mitigate anxiety [11], and it was assumed that the same effect may be achieved by non-invasive transcranial magnetic stimulation methods applicable, among other things, for the precompetitive state anxiety control purposes.

It may be pertinent to mention in this context that the past decades have seen a growing popularity of different transcranial magnetic stimulation methods including the theta packing transcranial magnetic stimulation ones (Theta Burst Stimulation, TBS). The TBS method has been proved beneficial for the attention control purposes [4]. It was also found that the TBS increases excitability of the cortex thereby improving the motor skills mastering process efficiency [16] and the sports-specific anaerobic performance [12].

The above data demonstrate good prospects for the transcranial magnetic stimulation applications in the sports training and competitive systems, although many in the sports research and athletic communities are somewhat concerned about the ethical aspects of such stimulations. Knowing that some stimulation methods may result in long-term effects on the attention control, motor memory and motor functions in

sports, the transcranial magnetic stimulation applications, particularly the precompetitive ones, it is not improbable that they may be considered a sort of “neural doping” [9].

Conclusion. Our analysis of the available study reports on the subject gives reasons to conclude that the EEG theta rhythm test rates as biomarkers of athletic performance and competitive fitness may be rather promising for many purposes, particularly the competitive performance improvement ones. The theta rhythm biomarkers may be used for the training system perfection, attention control and motor skills excellence purposes, with special benefits for the precompetitive mental/ emotional conditioning tools. Good understanding of the theta rhythm oscillation test benefits for the athletic performance control purposes will help develop the relevant transcranial magnetic stimulation application procedures (protocols) to ensure due attention and competitive performance controls for success.

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School physical education teachers' knowledge of modern physical education physiology: tests and analyses

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Abstract

Objective of the study was to test and analyze the professional physical education teachers' knowledgebase in modern physical education physiology.

Methods and structure of the study. We developed a special test methodology with a specific toolkit to rate competencies of the primary and high school teachers in modern physical education physiology. We sampled the 18+ year-old physical education teachers (n= 727) grouped by the ages, service experiences and qualifications. We were governed by the pedagogical competency test theory and practice when designing the two children-age-specific physical education physiology knowledge test versions, with the first one offering a few correct options and the second – one correct option out of three alternatives.

Logics and informational coverage of the tests were verified for specificity, correctness, consistency and validity, with the test contents and compositions checked by experienced teaching experts to select the top quality test tasks.

Results and conclusion. Qualitative analysis of the test data yielded by the study found that the sample had no problems with the questions on the functional state variations with trainings, physiological provisions for progress in motor skills, and some issues of the age-specific children's physiology. The sample also demonstrated fair knowledge of the general physiological classification of physical exercises by active muscle masses; physiological provisions for the physical exercising techniques; physiological provisions for the customizable physical education systems; and progress tests of functional state and health in trainings. Of special difficulty for the sample were the questions on the children's age-related physiological specifics in the context of physical education service, physiological classifications and specifics of dynamic cyclic varied-intensity trainings, functional state variations in rehabilitation periods, and physiological provisions for training systems. The study found the need for special training service in modern physical education physiology for the physical education teachers, with a high priority to the physical education physiology coverage in the regular higher physical education service.

Keywords: *physical education physiology, professional knowledge tests, physical education teachers, professional competency.*

Background. Modern effective and professional physical education systems need to be staffed with highly competent, knowledgeable and skillful human resource with special competences in physiology and latest scientific data. The national and international physical education sectors give a growing priority to these issues [2, 3, 4, 5].

Objective of the study was to test and analyze the professional physical education teachers' knowledgebase in modern physical education physiology.

Methods and structure of the study. We developed a special test methodology with a specific toolkit to rate competenes of the primary and

high school teachers in modern physical education physiology. We sampled the 18+ year-old physical education teachers (n= 727) grouped by the ages, service experiences and qualifications. We were governed by the pedagogical competency test theory and practice [1, 2] when designing the two children-age-specific physical education physiology knowledge test versions, with the first one offering a few correct options and the second – one correct option out of three alternatives.

Logics and informational coverage of the tests were verified for specificity, correctness, consistency and validity [1], with the test contents and compositions checked by experienced teaching experts to select the top quality test tasks. The tests were started from the relatively simple tasks with the growing difficulty to the middle of the test and gradually decreased difficulty by the end of the test. The test piloting sessions found the second test version more accessible for the sample. On the whole, the tests covered the key segments of the modern physical education physiology grouped by four basic modules: see Table 1.

Results and discussion. Having analyzed the test data, we found meaningful individual and group differences in the age-specific physical education physiology knowledge basics. The statistical data processing showed the sample giving on average 10-11 correct responses ($M = 11.6$; $m = 0.12$; $\sigma = 2.49$) out of 15 tasks. We analyzed the intergroup differences in physical education physiology knowledge by the age, experience and qualification groups and found insignificant rank correlations. The only statistically significant correlation ($r = 0.78$; $p < 0.001$) was found for the service experience and age groups. We also found no statistically significant differences in correct responses in the service experience, age and professional service groups.

Further analysis found significant differences in distributions of correct and incorrect responses in the physical education physiology knowledge tests. The sample mostly had no difficulties in the functional state and physiological provisions for progress in motor skills/ qualities. Most of the sample also demonstrated good knowledge of the general physiological classification of physical practices customizable by the active muscle mass, physiological provisions for physical exercising techniques, and functional state and health tests in trainings. Of special difficulty for the sample were the questions on the children's age-related physiological specifics in the context of the physical education service, physiological classifications and specifics of dynamic cyclic varied-intensity trainings, functional state variations in rehabilitation periods, and physiological provisions for training systems.

Having analyzed the test data, we found the sample poorly aware of some physical-education-physiology-special terms and definitions including "relative power zones", "super-compensation", "sensitive motor progress periods", "beginner training" as the specific motor skills mastering stage, "standard-intensity training progress test rates", "hypokinesia", "physical inactivity", etc.

Conclusion. The study found the need for special training of the physical education teachers in modern physical education physiology, with a special priority to the physical education physiology coverage in the regular higher physical education service. A high emphasis in the physical education physiology course will be given to characteristics of varied-intensity cyclic movements; post-training

Table 1. *Physical education physiology knowledge test modules, % in the total test*

Modules	Topics and tasks
Physiological classification and general specifications of physical exercises: 40%	Tasks Q13, Q15: Physiological classification and general specifications of physical exercises
	Tasks Q1, Q2, Q3, Q4: Functional progress with muscular system training
Physiological provisions for progress in physical qualities and motor skills: 20%	Tasks Q6, Q7: physiological provisions for motor skills/ qualities
	Task Q14: physiological provisions for motor skills mastering
Age-specific physiological provisions for physical education: 20%	Task Q5: physiological provisions for trainings and general physical education progress logics
	Tasks Q9, Q12: Under- and teenage group physical education: physiological specifics
Physiological provisions for physical activity: 20%	Tasks Q8, Q10, Q11: Basic physiology of physical activity

functionality rehabilitation/ restitution logics and phases; quiescent-state/ standard/ top-intensity physical fitness tests; children's muscular activity physiology, age-specific progresses in motor skills; age-specific functional progress tests and analysis for children's physical training systems, etc.

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Sudden cardiac deaths in sports: global statistics analysis

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Abstract

Objective of the study was to analyze the global situation with sudden cardiac deaths in sports.

Methods and structure of the study. We analyzed on a systemic basis study reports on the subject by the relevant keywords including sports, sudden cardiac death, athletes etc. in Elibrary.ru and Pubmed databases.

Results and discussion. Prospective studies have found that in Italy, US and France the sudden cardiac deaths in sports are 2.5, 3.65 and 4.5 times higher than in the unsporting populations, respectively. As reported by Bohm P. et al., the sudden cardiac death risk exposure for men is 20 times higher than for women. The British Sports Sudden Cardiac Death Register reports 357 sudden cardiac death cases in the national sports, with the victims aged 29±11 years (27 years on average) and 92% male.

Studies have proven that the male sex hormones provoke cardiac hypertrophy with QT interval growth, potential electrical instability of the myocardium and ventricular arrhythmias. K.G. Harmon reported the research data on the sudden cardiac death incidence growth in sports with the sporting and competitive records. Researchers tend to believe that sudden cardiac death may be due to multifactor health conditions, disorders and cardiovascular diseases, plus some hereditary issues including structural genetic heart diseases and cardiac arrhythmias.

The sudden cardiac death exposure is reported most high for male athletes, particularly for the black football and basketball players, and for the endurance-intensive sports in general. Every third sudden cardiac death case in sports for the last few years was reported for athletes with structurally normal hearts, with the actual causes need to be analyzed on a sound research basis; although at this juncture some researchers tend to blame heart overstrains in excessive trainings as the main cause of autopsy-negative deaths.

Keywords: *sports, sudden cardiac death, athletes.*

Background. Sudden cardiac death cases that account for more than 90% of sports-related deaths are of special concern for the sports communities today. The sudden cardiac death studies are highly relevant today due to the sudden cardiac death growth statistics and alarming sudden cardiac death structure on the whole.

Objective of the study was to analyze the global situation with sudden cardiac deaths in sports.

Methods and structure of the study. We analyzed on a systemic basis study reports on the subject by the relevant keywords including *sports, sudden cardiac death, athletes* etc. in Elibrary.ru and Pubmed databases.

Results and discussion. The sudden cardiac death incidence is presently reported at 1 case per 3000 athletes per year, i.e. close to the lightning strike risk [10] and classified by age, race, gender, sport, sports records, skill levels and some other factors. Many analysts report and analyze only sudden cardiac death cases in competitions or professional sports communities net of the mass sports, with

some researchers excluding cases of successful resuscitation from the sudden cardiac death statistics.

Thus K.G. Harmon [7] analyzed 13 sports-related sudden cardiac death study reports on the 9-40 year-olds' deaths, with the sudden cardiac death incidence reported at 1 case per 917,000 to 1 case per 3000 athletes per year. The most sophisticated and inclusive studies report the sudden cardiac death incidence rate at 1:40,000 to 1:80,000. The author found the sudden cardiac death incidence in sports being probably much higher than commonly believed, and called for more effective sudden cardiac death -prevention programs.

Prospective studies have found that in Italy, US and France the sudden cardiac deaths in sports are 2.5, 3.65 and 4.5 times higher than in the unsporting populations, respectively. The US statistics report the physical stress related sudden cardiac death incidence in the young group being only twice as little than the mortality in road traffic accidents, twice as high as suicides, and 8 times higher than the drug overdose mortality [10]. This means that the sudden cardiac death should be ranked currently among the most challenging social problems.

The US statistics singles out the sporting groups highly exposed to the sudden cardiac death risks including male athletes (1 case per 37,790 athletes per year) versus 1:121,593 for female athletes; black athletes (1:21,491 versus 1:68,354 for white athletes); plus basketball and football players (1:8,978 and 1:23,689, respectively) [10]. As reported by Bohm P. et al., the sudden cardiac death risk exposure for men is 20 times higher than for women [2]

The British Sudden Cardiac Death Register reports 357 sudden cardiac death cases in the national sports, with the dead aged 29±11 years (27 years on average) and 92% male. The high sudden cardiac death incidence for male athletes is explained by the higher sympathetic tone and higher levels of catecholamines that are known to cause malignant arrhythmias. Studies have proven that the male sex hormones provoke cardiac hypertrophy with the QT interval growth, potential electrical instability of the myocardium and ventricular arrhythmias.

Mechanisms behind the high sudden cardiac death incidence for basketball players are still unclear. Although Marfan syndrome and associated aortic dissections in the sudden cardiac death totals are higher for male basketball players, they account for only a small share of the sudden cardiac death causes in this group. It should be noted in this context that basketball players are almost 15 times more exposed to cardiomyopathies related death risks. The Italian, Spanish, French and German sports health statistics rank football, track and field sports, cycling and swimming among the highest-sudden-cardiac-death-risk sports [2].

As reported G. Finocchiaro et al. [4], 245 out of 357 (69%) sudden cardiac death cases in the British sports involve the following actively training and competing athletic groups: football and track and field sports: 25% each; cycling and gymnastics: 8% each: swimming and weightlifting: 6% each: rugby: 5%; tennis and golf: 2% each; and boxing: 1%.

K.G. Harmon reported new research data on the sudden cardiac death risk growth in sports with the sporting and competitive records; whilst German analysts reported 142 out of 144 (99%) sudden cardiac death cases in amateur athletes [2]. Researchers tend to believe that sudden cardiac death may be due to multifactor health conditions and disorders and cardiovascular diseases, plus some hereditary issues including structural genetic heart diseases and cardiac arrhythmias [5, 10] that can be diagnosed both in structurally normal and structurally compromised hearts.

It is sensational that the modern Europe and some other nations report the autopsies of athletes diagnosing unexplained sudden cardiac death cases [1, 10] often referred to as the sudden arrhythmic death syndrome. The unexplained sudden cardiac death (autopsy-negative deaths as they are traditionally called in Russia) cases show no visible diseases, health issues or pathological changes and thus are often reported as acute cardiovascular system failures normally associated with life-threatening arrhythmias or cardiac arrests.

The British Sports Sudden Cardiac Death Register [4], qualifies 149 out of 357 sudden cardiac death cases (42%) with autopsy-negative death (sudden arrhythmic death syndrome) as the most common; followed by idiopathic left ventricular hypertrophy and/ or myocardial fibrosis – that account for 59 deaths (16%); then goes arrhythmogenic right ventricular cardiomyopathy: 48 deaths (13%); hypertrophic cardiomyopathy: 23 cases (6%); and dilated cardiomyopathy (2%). Coronary artery pathology is reported in 7% of the cases, with the anomalies diagnosed in most of the cases.

As reported G. Finocchiaro et al. [4], 288 out of 357 sudden cardiac death cases (81%) had no prior symptoms. Of 69 (29%) symptoms-reporting athletes, 27 (8%) reported palpitations (including five having histories of paroxysmal atrial fibrillation), 20

(6%) complained chest pains; 18 (5%) fainting; 4 (1%) was tested with falls in the physical stress tolerance; and 28 (8%) reported sudden cardiac death cases among their close relatives under 50 years of age [4].

Until recently, hypertrophic cardiomyopathy was long considered the leading cause for sudden cardiac death in sports, although the recent studies found that it may not be so. Thus K. Harmon [6] revised the well-known 1866 autopsy reports of athletes in the United States [9] to find 36% of the sudden cardiac death cases caused by hypertrophic cardiomyopathy; plus most of the autopsy reports were left beyond the statistics due to no structural abnormalities detected in the hearts. She argued that these deaths need to be covered by the statistics and qualified with the autopsy-negative cases to actually account for 34% of the cardiovascular-disease-related deaths to make it the key cause of the sudden cardiac death cases in the world-largest sudden cardiac death register. This figure agrees with a report by the US National College of Athletic Associations (NCAA) [3] which estimates the autopsy-negative cardiac death cases at 31% of the sudden cardiac death total. Note that proven hypertrophic cardiomyopathy and possible hypertrophic cardiomyopathy were diagnosed only in 3% and 11% of the total sudden cardiac death cases, respectively.

E. Marijon et al. [8] reported the sudden cardiac death statistics for athletes and physically active 35-minus year-olds in France, with the autopsy-negative deaths accounting for 36% and hypertrophic cardiomyopathy for only 10% of the total sudden cardiac death cases. G. Finocchiaro et al. [4] found the highest sudden cardiac death incidence rate (56% of the total) for the youngest (18-minus years old) athletes.

Regretfully, Russian sports-related sudden cardiac death statistics are non-reported and, hence, no incidence/ cause studies are available.

Conclusion. On the whole, the sudden cardiac death exposure is reported most high for male athletes, particularly for the black football and basketball players, and for the endurance-intensive sports in general. Every third sudden cardiac death case in sports for the last few years was reported for athletes with structurally normal hearts, with the actual reasons need to be analyzed on a sound research basis.

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Individual orthotic insoles applying walking endurance building model for 60-plus year-olds with musculoskeletal disorders

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Abstract

Objective of the study was to develop and test benefits of individual orthotic insoles applying walking endurance building model for senior people with musculoskeletal disorders.
Methods and structure of the study. We sampled for the study the 60+ year-olds (n=35) with musculoskeletal disorders including foot deformities. Based on prior computerized podometric tests, every subject was offered individual orthotic insoles for a monthly endurance-building walking therapeutic model. The group was trained on a self-reliant daily basis with progress self-test data fixed in the individual logbooks. The individual progress in the model testing 30-day experiment was rated by the pre- versus post-experimental questionnaire surveys and interviews under the Healthy Foot and Active Longevity Project sponsored by the Presidential Grant Foundation. We used the following study methods: theoretical and practical literature analysis; questionnaire surveys, interviews; clinical examinations; computerized podometry, progress tests, and a standard mathematical statistics toolkit.
Results and discussion. The individual orthotic insoles applying walking endurance-building model for senior people with musculoskeletal disorders was tested beneficial as verified by the significant progress of the sample in the model testing experiment on the pain tolerance and endurance test scales.

Keywords: *musculoskeletal disorders, endurance, seniors, walking therapy, individual orthotic insoles, physical training, pains, foot deformities.*

Background. It is quite common that morphological and functional regresses with age result in multiple musculoskeletal disorders including arthritis, arthrosis, joint stiffness, joint pains, ligament ruptures, skeletal muscle atrophy, associated with regresses in the muscular strength and contractions [6]. Modern study reports recommend walking as the most accessible and effective physical training method for senior people with musculoskeletal disorders even in clinical rehabilitation periods [1].

Walking with its natural movements and physical training benefits due to the rehabilitative movement structure driven by the striding reflexes is commonly recommended as adaptable for the self-reliant trainings of senior people. One of the special benefits of walking practices is that they do not need daily supervision from physical training specialists or special equipment, facilities and financial investments. Walking is known to improve functionality of the cardiovascular, respiratory and nervous systems, develop and improve the trainees' musculoskeletal system and build up general endurance [5].

It should be mentioned, however, that the rehabilitative benefits of walking practices may be overshadowed by further MS regresses [3] in case of foot deformities diagnosed, as reported by statis-

tics, in more than 90% of senior people and dominated by flat footedness [2]. Modern individual orthotic insoles are recommended as the effective foot deformities correcting, biomechanical function rehabilitating and joint pain mitigation tool [4]. We used a variety of individual orthotic insoles in our foot biomechanics rehabilitation model with a special priority to endurance and motor activity of the seniors.

Objective of the study was to develop and test benefits of individual orthotic insoles applying walking endurance building model for senior people with musculoskeletal disorders.

Methods and structure of the study. We sampled for the study the 60+ year-olds (n=35) with musculoskeletal disorders including foot deformities. Based on prior computerized podometric tests, every subject was offered individual orthotic insoles for a monthly endurance-building walking therapeutic model. The group was trained on a self-reliant daily basis with progress self-test data fixed in the individual logbooks. The individual progresses in the model testing 30-day experiment were rated by the pre- versus post-experimental questionnaire surveys and interviews under the Healthy Foot and Active Longevity Project sponsored by the Presidential Grant Foundation. We used the following study methods: theoretical and practical literature analysis; questionnaire surveys, interviews; clinical examinations; computerized podometry, progress tests, and a standard mathematical statistics toolkit.

Results and discussion. The prior questionnaire survey, interviews and clinical examinations found foot deformities in every subject as demonstrated by the computerized podometric test data dominated by the uneven static load distribution in the legs and feet, with compensatory body mass center (BMC) shifts diagnosed in 100% of the sample. The interviews revealed, that despite the obvious varus (81%) and hallux valgus (41%) deformities, many in the sample still believed having no musculoskeletal disorders and had no idea of their walking-related pains being due to the foot deformities. Being unaware of the modern foot biomechanics restoration methods for further physical activation, they tended to limit their physical activity to avoid pains.

The walking pains were rated by the sample on a 10-point scale, with the maximal 10 points meaning unbearable pains in either of the following three sole and three MS areas: sole under toes 2-3, under the big toe, in the heel, knees, hips and lower back. For 94% of the sample, 100m endurance test found the endurance being correlated with the pain strength, i.e. the higher is the pain the lower is the endurance (see Figure 1), with the actual physical activity limited by the painless walking distance.

Given on Figure 2 hereunder are the pre- versus post-experimental test data that show that the pre-experimental endurance of 37% and 56% of the sample was limited by 300m and 500m painless walking distances, respectively.

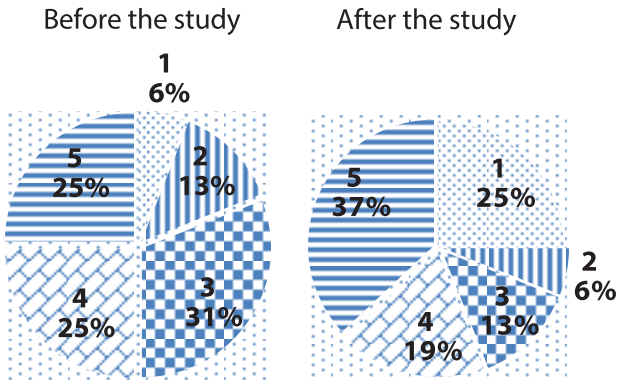

Figure 1. *Pre- versus post-experimental endurance test data*

1 – 300m maximum; 2 – 500m maximum; 3 – 1000m maximum;

4 – 2000m maximum; 5 – 3000m-plus

The pre- versus post-experimental survey data found benefits of the individual orthotic insoles applying walking endurance building model as verified by the statistically significant growth of the painless walking distances (see Table 1), with the virtually double distance growth as a result of the monthly experiment.

Table 1. *Pre- versus post-experimental endurance test data in the individual orthotic insoles application walking therapeutic model testing experiment*

Tests	Pre-experimental, X±m	Post-experimental, X±m
Distance, m	1200±30	1600±35
Pain, points	19,3±2,9	9±1,4

Conclusion. The individual orthotic insoles applying walking endurance building model for senior people with musculoskeletal disorders was tested beneficial as verified by the significant progress of the sample in the model testing experiment on the pain tolerance and endurance test scales.

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Levels of formation of anti-victim personality in athletes

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Abstract

Objective of the study was to identify levels of anti-victim personality formation in athletes.

Methodology and structure of the study. The study used the method of expert assessments. The experts were current and former athletes aged 18 to 55 years in the number of 50 people. The material of the study was specially selected cases, which recorded the facts of victimization of athletes. The study participants had to offer effective means to avoid victimization in such cases.

Results and conclusions. The analysis of the proposed options for resolving victim situations allowed us to prove that by the nature of the methods used to get out of the conflict, we can distinguish five levels of formation of an anti-victim personality: standard, medium-normative, borderline, pre-victim and victim. However, in reality, only 4% of the study participants were able to suggest ways to respond to a conflict situation at the reference level. Basically, options were offered that correspond to the victim and pre-victim levels. Special training is required to form a higher-level anti-victim personality.

Keywords: *anti-victim personality, sport, athlete's personality, levels of anti-victim personality, threats to personality.*

Introduction. The stability of the individual to negative environmental factors is important for its stable functioning. An anti-victim personality is a person who copes with threats that stand in his/her way, a person who is able to resist both offenses and violations of moral norms, who is able to overcome other factors and circumstances that threaten the person. In science, attention is paid to the problem of victimological security of the individual [2]. However, the problems of this type of security cannot be solved without studying the internal mechanisms of the individual that ensure victimological security, which has not yet become the subject of scientific study.

We believe that the level of formation of an anti-victim personality reflects the level of its victimological consciousness. The structure of the victimological consciousness of the individual must necessarily include such components as knowledge about threats to the individual, knowledge about ways to overcome these threats, and knowledge of various tools to ensure the security of the individual.

Currently, in the scientific literature there is a fairly simplified understanding of the formation of personal readiness to neutralize threats. A number of researchers believe that the usual experience of responding to threats is sufficient to form a readiness to overcome a similar threat again [5]. Other researchers argue that a simple awareness of the threat is enough to effectively counter it [4]. Studies that consider the negative experience of overcoming the consequences of victimi-

Table 1

The 1st level	The 2nd level	The 3rd level	The 4th level	The 5th level
To say in social networks about the issue and find allies in her decision to make the issue public	Use visual control tools to bring the culprit to legal responsibility	The upper limit of the norm is trolling the Harmer, the lower limit of the norm is equanimity in face – to – face meetings	To be patient and constantly be treated	To retire from the sport

zation, in particular in sports, from the point of view of psychological growth and development of athletes are promising [6].

Before we talk about the diagnosis of the level of formation of an anti-victim personality, we need to determine what levels can be formed in principle. Using the paradigms of social-role analysis, we have identified 5 levels of functioning of the anti-victim personality. Level 1 – reference, this is the highest level of formation of an anti-victim personality, which includes elements of creativity in implementing the rules of safe behavior. Level 2 – medium-standard, reflecting the situation of general readiness and discipline in the implementation of the rules of safe interaction, but does not contain the ability to effectively resist threats to the individual in non-standard situations. Level 3 – borderline. And it's like "the upper limit of normal" when the execution of safety rules is openly demonstrative, and "low-normal" when there is a lack of clear implementation rules and regulations on safe behavior. Level 4 – biased, when a person flippantly ignores the rules of safe behavior. Level 5 – victimized, when a person demonstrates openly victimized behavior.

In our empirical study, we made an attempt to identify levels of antimicrobial personality in athletes. Our previous research has shown that sport becomes a tool for forming an anti-victim personality only if it is recognized as such a tool [1]. Awareness and finding ways out of situations that threaten the athlete's personality and their effectiveness were studied in our study.

Research objective. Revealing the levels of anti-victim personality formation in athletes.

Methods and structure of the study.

The method of research was the method of expert assessments. The study participants were offered cases in which the victimization of an athlete occurred in one way or another.

Case 1. The defender of Kiev, unable to cope with the guardianship of the forward of the army, the roughest reception (jump feet on the heel of the opponent) injured V. Bobrov. As a result, V. Bobrov never recovered from the knee injury. He used painkillers. And the opponents deliberately continued to mercilessly beat Vsevolod Bobrov on the sore leg [3].

Case 2. In table tennis competitions, a player defiantly unwraps and puts a piece of gum in his mouth before playing. During the game shows how he gets pleasure from chewing it. His opponent, who is superior to chewing gum in the technique of the game, begins to get nervous and as a result loses (from the observations of G.V. Baturkina).

Instructions to study participants: "Offer as many options as possible for a productive way out of a problematic situation."

Subjects: athletes of different ages (from 18 to 55 years) in the number of 50 people.

Results and discussion. It was found that it is really possible to rank possible ways of reacting to a victim situation in accordance with the levels of anti-victim personality that we have identified.

Using the example of solving case 1, we will show how the responses of the subjects can be correlated with the levels of formation of an anti-victim personality (table 1).

Similarly, the options for solving case 2 were ranked. For example, the creative level was represented by the proposal "to love the opponent and learn from him calmness". In General, only 4% of the study participants formulated options for responding to the situation that correspond to the reference level. 20 % of experts gave answers typical for the average normative level. Basically, all participants in the study easily suggested options for victim or pre-victim level **(100 %).**

Conclusion. Spontaneously, without special training, athletes form mainly variants of the victim or pre-victim level of the anti-victim personality. In this regard, there is a need to develop special training programs for the formation of higher levels of anti-victim personality.

Acknowledgments

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Optimized physical education model for students with health disorders

UDC 796.011.3

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Abstract

Objective of the study was to substantiate optimal pedagogical decisions to improve the physical education process for students with health disorders.

Methods and structure of the study. As part of the study, we conducted a system analysis of special literature, analyzed the results of case monitoring and pedagogical observations, and pooled the data from medical examinations and sociological and psychological surveys, which made it possible to assemble a full picture of the subject matter. The study has been conducted since 1991. It involves the Ural Federal University students of all departments, who were attributed to the special health group based on the International Classification of Functioning, Disability and Health (ICF-10).

Results and conclusions. A specially organized learning environment focused on individual development paths was created. The combination of various forms of educational and cognitive activity, mutual assistance and cooperation with the administration of the university led to the optimization of the vocational training of students with health disorders and disabilities.

A sociometric technique was used to form the study groups taking into account the peculiarities and nature of their impact on personality development. A high level of communication was achieved in the student-teacher relationships and within the group itself. New methods and styles of pedagogical communication, which enabled students to successfully realize their potential, were introduced. The results of the independent testing of the 2017/18 academic year showed great academic progress of the special health group students (82% - excellent, 15% - good, 3% - satisfactory).

Keywords: *special health group students, physical education process optimization.*

Background. Lately the academic education service for students with disabilities and health disorders has been ranked among the key priorities of the national social and education policies. Rights of the people with disabilities and health disorders are protected by the Constitution of the Russian Federation of 12.12.1993, Federal Law of 29.12.2012 No. 273 "On Education in the Russian Federation" and Federal Law of 03.05.2012 No. 46-FL "On Ratification of the Convention on the Rights of People with Disabilities". The national educational system has persistently and successfully implemented special customizable physical educational models for vocational training of students with disabilities and special health needs to facilitate their adaptation and social integration.

Objective of the study was to theoretically substantiate and analyze benefits of a new optimized

physical education model for students with disabilities and special health needs.

Methods and structure of the study. We have analyzed the available literature on the academic physical education models for special health groups [2-7]. To comprehensively analyze the everyday needs and lifestyles of the special health group students, we used the G. Eysenck Personality Questionnaire [1] for the personality typing and profiling, plus "Lifestyle of students with special educational needs" and "Attitudes to physical education" questionnaire surveys.

The new physical education model piloting study was run since 1991 till present. We sampled for the study the Ural Federal University students attributed to the special health group based on the International Classification of Functioning, Disability and Health (ICF-10). The special customizable training model was designed to encourage the personality progress and self-development efforts of the sample and included the following three stages - motivational, cognitive operational and reflexive progress test ones. Of special interest for the surveys were the factors of influence on the learning motivations building component. The educational materials were selected to encourage healthy physical education interests and facilitate self-reliant, proactive and determined attitudes of the sample to learning, with a special attention to the individual physical health improvement agendas.

Results and discussion. In our methodological basis formation efforts followed by practical physical education service solutions we opted for a system approach with a special focus on the corrective developmental and educational technologies sensitive to creative thinking of the teaching personnel. The physical education model formation process from decision making to practical solutions may be classified into the following stages: selecting a few most efficient options to optimize the physical education service; analyzing the available data on the practical benefits of every option; sorting out the options to find the best two most suitable for the service; compare the time costs and benefits of the two options to arrive to the final decision. In view of the educational service mission and goals, we selected the most efficient tools to optimize the physical education service using a set of optimization criteria and education problems solving toolkit [4].

The first optimization **criterion** was to secure the individual goals and agendas being attained by every special health group student with a special attention to the individual progress needs and resources. As a result, up to 52% of the sample was tested with physical health improvements. Individual progress in physical fitness domain made it possible to re-qualify 8% to 10.5% of the sample from special health group to preparatory group, with 2.5% to 3.5% of the sample qualified fully healthy and written off the special medical records; and the health-related absenteeism was reported to fall by 38.88% for the period [7]. On the whole, analysis of the faculty's physical education service provided to the special health group for the period since 1991 till now showed that the training service mission has been basically attained.

The second optimization criterion was to prudently combine and standardize the physical education classes with extracurricular practices to find the most efficient combinations of the physical education service methods and tools. It should be emphasized that success of an educational service largely depends on the didactic teacher-student cooperation and communication facilitated by special educational provisions. Such pedagogical cooperation is essentially geared to establish a direct and indirect communication of the process actors to help them build up trustful and respectful teamwork. In case of the students with special health needs, the didactic forms and tools shall be selected on a particularly sensitive partnership.

We prioritized for the pedagogical communication optimizing purposes the communicative techniques meant to: prevent and remove barriers for communication; provide practical support for good communication; and encourage the counter educational and cognitive activity of the students. The communicative progress surveys classified the communication into the following three levels: high, with perfect mutual understanding and trust; low, with little if any understanding and cooperation; and moderate. Generally, it is the pedagogical skills that will form a basis for teacher-student communication and cooperation – largely driven by the individual personal and professional qualities of the teacher.

The physical education department faculty has been successful in maintaining and improving professional qualifications, with due contribution from the self-learning and advanced experience sharing elements assisted by special advanced training and retraining courses. For the last few years, the Ural Federal University management has taken special efforts (as required by the new legal and regulatory

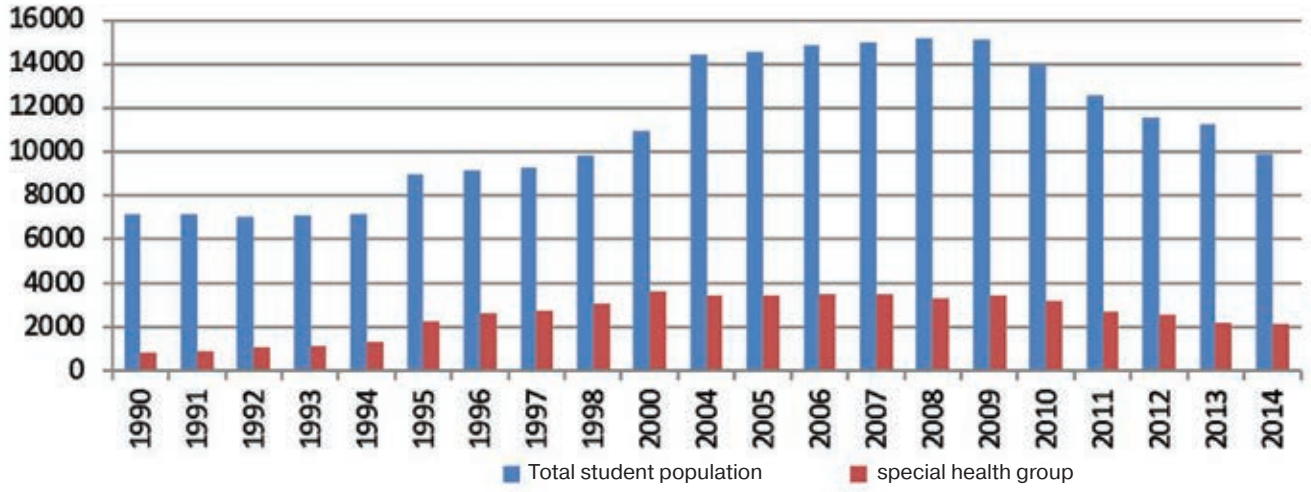

Figure 1. *Special health group numbers versus the total student population for the study period*

provisions) to facilitate vocational education service for students with disabilities and health disorders. It was in 2016 that the university established an inclusive education center. The faculty was trained by a special advanced course to acquire new knowledge and skills in the special health group training including the following courses: "Organizational and substantive provisions for educational service to people with disabilities", "First aid", "Operations of the theoretical and practical resource center for students with disabilities" etc.

The special health group composition is one more important factor for the special physical education service success since the interpersonal communication and cooperation in a group may be critical for an individual progress. The Figure hereunder shows the special health group progress statistics versus the total numbers of students in the physical education classes. Thus prior to the 2013-14 academic year when the physical education service took four years, the special health group grew from 10.44% in 1991 to 29.76% in 2001 of the total student populations. Since the merger of Ural State University and USTU-UPI, the special health group numbers continued to grow to reach 40.37% of the student population in 2018.

Having analyzed the study findings and experiences for the period, we made informed managerial decisions on the special health group compositions by the levels of psychophysical fitness for the special health physical education service. Our own experience, Mannheim system and the A.M. Vishnevsky's and P.V. Shlykov's recommendations made it possible to successfully form the training groups. In addition to the individual diagnoses, we took into account the following factors: intra-group activity, with tests of the individual activities of the group members; leaderships, roles and influences of some group members; group microclimates with the individual comforts; reference i.e. discipline in adherence to group standards and norms; group organization and self-management capacity; intellectual communication with mutual understanding and cooperation building resource; volitional communication needed for the group to cope with difficulties; and the group stress tolerance.

We used a special sociometric method to rate the interpersonal relationships in the groups and take timely administrative decisions to transfer students from one group to another as required for the individual progress. A special attention was given to the teamwork building aspects – from the initial diffuse state to the consolidated team. These managerial and practical solutions were geared to encourage active and effective communication and cooperation in the groups for success of the joint mission, goals and individual progress agendas of the group members.

Conclusion. The study found that the university was successful in establishing a special customizable learning environment for the special health group with the individual progress trajectories. Prudently combined and customized learning and cognitive methods and tools, with good cooperation and support from the university management helped optimize the physical education service for students with disabilities and special health needs. We composed the student groups using a sociometric method to facilitate the individual progresses and personality improve-

ment agendas based on constructive teacher-student communication and cooperation in the groups. The new pedagogical communication and cooperation encouragement methods and styles have helped the students to mobilize their individual resources for success. The independent academic physical education progress tests of 2017-18 rated the special health group high on average, with 82%, 15% and 3% of the special health group students tested excellent, good and satisfactory on the physical education progress scale, respectively.

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Academic physical education benefits for faculty/ research/ management personnel's progress agendas: survey and analysis

UDC 37.013

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Abstract

Objective of the study was to survey and analyze the academic physical education service benefits for the faculty/ research/ management staff.

Methods and structure of the study. We run a questionnaire survey of the academic faculty and research personnel (n = 300) and management staff (n = 140) in the Belgorod, Kursk and Lipetsk Oblast universities to profile the individual progress agendas; with the questionnaire survey data and analyses additionally verified by interviews of academic physical education experts (n = 20). The experts were requested to verify, among other things the questionnaire survey data and findings and contribute to the interpretations and resultant practical recommendations. We used for the purpose of the study combinations of the following theoretical research methods: analyses, comparisons, data generalization, systematization and modeling. The questionnaire survey was designed to profile the faculty/ research/ management staff attitudes to the progress opportunities offered by the academic physical education system classified into: leisure-time trainings in gyms; university mass physical education events; and the GTO Complex tests.

Results and conclusion. The questionnaire survey data and analyses made it possible to profile the faculty/ research/ management staff attitudes to the progress opportunities offered by the academic physical education system classified into: leisure-time trainings in gyms; university mass physical education events; and the GTO Complex tests. The study found the faculty/ research/ management staff engaged in the academic physical education mostly on an occasional basis, with a special preference for the GTO trainings and tests and some mass physical education events.

Keywords: *academic physical education system, individual progress agenda, faculty, research personnel, university management.*

Background. Modern academic physical education service system may be described as the system of interrelated and interdependent institutions providing health and physical development services to students, faculty and management [2]. Its key mission is to encourage and facilitate the individual physical and professional progress agendas; with the university physical education system development projects always geared to improve health and physical fitness standards [3].

Objective of the study was to survey and analyze the academic physical education service benefits for the faculty/ research/ management staff.

Methods and structure of the study. We run a questionnaire survey of the academic faculty and research personnel (n = 300) and management staff (n = 140) in the Belgorod, Kursk and Lipetsk Oblast universities to profile the individual progress agendas; with the questionnaire survey data and analyses additionally verified by interviews of academic

physical education experts (n = 20). The experts were expected to verify, among other things the questionnaire survey data and findings and contribute to the interpretations and resultant practical recommendations. The expert team was composed of the most experienced and knowledgeable academic physical education specialists at active service in the academic research and teaching groups. In addition, the questionnaire survey findings were discussed, verified and analyzed by a designated focus group composed of the Belgorod State National Research University faculty, researchers and management (n = 12).

Results and discussion. The questionnaire survey data made it possible to analyze how the faculty/ research/ management staff's progress agendas are facilitated by the academic physical education system. The respondents were found to benefit from the academic physical education by (1) leisure-time university gym workouts; (2) joining the university physical education events; and (3) joining the GTO Complex trainings and tests.

(1) Leisure-time university gym workouts were found differently opted for by the sample, with only half of the sample reporting attending gyms 2-3 times a week for the following reasons: health agenda; physical fitness; body shaping for it is fashionable etc. Therefore, the sample's motivations for the academic physical education were found dominated by the professional service performance facilitating ones. Almost half of the sample reported seldom (once a week at most) visits to the gyms due to not only the low motivations, but also the time constraints and heavy academic workloads. Therefore, there is a contradiction between the group physical progress and health agendas and unhealthy working conditions with the constantly increasing job intensity due to, among other things, growing formalization of the educational process.

(2) University physical education events were found joined by the sample on an occasional basis, with their motivations dominated by the physical education events facilitating their personality/ professional progress agendas and desire to communicate with professional athletes. It should be noted that the management staff was found determined in their health agendas although mostly keeping beyond the mass university physical education events at the same time.

(3) The GTO Complex tests were reported joined by 75% of the sample and rated highly positive, with no one of the focus group members reporting any negative aspect of the events. The focus group emphasized excellent organization, friendly service staff, physical fitness test opportunities, and contributions of the tests to the own self-esteem.

It should be noted that the GTO Complex tests and university sports festivals were ranked on top among the academic physical education elements by the sample due to the excellent organization and traditional festive climate. The latter aspect may be considered significant in the context of the growing festive tendency in the modern lifestyles as a sublimation form i.e. defensive response to the social instability and crises. Thus the typical responses of the focus group members on the GTO trainings and tests were as follows: "Trainings for the GTO tests are highly beneficial to my mind as they advance both health and patriotism" (44 years old male BSU teacher); "My whole family always joins the GTO tests for they contribute to the athletic and competitive spirit and bring people together" (42 years old female BSU manager); and "GTO tests contribute to my self-confidence and self-esteem" (39 years old female BSU manager).

Conclusion. The questionnaire survey found the faculty/ research/ management personnel appreciating mostly the GTO Complex trainings and tests in the academic physical education system for their popularity, festive atmosphere, physical fitness test opportunities, communication and socializing aspects, plus they were found equally popular in every age group. Faculty and management staff reported appreciating the university sports festivals and swimming pool services. It should be emphasized that the physical progress agendas of these groups were found complemented by the socialization needs with the friends-making opportunities, plus master classes from the sports celebrities. The communicative/ socialization aspect of the academic physical education system for the faculty and management staff was reportedly appreciated, among other things, due to the festive climate that eases pressures of the formal academic lifestyles. We would recommend this finding being seriously taken into account by the academic physical education system designers and managers.

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Elementary school students' distance learning period: motor activity survey

UDC 796.034.2

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Abstract

Objective of the study was to analyze the elementary school students' motor activity in the distance learning period using an online questionnaire survey.

Methods and structure of the study. The elementary school students' motor activity in the distance learning period profiling online questionnaire survey was run using a special interactive questionnaire form of our own design including open and confidential questions. We sampled for the study the elementary school students' families (n=343) from Lyceum No. 32 and Secondary Schools No. 7, 17, 33, 35, 36, 42 and 50 in Belgorod city. The online questionnaire survey was intended to profile the opinions of elementary school students' families on their children's actual motor activity, leisure-time preferences, family roles in the motor activity control and the actual elementary school students' progress needs.

Results and conclusion. The online questionnaire survey data of elementary school students families and analysis geared to profile the motor activity preferences and family roles in the children's motor activity control found that in the digital distance learning period during the COVID-19 pandemic the elementary school students tend to neglect the healthy time limitations for home works at computer – partially due to the children being overloaded by educational tasks and, hence, doomed for motor inactivity in limited spaces. The survey data and analyses demonstrate that special efforts need to be made to efficiently encourage, control and manage the elementary school students' motor activity in the distance learning period.

Keywords: *motor activity, elementary school students, distance learning, online questionnaire survey.*

Background. Lately the popular motor activity has been reported to fall fast with the economic progress – as is the case for many rapidly developing economies the world over. Thus, according to the recent Russian statistics the popular physical activity has contracted by 18% for the last 16 years and is to further fall by 32% on the whole till 2030. Presently the situation is aggravated by the lockdown, home isolation and distance learning in the period of the COVID-19 pandemic [13]. The World Health Organization (WHO) reports the home isolation for a long time heavily contributing to the growing motor inactivity and sedentary lifestyles with inevitable serious detriments to health, wellbeing and life quality, and with potential high risks for mental health of the most vulnerable social groups [12].

It should be emphasized that the necessary isolation at home with transition to distance learning technologies is of special health risks for the school students on the whole and primary student groups in particular – for an optimal motor activity is their vital biological need as it is known to largely facilitate the physical and mental progress [1, 8, 9]. Therefore, the situation-specific motor activity control issues and

motor activity limitation factors in the distance learning period undoubtedly deserve a special attention of the research community.

Objective of the study was to analyze the elementary school students' motor activity in the distance learning period using an online questionnaire survey.

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Results and discussion. A few study reports on the children's leisure-time preferences with the growing dependences on computers for the learning and leisure-time purposes have found rather alarming negative effects on the children's health – that need to be seriously addressed by society [2, 3, 5, 11]. Thus, it was found that the free time used or outdoor health-improvement physical activity is actually dominated by customary sedentary behavior indoors for many hours – both for the learning and entertainment purposes [4, 6, 7, 8, 10]. The survey data analysis of the elementary school students' motor activity in the distance learning period found that the elementary school students' families tend to believe that 51.9% of their children's activity is fairly versatile to combine reasonable motor activity with inactive and sedentary behavior.

Furthermore, 30.3% of the sample reported their children preferring low- and moderate motor activity; and 16.3% reported high-intensity motor activity, with 86% of the two-plus-children families reporting their children actually stimulating one another for motor activity; and 51.6% of the sample reported the children's motor activity being limited by shortage of sporting space and equipment at home.

The online questionnaire survey found only 20.5% of the sample having sufficient knowledge and experience to encourage their children's motor activity at home; with 23.7% of the sample complaining time limitations for the efforts to control the child's motor activity. Around 31.7% of the sample confessed shortages of knowledge and experience for assistance in the child's motor activity design and management at home, with only 39.4% reportedly taking some efforts to encourage the children's motor activity at home. 28.3% of the sample, however, reported joint morning exercises with their children albeit 57.1% said they never do other calisthenics at home.

The respondents were of contradictory opinions on the children's home motor activity rating issue, with 38.8%, 32.6% and 28.3% rating it poor, limited and adequate, respectively; and 21.6% considering their children's motor activity intensity adequate. 52.8%, 31.2% and 3.5% of the families reported trying to control and manage their children's motor activity every day, on weekends and during vacations, respectively; and 11.7% was found negligent to the children's motor activity at home. On the whole, the online questionnaire survey data may be interpreted as indicative of the families mostly complaining lack of opportunities, knowledge, experience, skills and willingness to control their children's motor activity in the distance learning period.

Conclusion. In the digital distance learning period during the COVID-19 pandemic, elementary school students were found to neglect the healthy time limitations for home works at computer – partially due to the children being overloaded by the school educational tasks and, hence, doomed for motor inactivity in limited spaces indoors. The survey data and analyses demonstrate the need for special efforts to efficiently encourage, control and manage the elementary school students' motor activity in the distance learning period.

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Self-isolation during covid-19 pandemic: university students' health-related life quality variation survey

UDC 796.011

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Abstract

Objective of the study was to rate and analyze the physical and mental health and life quality variations in the university student communities during the COVID-19 pandemic.

Methods and structure of the study. The study was run at Surgut State University. We sampled for the questionnaire survey the 2-3-year students (n=128) aged 18-20 years, including 66 full-time students sampled in March-April 2014 during public learning period [4]; and 62 students sampled in February-March 2021 in the distance learning period. The sample was qualified with Health Group 1 eligible for elective academic physical education and sports course. We used the Russian version of SF-36 Health Status Survey (SF-36v.2) with its unspecific life quality self-rating surveys and 8 health-related life quality tests. Every test question is scored by 0 to 100 points, with 100 points meaning excellent health [6]. The SF-36 survey form was translated into Russian and tested by the Institute of Clinical and Pharmacological Research in St. Petersburg. Meanings of differences in the test data arrays were rated by the parametric Student t-test.

Results and discussion. The full-time and distance learning groups scored virtually equal on the physical health test scales due to the relatively young age as they tend to consider themselves healthy and see no limitations for their physical state, although the distance learning group was clearly limited in its physical activity during the pandemic. The latter group, however, was found stressed by limitations in the social contacts and activity in the self-isolation period with the associating falls in the mental health self-rates.

Keywords: *health-related life quality, academic academic physical education, physical health, mental health, self-isolation, distance learning, COVID-19 pandemic.*

Background. The leading world economies give a growing priority to the national health programs for a few last decades [1], and the Russian Federation is no exclusion with its public health and life quality protection policies and practices. As stated by Prime Minister M. Mishustin, the Cabinet of Ministers ranks "… the life quality of every citizen secured by economic and social progress and the national policy objectives approved by the President." among its key values and policies.

Physical inactivity (hypokinesia) is increasingly ranked among the key risks for the population health in addition to the well-known environmental, man-made and sanitary-epidemiological ones. As found by the relevant studies "… physical activity, when it is prudently designed and managed, is highly beneficial for health" [2]. In 2020 the humanity faced one of the greatest pandemics that seriously affected the life-styles and life quality on the whole and physical activity in particular. The World Health Organization (WHO)

announced of the COVID-19 pandemic and recommended self-isolation regimen among the other disease prevention measures. The Russian Federation introduced and kept this regime in March through July 2020.

The Ministry of Science and Higher Education Order of March 14, 2020 No. 398 "On the institutional policies and practices to prevent the spread of the new coronavirus infection in the Russian Federation", required the national universities make transition to distance learning in the self-isolation period. It should be emphasized that the strict isolation and social distancing requirements at the time of pandemic have proved to be detrimental to the mental health standards the world over [5]. Thus, the mental health surveys in France during the pandemic found anxiety peaks at the start of the coronavirus outbreak (Santé Publique France 2020 b). A similar study in the United States found the incidence of depression and anxiety on the rise.

We undertook this study as highly relevant due to the obvious negative impacts of self-isolation on the popular health and life quality standards, since the population groups need to adapt to the new living lifestyles, with special challenges faced by the university students due to distance learning and new communication format that cannot but be detrimental for the physical and mental health.

Objective of the study was to rate and analyze the physical and mental health and life quality variations in the university student communities during the COVID-19 pandemic.

Methods and structure of the study. The study was run at Surgut State University. We sampled for the questionnaire survey the 2-3-year students (n=128) aged 18-20 years, including 66 full-time students sampled in March-April 2014 during public learning period [4]; and 62 students sampled in February-March 2021 in the distance learning period. The sample was qualified with Health Group 1 eligible for elective academic physical education and sports course. We used the Russian version of SF-36 Health Status Survey (SF-36v.2) with its unspecific life quality self-rating surveys and 8 health-related life quality tests. Every test question is scored by 0 to 100 points, with 100 points meaning excellent health [6]. The SF-36 survey form was translated into Russian and tested by the Institute of Clinical and Pharmacological Research in St. Petersburg. Meanings of differences in the test data arrays were rated by the parametric Student t-test.

Results and discussion. The health-related life quality survey is a modern method to self-rate own physical and mental health and social well-being [3]. The survey found the physical activity of the full-time student group on the elective physical education and sports course of 2014 being higher than in the distance learning group: 95±5.89 points versus 93±8.19 points, respectively: see Table 1.

The distance learning group rated its physical state impacts on the routine performance (RP) higher than their full-time peers (69.0±9.4 versus 77.42± 4.91, respectively; p≤0.01). This may be due to the limitations

Table 1. *Physical and mental health test data of the student groups*

Life quality rates		Code	Full-time learning group on elective physical education and sports of 2014, n=66 (x±σ)	Distance learning group of 2021, n= 62 (x±σ)	p
Physical health test rates	Physical functioning	PF	95,00 ±5,89	93,53±8,19	≥0,05
	Physical state impacts on the lifestyle	RP	69,00 ±9,4	77,42±4,91	≤0,01
	Pain impacts on lifestyle	BP	73,00 ±3,36	81,39±8,62	≤0,05
	General health	GH	69,00 ±7,67	75,47±2,23	≤ 0,05
Mental health test rates	Vital activity	VT	58,00 ±8,78	63,86±2,29	≤0,05
	Social functioning	SF	81,70 ±6,77	68,36±3,16	≤0,01
	Emotionality impacts on the lifestyle	RE	60,00 ±4,48	63,48±5,39	≤ 0,05
	Mental health self-rate	MH	62,00 ±8,44	63,06±8,92	≥0,05

Table 2. *Average physical and mental health scores of the groups*

Health tests	Full-time learning group on elective physical education and sports of 2014, n=66	Distance learning group of 2021, n= 62
Physical health	48,87	51,28
Mental health	46,58	45,95

of daily duties in need of special physical efforts during the pandemic.

On the whole, both groups self-rated them medium and high on the physical health test scales; and the distance learning group scored higher on the general health scale than the full-time group – probably due to the natural fall in the respiratory viral infections and "dirty hands" related diseases in the period of special hygienic measures.

As far as the mental health test rates are concerned, the groups scored virtually equal on the social functioning scale. The average scores of the distance learning group were meaningfully lower in the other tests. The lower social functioning scores are indicative of the serious restrictions of the group social contacts, communication and, hence, the emotional and mental health. Despite the fact that the intergroup difference in the "Emotionality impacts on the daily lifestyle" (RE) test made up only a few points (60.00±4.48 versus 63.48±5.39), the Student's t-test showed the difference being statistically significant.

Averaged physical health scores (four tests) of the full-time and distance learning groups made up 48.87 and 51.28 points, respectively: see Table 2.

Averaged mental health scores (four tests) of the full-time and distance learning groups made up 46.58 and 45.95 points, respectively. It should be mentioned that the distance learning group score in the mental health related life quality test was at the bottom of the "norm" – that may be interpreted as indicative of the depressing effects of the pandemic and isolation on the group emotion health.

Conclusion. The COVID-19 pandemic was found of notable impacts on the students' health related life quality. The full-time and distance learning groups scored virtually equal on the physical health test scales due to the relatively young age, whilst the mental health self-rates were indicative of an expressed shift in the emotional and mental health domains in the distance learning self-isolated group.

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Governmental youth policies to encourage socially sensitive physical education and sports projects

UDC 796.011.3

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Abstract

Objective of the study was to analyze motivations for and priorities in the physical education and sports / healthy lifestyle domains based on reports of the federal grant foundations with their social investment technologies.

Methods and structure of the study. We analyzed, for the purposes of the study, reports and infor-mation materials of "Rosmolodezh" Federal Agency for Youth Affairs, including information for the bidders in grant contest and experts, grant award reports, information on the most beneficial practices, content analyses of the grant contest bids of universities and individual bidders for expert valuations.

Results and discussion. The study demonstrates that the grant contest popularity and bidding statistics provide important information about regional youth motivations for and activity in the physical education and sports sector, with the specific project bids indicative of the most popular healthy lifestyle / physical education and sports service formats with the grant support requirements. It was also found that the mod-ern grant contest technology in application to the socially valuable youth/ students initiatives in the physi-cal education and sports sector is ranked among the most efficient youth health tools in the toolkit of the federal and regional physical education and sports sector development policies and practices under control of the Ministry of Sports to ensure the young people being actively involved in the physical education and sports infrastructure development, mass physical education and sports events hosting and new physical education and sports projects implementation initiatives. The grant contest models has proved highly beneficial, among other things, for the social initiative geography tracking purposes to timely update the relevant databases of the responsible governmental agencies and analyze progresses of the popular acces-sible physical education and sports / healthy lifestyle services in the regions.

Keywords: *social initiative, youth, students, sports, physical culture, grant support, state youth policy.*

Background. Modern discussions of the youth support policies in the Russian society give a special pri-ority to the governmental initiatives to encourage healthy youth communities and projects [3, 6]. Quite a few latest studies [1, 2, 5, et al.] have analyzed the inspiring youth fashion for healthy lifestyle and university students' contributions to the national physical education and sports movement. It should also be noted that the national elite sports management agencies effectively facilitate progress of the national young population in every sport discipline, with a special emphasis on the grassroots youth physical edu-cation and sports movement and its advancement by the governmental youth policies and research com-munity. Many analysts call for new management models for the university student sports. Thus N.V. Peshkova prioritizes, among the other potential solutions, the need to "control the university physical education and sports by the environment-focused soft power tools as required by the mission and objectives

of the educational establishments" [4, p. 96]. We believe in this context that the youth and student social initiatives and activities in the physical education and sports domain deserve special research.

Objective of the study was to analyze motivations for and priorities in the physical education and sports / healthy lifestyle domains based on reports of the federal grant foundations with their social investment technologies.

Methods and structure of the study. We analyzed, for the purposes of the study, reports and information materials of "Rosmolodezh" Federal Agency for Youth Affairs, including information for the bid-ders in grant contest and experts, grant award reports, information on the most beneficial practices, con-tent analyses of the grant contest bids of universities and individual bidders for expert valuations.

Results and discussion. The Presidential "Russia: Country of Opportunities" Platform successfully im-plements, among other initiatives, a grant contest of Youth Initiatives Project intended to encourage healthy lifestyle and mobilize young people for physical education and sports. The Project supports annual grant contests in line with the governmental policies to facilitate specific socially valuable initiatives and provide extra progress opportunities for the young people's projects.

Since the Physical Education and Sports and Tourism nomination in the above Project is ranked among the key ones, numbers of the regional bids for this nomination may be indicative of the local youth's mo-tivations for physical education and sports, whilst contents of the bids demonstrate the most popular physical education and sports formats in the relevant Russian regions and municipalities. Moreover, the bidding activity analysis makes it possible to find the most active young people' groups. Our own practical bids analyzing experiences in expert groups on commission from the Rosmolodezh Federal Agency in 2017-2020 showed that university students are much more likely than the other youth groups to win the grant contests due to their greater awareness of the grant contest rules and requirements plus better knowledge of the modern social design technologies.

The following reported data provide an insight into the scale and priorities of the youth initiatives. In 2018, the federal budget financing for the grant campaign was reported at RUR 2.5 billion for all kinds of grant contests, including the individual project grant budget of RUR 235.4 million, with the specific project grants limited by RUR 300 thousand. The grant contests commissions reported 7809 bids in every grant contest field, including 259 winning bids estimated at 16% of the total. The winning bids included 81 healthy lifestyle / physical education and sports project bids submitted from 41 constituents of the Russian Federation and estimated at RUR 15.150 million on the whole. The winning bids advanced the local sports promotion, sports event organizing, and educational initiatives support projects, plus new sports clubs and new sports ground development projects.

Youth progress opportunities of the above mechanisms were demonstrated by the 2020 Pan-Russian Grant Contest of Youth Projects accessible for the 14-30 year-old residents of the Russian Federation, with specific grants up to RUR 3 million and the total budget of RUR 1.151 billion; including the RUR 171.3 million budget for the Sports, Healthy Lifestyles and Tourism nomination. The Grant Contest col-lected 155 project bids from 53 regions of the Russian Federation, including 16 project bids from Mos-cow, 8 from the Moscow Oblast, 7 bids from the Republic of Ingushetia, 7 bids from Karelia, 7 bids from the Nizhny Novgorod Oblast, 6 bids from the Republic of Dagestan, 6 bids from the Sverdlovsk Oblast; 5 bids from the Perm Territory, 5 bids from the Republic of Sakha (Yakutia), 5 bids from the Ryazan Ob-last; and 4 or less bids from the other regions.

Of the six winning bids from the Sverdlovsk Oblast (that totaled RUR 10.4 million), three project bids were from the university physical education and sports activist groups including the Katadze Youth Sports and Education Camp Deployment Project; Mobile Guide for the Russian Ski Resorts Development Project by UrFU; "Pride School" Sports Events Promoting School Associations Support Project by the Youth Government and UIU branch of RANEPA. In addition, two bids from the Sverdlovsk Oblast won the University grant contest for grants up to RUR 15 million, namely 'Triathlon Mania" Resourcing and Training Center for Triathlon Teams by UGLU for the grant of RUR 700 thousand; and the "III Pan-Russian Student Games in Martial Arts" Project from the Ural Federal District based Ural State Law Uni-versity, for the grant of RUR 4 million.

The 2020 grant campaign in progress has at this juncture generated an extra finance of RUR 15 million for the local governmental budgets for their youth healthy lifestyle / physical education and sports advancement projects. It should be emphasized that these projects are mostly unique and interdisciplinary and, hence, have high success chances in the other

grant contest nominations. This is particularly true for the grant contest forum campaigns that are still limited in numbers albeit highly beneficial for a wide range of the youth and student healthy lifestyle / physical education and sports initiatives.

Conclusion. Modern grant contest technology in application to the socially valuable youth/ students initi-atives in the physical education and sports sector is ranked among the most efficient youth health tools in the toolkit of the federal and regional physical education and sports sector development policies and prac-tices under control of the Ministry of Sports to ensure the young people being actively involved in the physical education and sports infrastructure development, mass physical education and sports events host-ing and new physical education and sports projects implementation initiatives. The grant contest models has proved highly beneficial, among other things, for the SI geography tracking purposes to timely update the relevant databases of the responsible governmental agencies and analyze progresses of the popular accessible physical education and sports / healthy lifestyle services in the regions.

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Public-private partnership model for physical education and sports sector: benefits analysis

UDC 796.062

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Abstract

Objective of the study was to identify mechanisms of effective implementation of public-private partnership in the Sverdlovsk region as part of the development of the region's ice hockey infrastructure.

Methods and structure of the study. The study was carried out on the Sverdlovsk region ice arenas built and put into operation within the framework of the implementation of "Agreement between the government of the Sverdlovsk Region and UMMC-Holding, LLC".

Results and conclusions. Considering the implementation of the mechanisms of public-private partnership by the example of the above-mentioned "Agreement", it can be said that the actions of the regional authorities contribute to the sustainable development of the sector, as well as the strategic planning of the economic and social development of the region. The system approach and the long-term project implementation have had a positive impact on the development of sport and the increase in the number of participants: the number of ice hockey players in the Sverdlovsk region increased from 16,258 in 2017 to 24,155 in 2019.

With regard to the economic dimension and further improvements in the partnership mechanisms, it is necessary to increase the profitability of sports facilities, their sustainability, and the level of management efficiency, which can be realized through other forms of public-private partnership as part of the models involving the maintenance of sports facilities by a private partner.

Keywords: *public-private partnership, sports infrastructure, ice arena, resource management, physical education and sports ecosystem.*

Background. One of the key avenues the physical education and sports sector progress is the sports infrastructure development business with versatile sources of finance and modern efficient mechanisms, with a special encouragement of modern public-private partnership models – in view of the fact that the existing 300,000 sports facilities available in the Russian Federation are estimated to meet only about 50% of the popular demand for accessible physical education and sports infrastructure [3]. Well-developed and accessible physical education and sports infrastructure is critical for luring local communities in habitual physical education and sports to indirectly facilitate the national socio-economic progress due to improvements in the life quality [5].

Objective of the study was to analyze benefits of a public-private partnership model implemented in the Sverdlovsk Oblast to contribute to the ice hockey infrastructure development initiatives.

Methods and structure of the study. Modern physical education and sports sector is known to directly improve the social living standards although its services are still poorly if ever supported by the local and federal budgets – in contrast, e.g. to the health

and education sectors [1, 4]. This is the core reason why the physical education and sports sector needs additional investments and alternative sources of finance for its infrastructure development projects. Public-private partnership models are ranked among the most beneficial alternatives for the sector progress. Generally, the public-private partnership concept has two versions of interpretation. In a narrow definition – as provided by Federal Law No. 224-FL dated July 13, 2015 "On public-private partnership, municipal-private partnerships in the Russian Federation and amendments to the relevant legal provisions" – public-private partnership refers to the new infrastructure development projects by private and public entities. It a broader definition, public-private partnership is interpreted as cooperation of public and private interests in different forms regulated, in addition to Federal Law No. 224-FL, by Federal Law No. 115-FL of 21.07.2005 "On Concession Contracts", Federal Law No. 208 "On Joint Stock Companies", Federal Law No. 135-FL dated July 26, 2006 "On Protection of Competitiveness", and Federal Law No. 44-FL dated 05.04.2013 "On contracting system for procurement of goods, works and services for the federal and municipal projects".

We analyzed, for the purposes of the study, the progress of the "Public-private partnership Contract of the Sverdlovsk Oblast Government with UGMK-Holding LLC" effective for 5 years (2017 through 2021). Subject to the analysis were the ice arenas constructed and commissioned under the public-private partnership Contract: see Table 1.

Results and discussion. The public-private partnership in the regional physical education and sports infrastructure development projects has been found to effectively encourage the habitual popular physical education and sports activity as verified, among other things by the ice hockey sporting population growth statistics reported by physical education and sports Statistics Form No. 1 for 2017–2019 as follows: 2017: 16,258 people: 2018: 22,677 people; and 2019: 24,155 people. Of special interest in this context is also the statistics of the popular demand growth for the physical education and sport services in 2017-2019. Thus the commercial physical education and sport service revenues of the local clubs and groups were reported to grow as follows: 2017: RUB 835 572.7 thousand; 2018: RUB 1,465,249.2 thousand; and 2019: RUB 1,719,017.0 thousand.

One of the most popular winter sport in the Sverdlovsk Oblast at present is ice hockey – that is ranked second in the sporting population statistics, with its popularity being clearly and largely correlated with the ice sports infrastructure supply: it is only natural that the more accessible are the local ice arena, the higher is the demand. This is the reason why the local government gives a special priority to the ice arena development projects in view of the high popular demand for the affordable ice arena services. However, it should be mentioned that despite the recent progress the local ice arenas in 2019 were reportedly economically unsuccessful, and this is why the government needs more efficient physical education and sports infrastructure operation and management models. Given in Table 2 hereunder are the key operational statistics of the Sverdlovsk-Oblast-based ice arena.

We believe that the financial performance of the local physical education and sports infrastructure may be improved by efficient modern interdepartmental cooperation models with a special priority to the inclusion of ice arena in the local socio-cultural environments as their key service elements accessible for the local communities.

Conclusion. Based on the study data and analysis, we would recommend redesigning the federal and municipal physical education and sports policies and projects so as to prioritize the income-generating federal, municipal and combined projects with flex-

Table 1. *New ice arenas constructed in the Sverdlovsk Oblast under the public-private partnership Contract*

Ice arena, location	Year	Cost, RUB mln.
Metallurg ice arena, Revda	2018	284,9
Molodost ice arena, Krasnouralsk	2018	338,0
Municipal ice arena, Rezh	2018	200,0
Municipal ice arena, Yekaterinburg	2018	95,0
Ice Sports Palace, fist project, Verkhnyaya Pyshma	2018	368,6
Ice Sports Palace, Kirovograd	2018	373,3
Small ice arena, second project, Verkhnyaya Pyshma	2019	215,5
Blagodat ice arena, Kushva	2019	43.5 (20% share co-financed)
Municipal ice arena, Sukhoy Log	2020	256,6

Table 2. *Operational statistics of the Sverdlovsk Oblast based new ice arena*

Ice arena, location	Space, square m	Clientele	Service staff	Costs, RUB thousand	Incomes, RUB thousand	Cost-to-income ratio
Yekaterinburg	2 684,21	108 000	33	22 681	10 417	0,459
Rezh	3 335, 4	5195	111	20 774	2 735	0,131
Revda	5 241, 3	5195	54	60 470	24 807	0,410
Kirovograd	5 219, 3	54 234	21	22 266	6 504	0,292
Krasnouralsk	5 241, 3	79 000	29	25 166	7 460	0, 296

ible application of inter-budgetary transfers. Modern versatile physical education and sports infrastructure management models will help expand the range, quality and accessibility of the popular physical education and sport services, with the local physical education and sports facilities evolving into popular hubs in the socio-cultural environments to effectively encourage the physically active, sporting and healthy lifestyles in every individual and social progress field.

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Physical education and sports landscaped infrastructure for regional sustainable development

UDC 796.062

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Abstract

Objective of the study was to identify the specific features of the mechanism of formation of the landscape physical education and sports infrastructure as a form of socially-oriented development of the territories.

Methods and structure of the study. The methods used during the study were as follows: analysis, synthesis, comparison, description. The approaches to the architectural and infrastructural development of the territories of inhabited locality in terms of urbanization. Based on the learnt material, it was proposed to view the landscape infrastructure in the context of physical education and sports and achievement of goals of the national project "Demography".

Results and conclusions. The landscape infrastructure of physical education and sports is positioned as a spatial-functional environment simulated in accordance with the principles of ecological safety, safety, functionality, and interdepartmental interaction. In addition to the infrastructural objectives, the proposed approach aims to form a new system of values, develop the mass physical education and sports ecosystem, and expand the functionality of the sports infrastructure facilities and their acquisition of the status of social attractors that integrate various forms of social activity.

Keywords: *landscaped infrastructure, physical education and sports ecosystem, sustainable development, «Sporting Life Norm», development strategies.*

Background. As provided by Presidential Decree of 05/07/2018 No. 204 "On the national objectives of the Russian Federation and strategic development priorities for the period up to 2024", popular living standards, health and well-being are ranked among the key national objectives of the Russian Federation [6], with the percentage of habitually sporting population (among the other progress factors) expected to grow to 55% by 2024 [5] and 70% by 2030 [6]. The progress of the national physical education and sport sector is of special importance in this context. Presently the federal government takes efforts to implement the "Sporting life norm" Project as complementary to the national "Demography" Project geared to facilitate access of every population group to physical education and sport services and mass sports, with a special priority to the local sports infrastructure development and sports reserve training initiatives [3].

The above Project encourages the local physical education and sport infrastructure development initiatives, with their progress rated by one of the key indicators. The physical education and sport infrastructure development projects are designed to facilitate the local sustainable development in line with the modern global trends. As stated by the Declaration on Environment and Development, the sustainable development

projects will be designed to protect and improve the popular living standards for happy and fruitful communal life in harmony with nature [2]. Good health and well-being of every population group and sustainable municipal and communal progresses are ranked high on the list of priority Sustainable Development Goals declared by the United Nations. Many analysts of regional development progress emphasize that "the regional progress policies will be driven by humanitarian socio-economic development paradigm [4]. Of special importance in this context are the new physical education and sport sector development encouragement models including both the physical education and sport infrastructure modernization and expansion and physical education and sports landscaping components.

Objective of the study was to analyze the physical education and sports infrastructure landscaping mechanisms for socially responsible regional development projects.

Methods and structure of the study. We used for the purposes of the study a set of traditional scientific methods including analysis, synthesis, comparisons and descriptions to analyze the most beneficial architectural and infrastructural development solutions for urban and urbanized regions. Based on the study data and analysis, we offer a new understanding of the physical education and sport landscaped infrastructure in the context of the national physical education and sport sector and "Demography" Project progress goals.

Results and discussion. The landscaped infrastructure concept has been in use for the last decade, with the landscaped infrastructure commonly interpreted as "the approach geared to expand functionality of a project landscape to host a multifunctional and highly productive social system" [1]. A.V. Vyazovskaya [1] reviewed different landscaped infrastructure interpretation versions to emphasize that their core idea is to integrate the social and economic sectors into the local environment at no detriment to their functionalities and values. In its application to national physical education and sport sector, the physical education and sport landscaped infrastructure will be designed to design/ redesign the urban landscape so as to facilitate the popular physical education and sport in every physical activity form in harmony with the other social activities in the area. The priority physical education and sport landscaped infrastructure development goals may be listed as follows:

- Model the space and functions with the local assets and networks so as to facilitate the popular motor activity;
- Staff the local physical education and sports infrastructure with the competent human resources to provide practical support to the local sporting population, with a special priority to the local physical education and sports events;
- Secure good informational support on an external and internal basis to promote healthy lifestyle with communal awareness in modern healthy lifestyle issues, and encourage progress of the local physical education and sport service personnel; and
- Ensure good institutional, legal and regulatory provisions for the physical education and sport landscaped infrastructure operations.

The above physical education and sport landscaped infrastructure projects have been implemented by a few municipalities in the Sverdlovsk Oblast and found beneficial as verified by the reported growth in the habitually sporting local population and healthy lifestyle advancements. Thus the Verkhnyaya Pyshma physical education and sport landscaped infrastructure is reported to integrate the local Sports Palace, Cedar Physical Education and Sport Center and the municipal Alexandra Kozitsyna Sports School into the local physical education and sport system that includes 143 municipal sports facilities. It may be pertinent to mention among the latter the Ice Arena, Ice Sports Palace and municipal stadium with an artificial football field, outdoor ice hockey court, outdoor basketball court, beach volleyball court, chess room, aerobics gym, track and field sports facility, shooting range and rehabilitation center with sauna. These facilities are readily accessible for the local actively sporting population.

One of the most popular physical education and sport service formats for the active population groups is the social physical education and sports contracts with the local corporate entities. Thus the municipal Alexandra Kozitsyna Sports School provides the GTO Complex test services and acts as the municipal coordinator for the "Sports Leader" Project. The municipality hosts about 300 mass physical education and sports events in 40 sports disciplines per year on average; and the local habitually sporting population as a result was reported to grow from 25,735 people in 2017 to 33,978 people in 2019.

Conclusion. The local physical education and sport landscaped infrastructure initiatives will be

geared to form a harmonic socio-cultural living environment with due contribution from interdepartmental cooperative efforts to secure sustainable municipal and rural development with a special priority to the communal physical education and sport services and healthy lifestyle encouragement initiatives in every social sphere. The physical education and sport landscaped infrastructure model analyzed herein may heavily contribute to the national progress goals via the regional sustainable development projects.

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Football techniques and tactics statistics: case study of wyscout analytical system

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Abstract

Objective of the study was to conduct a correlation analysis to substantiate the independence of evaluation of the game outcome from the increase in the number of registered tactical-technical actions of football players.

Methods and structure of the study. A total of 140 games of the leading championships were analyzed: England, Germany, Spain, Russia, France, and Italy. For each game, the Wyscout report on tactical-technical actions was studied and the total number of tactical-technical actions was calculated. The advantage in tactical-technical actions was assessed by the difference in the total number of tactical-technical actions of both teams. The assessment through the Wyscout Platform involves tactical-technical actions as such and various aggregations that are formed from the correlating characteristics.

Results and conclusions. The analysis of 140 games of the English Premier League, Primera, and Russian Premier League of the 2019/2020 season revealed a negative correlation between the total number of tactical-technical actions and game outcome (r=-0.06). Today, there are at least 10 platforms that count tactical-technical actions in top-level team games. The commercialization of this line of work led to the desire to inflate the amount of tactical-technical actions calculated at the cost of losing the connection between the tactical-technical actions advantage and the game outcome. The authors have previously shown that with the minimum number of factors, the regression equation has the best agreement with the results of the football matches if non-correlating characteristics are taken into account. The negative correlation of the number of tactical-technical actions with the game outcome exhausts the theme of tactical-technical actions, creates a prerequisite for the transition to the game scoring through technical-tactical martial arts, assessed by their cost - impact on the match outcome.

Keywords: *technical and tactical actions, football, result.*

Background. Since 1980 the football analysts have extended the range of the technical and tactical actions subject to analysis [2-5] – from 8 items in the Y.A. Morozov (1980) method [6] to as many as 100 items in the presently popular Instat and Wyscout analytical systems – despite the fact that the higher are the technical and tactical actions numbers, the poorer they are normally correlated with the actual competitive performances.

Objective of the study was to demonstrate, by a correlation analysis, little if any correlation between the formally fixed technical and tactical actions numbers and the actual match results.

Methods and structure of the study. We sampled for analysis 140 matches in championships of England, Germany, Spain, Russia, France and Italy. We analyzed the match technical and tactical actions reports by Wyscout to find the technical and tactical actions totals of the both teams. Then we ranked the matches in a descending order for the match hosts' advantages in the technical and tactical actions numbers and provisionally split them up into 7 intervals of

20 matches each. The total goals scored in 20 matches of every interval were divided by the goals conceded to find the scoring averages. The scored points were subject to the same analysis: see Tables 1 and 2.

Results and discussion. The values were transformed for analysis to put them on a universal basis within the 0-1 range using equation Y = (Xi - Xmin) / (Xmax - Xmin).

We compared the above data with findings of one of the 1995 studies [1, 6] that used equation Δ = (N (+) - N (-)) / (N (+) + N (-)). Note that for a regression analysis it is recommended to select the parameters with the highest internal correlations. Having processed the data, we arrived at r = 0.81 correlation of the expected points with the actually scored points: Δ = 0.75X1 + 0.71X2 + 0.62X12.

Table 1. *Comparative analysis of 140 European championship matches reported by Wyscout*

Match		Nation	Score		Difference	Technical and tactical actions	Technical and tactical actions	Technical and tactical actions difference	Points
Bournemouth	Man United	Engl	1	0	1	844	979	-135	3
Arsenal	Woolverhampton	Engl	1	1	0	1045	881	164	1
Aston Villa	Liverpool	Engl	1	2	-1	725	1198	-473	0
Brighton	Norwich City	Engl	2	0	2	1037	858	179	3
Man City	Southampton	Engl	2	1	1	1250	707	543	3
Sheffield	Barnley	Engl	3	0	3	852	958	-106	3
West Ham	Newcastle	Engl	2	3	-1	1058	730	328	0
Watford	Chelsea	Engl	1	2	-1	818	1204	-386	0
Crystal Palace	Lester	Engl	0	2	-2	762	860	-98	0
Everton	Tottenham	Engl	1	1	0	865	910	-45	1
Everton	West Ham	Engl	2	0	2	895	857	38	3
Bournemouth	Norwich City	Engl	0	0	0	954	987	-33	1
Aston Villa	Brighton	Engl	2	1	1	929	902	27	3
Chelsea	Newcastle	Engl	1	0	1	1128	739	389	3
Lester	Barnley	Engl	2	1	1	967	745	222	3
Tottenham	Watford	Engl	1	1	0	1238	823	415	1
Wolverhampton	Southhampton	Engl	1	1	0	950	865	85	1
Crystal Palace	Man City	Engl	0	2	-2	723	1158	-435	0
Man United	Liverpool	Engl	1	1	0	783	1107	-324	1
Sheffield	Arsenal	Engl	1	0	1	750	1105	-355	3

Table 2. *Key Wyscout indicators ranked by their correlations with the match scores and weight in the regression equation*

Indicator	Regression ratio	r
45s-plus ball control	0,900	0,61
Long passes	0,730	0,61
Average passes per match	0,655	0,52
High passes	0,533	0,5
Average shots per match	0,523	0,75
5-15s ball control	0,367	0,28
Ball control in % per match	0,079	0,57
Repossessions and interceptions	0,039	0,59
Ball losses in the last third	0,038	0,65
Average losses per match	0,015	0,34
Attacking/ forward passes	-0,016	0,55
15-45s ball control	-0,099	0,59
Ball control time per match	-0,278	0,46
Passes to the last third	-0,445	0,65
Contacts in the penalty area	-0,569	0,6
Average ball control time	-1,484	0,38

The team advantages in the shots on goal, field control (penetration depth) and repossessions provide a sound basis for the match result forecasts. When the key factors for analysis are minimized, this equation yields the most reliable outcome. Actually the Wyscout analysis offers only two of three most important indicators and, hence, not effective enough in analyzing the defense quality and shots on goal: see Figures 1-4.

The correlation ratio for the scoring advantage and points per match was estimated at r = 0.871. The correlation ratio for the scoring advantage and technical and tactical actions totals for the 2018-2019 championships of England, Spain and Russia (140 matches) was estimated at r = -0.06. And the correlation ratio for the match points and technical and tactical actions totals for the 2018-2019 championships of England, Spain and Russia (140 matches) was estimated at r =

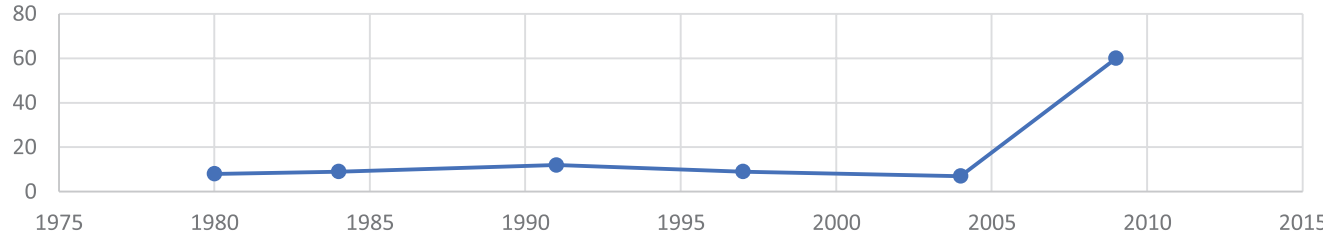

Figure 1. *Growth of the analyzed technical and tactical actions numbers since 1980*

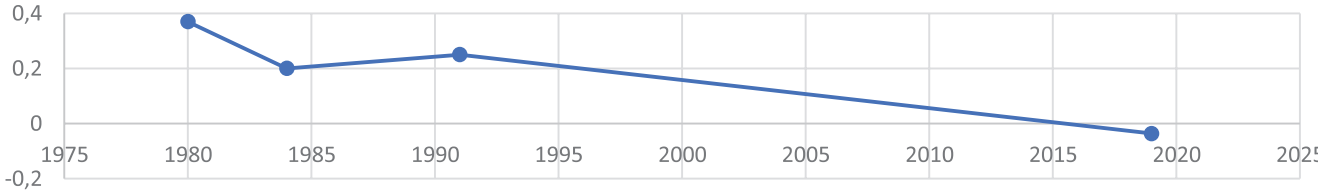

Figure 2. *Correlation of the technical and tactical actions numbers with the match results since 1980*

-0.052. An attempt to add new technical and tactical actions indicators yielded in a poorer correlation with the match results in fact.

It should be emphasized that the technical and tactical actions totals were found virtually non-correlated with the goals scored to goals contended ratios, with the only peak found close to the zero technical and tactical actions total. Paradoxically enough, the hosts' and guests' equality in this indicator was found associated with the hosts' wins; whilst the high advantages in the technical and tactical actions totals were found virtually non-beneficial for the teams: see Table 3.

Conclusion. The present Wyscout and Instat systems analyze individual technical and tactical actions and aggregated technical and tactical actions; with the individual technical and tactical actions including passes, shots on goals, etc.; and the aggregated values including XG, 45s-plus ball control etc. It should be noted, however, that the correlated indicators are normally aggregated. It was back in 1995 that one

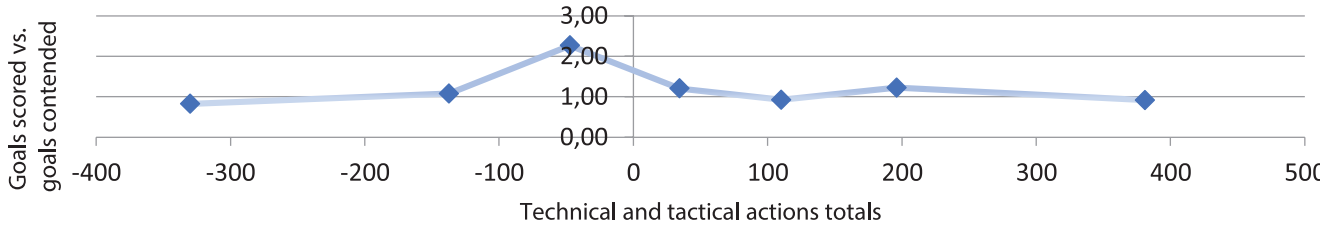

Figure 3. *Correlation ratios for the scoring advantages and technical and tactical actions totals for the 2019-20 England and Russia championship matches (n=140)*

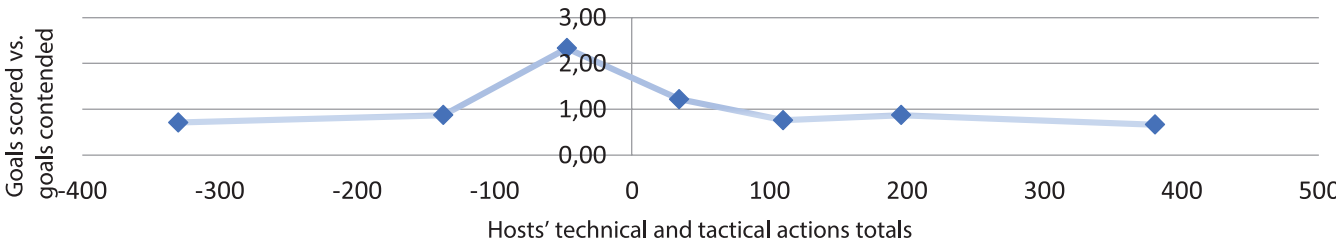

Figure 4. *Correlation ratios for the points scored and technical and tactical actions totals for the 2019-20 England and Russia championship matches (n=140)*

Table 3. *Correlation between the match points and the hosts' technical and tactical actions advantage for the 2019-20 England and Russia championship matches (n=140)*

Hosts' technical and tactical actions advantage	Match points	Difference in scores
380,85	0,67	0,92
196	0,88	1,23
110,1	0,76	0,93
34,45	1,22	1,21
-47,25	2,33	2,27
-137,35	0,88	1,08
-330,1	0,71	0,83

of us found the regression equation yielding a product fairly correlated with the match result when the technical and tactical actions numbers are minimized; particularly when a special priority is given to the non-correlated indicators like the team advantages in the shots on goals, field control (penetration depth) and repossession percentages. The study found that extensions of the technical and tactical actions numbers never improve the model efficiency and dependability. Therefore, we recommend the technical and tactical actions counts being replaced by the technical and tactical actions cost estimates i.e. their contributions to the match results/ competitive performance.

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Evolution of material for tennis racket frame manufacture

UDC 796.002.3

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Abstract

This paper presents the materials used and the changes that have occurred over time, in terms of making tennis rackets. Scientific advances in the field have also marked the evolution of the game of tennis, the type and characteristics of materials used in this direction, determining adaptations and improvements of the general style of play, specific possibilities for technical sports procedures and last but not least an increase in sports performance. The quality of the composite materials used at the current stage in relation to those used in the past (wood and metal) is highlighted. It also reveals the remarkable progress of the last 40 years of composites. The special properties of these materials have made tennis rackets more and more light, but with a higher impact resistance and a reduction of the vibrations felt by the practitioner. This has led to greater comfort and increased lightness in their use in sports. The current technology involves the use of carbon fiber in combination with various types of resins, the resistance being given by the optimization of the angles at which these fibers are arranged.

Keywords: *evolution, tennis rackets, materials, composite*

Introduction. By way of definition, we can affirm that sports with racket are those sports modalities that need an implement called a racket for their practice. This implement, instrument, or tool according to the sport in question, and may have different characteristics: dimensions, construction material, strung or not, etc. [12].

These implements are characterized by being made up of three clearly differentiated parts: the handle (area through which the practitioner holds the racket), the neck (intermediate area of the racket and which is usually long) and the head (area with that the ball is hit) [5].

Tennis is a sport that belongs to the ball sports family, and although it is modern origins date back to the end of the last century, its antecedents are much older [3, 4]. In tennis, as it happens in most areas of life, as time goes by, certain improvements are introduced, and some things change. Logically, tennis rackets have also evolved through the more than 6 centuries of history that this sport has.

"Tennis is boxing, it is a violent sport, one against the other, it is boxing without contact" [9]. Andre Agassi was right; the blows come and one can feel them. It only takes one arm extension, a live instrument called a racket, to receive and hit, choose the trajectory, power and speed of the ball, the shot. A conceptually simple instrument: there is a loom, to which a plate of crossed strings is attached, and a handle. That is all. However, the racket, in its technological evolution of almost 150 years, has not only been crucial for the performance and psychological

component of the tennis player, but has also been able to redefine the style of tennis [1].

Research methods and structure. To elaborate this study, we identified mainly several sources of information that targeted materials from which tennis rackets were and are made. There were accessed bibliographic sources that aimed at the field of plastics, composites, and specific patents in the construction of these sports objects but also studies that refer to interdisciplinary fields, of the latter are of interest those with a predilection focused on performance training in tennis. In this regard, various international databases were accessed (Web of Science, Scopus, Springer Link, DOAJ and Google Scholar). We also watched various documentaries and interviews with several manufacturers, video resources that refer to the technological process of making tennis rackets to complete as much as possible the conceptual area of our study topic.

The purpose of this research is to understand the evolution of the materials used to make tennis racket over time, by referring to their characteristics and to the effects felt in the evolution of this sport.

Results. In the early 20th century, the material used for both the frame and the neck used to be mahogany. Nevertheless, it changes in the mid-twentieth. Materials become more important and manufacturing is separated from parts. Thus, the frame will be made of walnut, ash, holly and oak woods. These lightwoods helped reduce the weight of the racket. For the grip, what was sought to improve the grip, so maple, cedar and birch woods were chosen [1].

In addition to the wood, all the rackets carried a metallic nail transversely, seeking more solidity in the center of the tennis racket [2].

Until 1930, only closed-hearted missiles were designed. Then, the Coq Sportif brand launches its legendary open-hearted models with three bars. This design will soon be replaced by the open heart without a center bar. In the 40's and 50's, the transition is made from artisanal to industrial manufacturing, using wood and laminates [6].

In the 1950s, tennis was fully established as a sport. Tournaments and competitions as important as Wimbledon and US OPEN appear. Thus, to the enthusiasm generated around these tournaments and their winners, the new tennis rackets from the big brands are named after the championship winners, illustrative being the cases of Jack Kramer or Pancho Gonz lez, for rocket models from Wilson and Spalding [15].

Changes in the materials used in rackets did not happen until the 1960s, when technology began to take off. The new materials were used in the construction of rackets and a rapid development of the materials began [1].

From highest to lowest stiffness, the most popular materials are:

Wood: From the beginning of tennis, wood has been the predominant material in the construction of rackets. Many frames were made of wooden sheets, and due to the pores of the wood, it absorbs the shocks and vibrations of the rocket, making it less harmful to the arm. Wood is a natural material and therefore the type of tree and the growing conditions have a lot to do with the structure of the wood. In this way, the sheets used came from: ash, beech, maple, birch, walnut, and mahogany [10].

In 1967, aluminum (bitubular) and steel missiles were introduced. The aluminum frames were stiffer, lighter than the wooden ones, they offered more control. Combining these two materials resulted in rockets of greater durability and strength but lacking the ability to absorb vibrations. Manufacturing cost and weight were low, moderate rigidity and ease of processing. It is more suitable for players who want flexibility in their racket and do not have enough accuracy and power [6].

Ceramic: It is a relatively modern fiber from the ceramic family, very rigid and with excellent properties in reducing vibrations. It has the disadvantage

Table 1. *The evolution of the materials used in making tennis rackets over time.*

Time period (years)	Materials used in the manufacture of tennis rackets
1920-1940	Wood (mahogany, walnut, ash, oak, etc.)
1940-1970	Wood (on several layers) Metal (steel and especially bi-tubular aluminum)
1970-1990	Composite materials: fiberglass, carbon, graphite, Kevlar, ceramics, boron
1990-2010	Composite materials: Graphite combined with Kevlar
2010-2020	Composite materials: Carbon fiber combined with certain types of resins

of being too heavy and very expensive to manufacture [12].

Fiberglass: It arises in the early 70s. It is a staple in the industry due to its resistance and low cost. The builders developed a first composition of rackets through the combination of these with aluminum. It is somewhat heavy, but its impact resistance is excellent. It is the ideal complement to graphite. It could never constitute a framework by itself, as it would be too flexible [10].

Graphite: Graphite is used in the frame of rackets since it is the ideal fiber to give rigidity to a frame and is usually combined with other fibers. It is a compound of aligned carbon molecular chains that produce a very stiff and light fiber. Graphite provides rigidity and hardness to the plastic resins with which it is mixed. When a racket is made of resin and graphite only, it is said to be 100% graphite even though 40% is resin. If other materials are added we are talking about compounds [8, 9].

Composites: The base of these materials is generally made of graphite and fiberglass, and sometimes of other materials such as titanium and Kevlar mixed with a plastic resin. The stiffness and cost of composite materials varies depending on the exact mix of materials [9].

Boron: It is produced by depositing boron elements on tungsten filaments in a high temperature environment. The result is a very stiff fiber, but excessively expensive. It is usually used as local reinforcement and in very small quantities [12].

Kevlar: Fiber of moderate rigidity, very light, resistant to impacts and with vibration reduction properties. Therefore, it is used as a reinforcing element at critical points in the frame structure [9].

Titanium: Titanium is a metal used in racquet frames because it offers a good ratio of stiffness to weight, it is a combination of ultra-strong titanium fibers with ultra-light graphite fibers. The hardness depends on the orientation of the fibers. The first thing to know is that it is not titanium that has made these rackets so light and manageable. Graphite is 2.7 times lighter than titanium and 2.8 stiffer [7, 13].

From 1990 to 2010 tennis rackets were made from the combination of 80% graphite and 20% kevlar [14, 15] and in the current stage, studies in the field have focused on reliability, but also lower costs have led to the emergence of tennis rackets containing carbon fibers in combination with different types of resins. This combination of materials offers superior strength to new types of missiles if certain placement angles of the component materials are observed [8].

Type of material and the influence of the teaching method of tennis today

The evolution of racket construction materials has led tennis to a new level of sport. As everyone can see, tennis has become more competitive, with new, stronger, and faster hits. This is because the evolution of racket building materials has allowed coaches to use different types of rackets (in terms of size, material, and weight) in their teaching to make teaching more enjoyable, more specialized, more specific and more efficient. This is even suggested by the International Tennis Federation (ITF) as an ideal teaching method. ITF calls it “Play and Stay” and in addition to the other parameters it proposes, also refers to the use of appropriate tennis rackets depending on the age, body type and skills of the student. The teaching method “Play and stay” is more effective, more enjoyable, and faster than the classical teaching method [11]. This teaching method could not be applied without the development of equipment as it is today.

Therefore, the evolution of the rackets now offers the athlete the possibility to choose an individual racket by reference to his own style below and to the financial possibilities. There are rockets for strong flat blows, for rotary blows, for better ball control, rockets with weight distribution either on the head, handle, or center.

Conclusions. Tennis rackets have evolved in over 6 centuries of history of this sport, this evolution being due to a relevant extent to the materials from which they were made. Starting with those made of wood, then with aluminum and continuing with composite materials of different types, we can say that each material or combination of materials, due to specific characteristics, have influenced the actual tennis game (learning methodology, possibilities of technical procedures, how to approach the competition).

The evolution in the manufacturing mode culminates in the current stage with the existence of the possibility for a tennis racket to be made in accordance with the individual characteristics: age, level of training, purpose (professional or amateur), etc.

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Neuroticism control project for underage figure skaters

UDC 796.01:159.9

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Abstract

Objective of the study was to test benefits of a new neuroticism control and mental conditioning project for underage figure skaters.

Methods and structure of the study. The new neuroticism control and mental conditioning project piloting experiment for the underage figure skaters was run at Titan Ice Sports Palace in Surgut. We sampled for the experiment the 8-9 year-old figure skaters (n=6) on requests from the families and coaches concerned by symptoms of neuroticism. We were governed by the known basic project design principles (objectivity, plotting, strategic mission, abstract-to-concrete progress, cooperation, etc.), with application of the following mental conditioning tools: (1) dialogic disposition development by imaginary conversations with spectators during the program; (2) motor skill excellence with a special emphasis on the movement semantics; (3) new motor skills mastering in the context of the program mission and semantics on the whole. Neurotic symptoms were tested by the pre- versus post-experimental tests using three-level criteria (1st - neurotic, 2nd - transitional and 3rd – mental fitness) to rate: (1) asthenic emotional/ somatic responses/ self-control; (2) excessive/ humble aspirations/ ambitions; (3) excessive/ low/ adequate self-esteem; (4) external / internal figure skating motivations; (5) distraction / attention focusing/ stress tolerance; (6) involuntary/ controllable behavior; and (7) egocentric disposition / dialogic disposition in the figure skating program execution. Benefits of the neuroticism control project were rated by the progress tests.

Results and discussion. The neuroticism control and mental conditioning project for underage figure skaters was found beneficial in the following aspects: (1) anxiety control; (2) normalized self-esteem and aspirations; (3) increased internal figure skating motivations; (4) increased stress tolerance; (5) improved success motivations; and (6) mental shift to a dialogue with a spectator.

Keywords: *competitive mental fitness, egocentric disposition, dialogic disposition, neuroticism control project.*

Background. Figure skating is ranked among the most beautiful sports with its popularity growing the world over to greatly encourage the children's engagement since three years of age. The Khanty-Mansi Autonomous Yugra Territory takes pride in its great sports infrastructure and potential with special progress opportunities for youth figure skating, and with the local figure skating sports community giving a special priority to the competitive mental conditioning methods critical for success.

Competitive mental fitness may be defined as the special determined mindset with the athlete fully mobilized for success in the following aspects: (1) informed confidence in the own skills and performance, plus knowledge of the opposition and competitive settings; (2) high success motivations; (3) good mental/

emotional controls; (4) high stress tolerance; and (5) high controllability of the actions and feelings.

One of the key prerequisites for a good mental fitness is the encouraging effect of own competitive accomplishments, although modern high-coordination-intensive figure skating sport requires long-term hard trainings for progress and success. It should be noted that the mental conditioning process may be complicated by the premature expectations of and pressure from the families and coaches; inappropriate competitive mental conditioning methods and tools; and still limited individual mental control toolkits in disposal of the underage skaters. These factors may provoke neuroticism manifested in the fear of responsibility under pressure from a respected adult(s); excessive expectations of the surrounding; egocentric disposition detrimental to focus on the competitive performance, and asthenic emotional/ somatic responses to successes and failures associated with losses of interest in sport up to retirements from figure skating.

The neuroticism-related competitive unfitness in the underage figure skating sport should be controlled by due psychological support service based on the planned/ staged motor skill building theory by P.Y. Galperin, plus the N.A. Bernstein's paradox of "repetition-free repetition" in the figure skating skills training projects [1, 2, 6].

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Neurotic symptoms were tested by the pre- versus post-experimental tests using three-level criteria (1st - neurotic, 2nd - transitional and 3rd – mental fitness) to rate: (1) asthenic emotional/ somatic responses/ self-control; (2) excessive/ humble aspirations/ ambitions; (3) excessive/ low/ adequate self-esteem; (4) external / internal figure skating motivations; (5) distraction / attention focusing/ stress tolerance; (6) involuntary/ controllable behaviors; and (7) egocentric disposition / dialogic disposition in the figure skating program execution. Benefits of the neuroticism control project were rated by the progress tests.

The pre- and post-experimental tests were the following: unfinished sentences test; training/ competitive performance rating expert observations; A.I. Zakharova Child Neurosis questionnaire survey; L. Sobchik ITDO; "Life Line" by A.A. Kronik; "Family Relationship Analysis" by E.G. Eidemiller; "Self-esteem test method" by Dembo-Rubinstein; "Drawn apperception test" by G. Murray; Rosenzweig Frustration test (children's version); and "Athletic Progress Diary" of our own design. The test data were processed by a standard mathematical toolkit with the Fisher test.

Results and discussion. The pre-experimental tests found symptoms of neuroticism in every subject, with 84% of the sample tested with high anxiety and high aspirations, and 50% tested with compensatory high self-esteem: see Table 1 hereunder.

Such test data may be interpreted as indicative of the excessive pressure of success expectations from families and coaches on the children. The premature excessive success expectations were found to depress the underage athletes and undermine their self-esteem – as verified by the external success motivations tested in 84% of the sample. The young athletes were tested driven by the pressures from the parenting system with its praises and punishments rather than

Table 1. *Pre- versus post-experimental neuroticism tests of the sample, %*

Test	Anxiety			Aspirations			Self-esteem			Figure skating motivations			Attention control			Determination			Decentration		
Level	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Pre-exp.	84	16	0	84	16	0	50	0	50	84	16	0	68	32	0	0	84	16	68	32	0
Post-exp.	16	68	16	32	68	0	16	16	68	32	68	0	0	68	32	0	16	84	0	84	16
Fisher test	10.578	7.891	4.405	7.891	7.891	0	5.289	4.405	2.602	7.891	7.891	0	12.297	5.204	7.092	0	10.578	10.578	12.297	7.891	4.405

the skating progress as such; with the sports career considered a core of the family communication – important on the one hand and unloved on the other and, hence, largely hampering the training and competitive progress.

The pre-experimental attention control, stress tolerance and determination test data were paradoxical in the sense that they found high abstraction in training and competitive process in 68% of the sample versus the high (84%) and very high (16%) figure skating motivations – that means that the sport is no more a core driving force for the children. Moreover, 68% of the sample was tested with a competitive abstraction, with the children matching themselves with the rivals in a highly critical manner, i.e. rating themselves from the respected adults' point of view. This appeared to be the prime reason for abstraction from active determination to aside viewer's position, with the movements being automated, inhibited and constrained at sacrifice for harmony and integrity of the skating program, and with the total abstraction from a dialogue with spectator.

The post-experimental tests found a significant progress in the neuroticism control and competitive mental fitness aspects as verified by the Fisher's φ* criterion (see Table 1). Thus 68% of the sample was tested with the anxiety falls from the high to moderate level and even leveled down in 16% of the sample. The premature (age- and skill-unmatched) aspirations were tested falling back to normal in 68% of the sample. Self-esteem was tested to fall to more realistic levels in 16% and to the norm in 68% of the sample. The figure skating motivations were found to become more personal/ internal progress driven in 68% of the sample. Stress tolerance was tested to grow to the medium and high levels in 68% and 32% of the sample, respectively; and the success motivations were found to improve in 84% of the sample. Decentration was found to change to moderate (84%) and high (16%) – that may be interpreted as indicative of the better dialogue with spectator in the efforts to deliver the message of the skating program.

Conclusion. The pre- versus post-experimental test data demonstrated benefits of the new neuroticism control and mental conditioning project for the underage figure skaters. The project facilitated a shift from formal and isolated training of elements to determined skill building in harmony with the skating program semantics and mission with a special priority to a dialogue with the spectator using the skating body language; and with the mission of the skating program achieved by its semantics shaped up in the skating "form" with its strategy, techniques and tactics. When the skating program is well harmonized in its every element, its "form will go beyond the content" as stated by L.S. Vygotsky to make the program an artistic masterpiece and facilitate the skater's neurotic centering on the own self being transformed into a dialogue with the spectator – as one of the key indications of due competitive mental fitness.

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Arms overhead squats test for physical malfunctions detection and correction purposes

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Abstract

Objective of the study was to develop an arms overhead squats test version for physical dysfunctions detection and correction purposes.

Methods and structure of the study. The authors suggested that the functional testing of movement in the arms overhead squats test would help identify the risk of injury to people engaged in sports and active physical activities (fitness, dancing, etc.). Coupled with this screening technique and well-chosen correc-tional exercises, it will be possible to design a training system to develop effective fitness and real-life movements. The authors emphasized that the squat execution technique can be observed and analyzed from three different positions - front, side and back, to identify the compensation of movements in each of them. Having focused on these key areas, they were able to clarify the test techniques.

The arms overhead squats test was conducted in October 2019 and involved 50 people of the 1st and 2nd mature ages (34-53 years). A myograph was used in the test to determine the degree of activation of the subjects' trunk muscles in two types of squats: back squats (women - 10 kg, men - 20 kg) and arms over-head squats. The muscular activity was analyzed in the following areas: rectus abdominis muscle, oblique abdominal muscles, extensors of the back, greater and minor rhomboid muscles, and broadest muscle of the back.

Results and conclusions. The arms overhead squats test showed an average increase of 4-7% in the de-gree of activation of all the muscles. It should be noted that, versus the basic squats, such squats activated 10% more upper abdominal muscles. In addition, during the arms overhead squats, noticeable differences were observed in the two positions of the joints, six differences in the kinetic chain, and gender-specific differences in the muscle activation.

Therefore, the research conducted confirms the possibility and expediency of using the arms overhead squats test to detect bodily dysfunctions and further develop the program to eliminate them.

Keywords: *physical fitness, movement, physical dysfunctions, arms overhead squats, testing.*

Background. Physical movements may be defined as the high-coordinated interaction of muscles, bones and joints controlled by the central nervous system. Key movements screening tests may help find out whether or not an individual is physically fit for a specific physical activity program [1]. Presently the sport science offers a wide range of physical fitness/ functionality tests, although an analysis of the rele-vant reference literature shows a shortage of specific accessible tests (that need no special test equipment) to detect pains, movement asymmetries, muscle malfunctions or serious musculoskeletal system function-ality issues. Moreover, it is not unusual that coaches and physical educa-

tion specialists are in need of rea-sonably fast (10-15 min at most) and simple tests to select physically fit people for group trainings. In such situations we would recommend the arms overhead squats test taking only 2-3 minutes. Our study was designed to develop an arms overhead squats test version and analyze its benefits.

Objective of the study was to develop an arms overhead squats test version for physical dysfunctions detection and correction purposes.

Methods and structure of the study. It should be mentioned that observations of an individual move-ment style seldom if ever help collect all the information required for a functionality analysis. Limitations of the standard observations have been analyzed by the National Academy of Sports Medicine (NASM), and the analysts recommended the arms overhead squats test as a reliable method to fairly rate the indi-vidual functionality and movement amplitudes. It was found that the arms overhead squats mobilize more than 200 lower- and upper-body muscles since the test requires the upper- and lower-body muscle move-ments being well harmonized to perfectly and harmonically perform the three-joint flexion (in the squat phase) and extension (standup phase) sequence.

Actually the arms overhead squats test is widely used for the movement analyses – for example, in the FMS (Functional Movement Screen) procedures; in the NASM models; and in the Fusionetics Human Performance technology for the movement efficiency rating purposes [3]. Popularity of the arms overhead squats test is due to the fact that it makes it possible to basically rate an individual functionality on the whole. In addition, as demonstrated by Noda and Verchure (2009) from the University of Michigan, the arms overhead squats test is indispensable for the individual movement range and potential injuries forecasting and prevention purposes. It is recommended to observe the arms overhead squats tests se-quence from the front, side and back viewpoints to detect and fairly profile the movement disorders and compensatory moves. When the observer is attentive enough in every of these key projections, the arms overhead squats test may generate high-quality data for analyses as a basis for an individual practical cor-rective program [2].

We analyzed the available literature on the subject, improved the arms overhead squats technology and tested it in the fitness clubs of Yekaterinburg city to accumulate the arms overhead squats testing experi-ence and analyze benefits of our arms overhead squats test version. It was in October 2019 that we tested the arms overhead squats test version on the 34-53 years old sample (n=50). The test was designed to pro-file by myographer the trunk muscles activation patterns in the 10/ 20kg barbell arms overhead squats test (with the 10kg version for women). We also analyzed the muscles activation patterns of the rectus ab-dominis, oblique abdominal, dorsal extensors, large/ small rhomboid muscles and latissimus dorsi.

Results and discussion. Our arms overhead squats test version was designed as follows.

Front view The arms overhead squats sequence observer shall find if the person can squat with the feet kept under the hips or shoulders with the toes pointing forward. Despite some possible modest variations, a healthy individual (free of pains/ orthopedic malfunctions) should have not problems in keeping the toes straight in the arms overhead squats sequence. When the observer notes a trend to turn out the feet lateral-ly or extend the support square, it may be indicative of a potential limitation in the ankle joint movement range. The most usual compensatory movement detectable in this projection are the feet turns out with the knees shifting inward. When the observer detects some of the above malfunctions, they should be verified by extra tests. The compensatory moves normally mobilize the following muscles: soleus, gastrocnemius and biceps femoris; with these muscles being either overactive, or just pinched and shortened due to some customary limitations – e.g. unfitting shoes, weaknesses in the thigh muscles etc. – that need to be priori-tized by the corrective program. It is the gluteus maximus, gracilis and hamstring muscles that most often get inactive or loose tones – and therefore, require special strength exercises for correction.

Side view The observer (fitness professional in the case) should find out if the subject is comfortable keeping the arms stretched overhead for the whole arms overhead squats sequence, with a special atten-tion to the feet positioning that should ideally be under the hips or shoulders with the toes pointed for-ward. The arms should be kept straight overhead with a stable spine and no compensatory moves in the body inclination angles and shins. The most common compensatory moves visible in this

projection are the fluctuations in the torso inclination angle and tibia position, arms lowering forward, difficulties in keeping the spine vertical, plus hyperdeflections in the lumbar section. Hyperactivity may be detected also in the soleus and gastrocnemius muscles, i.e. hips/ abs flexors and some others. Inactivity in need of correction may be diagnosed in the tibial, gluteus maximus, spinal extensors, rhomboid and deltoid muscles.

Back view The observer should find out from this viewpoint whether the movement sequence is symmet-rical and the heels are kept tight to the floor. The most common compensatory moves visible in this pro-jection are the weight shifts to the either side or the heels losing contact with the floor. The latter plus sideward shifts of the feet may be indicative of shortenings in peroneal, gastrocnemius, biceps femoris and soleus; plus potential malfunctions/ inactivity of the gluteus medius muscle. In case of the trunk movement asymmetry with the weight shift to either side, the observer may diagnose shortenings/ over-loads in the thigh abductor, piriformis, quadriceps muscle of the thigh, and/or gluteus medius muscle; normally associated with inactivity of the gluteus maximus and thigh abductor muscles.

Having completed and analyzed the test logs, the fitness specialist may design a correction program in-cluding the following components. Every practice should start from a massage cylinder application for relaxing; followed by specific stretching practices for inactive muscles. And the practice will be finalized by multisided joint movements geared to harmonically train the relevant synergistic muscles as a whole.

Our arms overhead squats tests found all muscles being activated by 4-7% more on average – and 10% more for the upper abdominal muscles – than in the traditional squats. It should be emphasized that the arms overhead squats test makes it possible to detect differences in at least two joint positions and six gender-specific differences in the kinetic chain.

Conclusion. Simple functionality tests on the whole and arms overhead squats tests in particular are high-ly beneficial for practical applications since not every physical education specialist has a ready access to expensive modern movement test and analyzer systems. The study data and analysis demonstrates practi-cal benefits of the customizable arms overhead squats test version for the bodily malfunctions detection and correction purposes.

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