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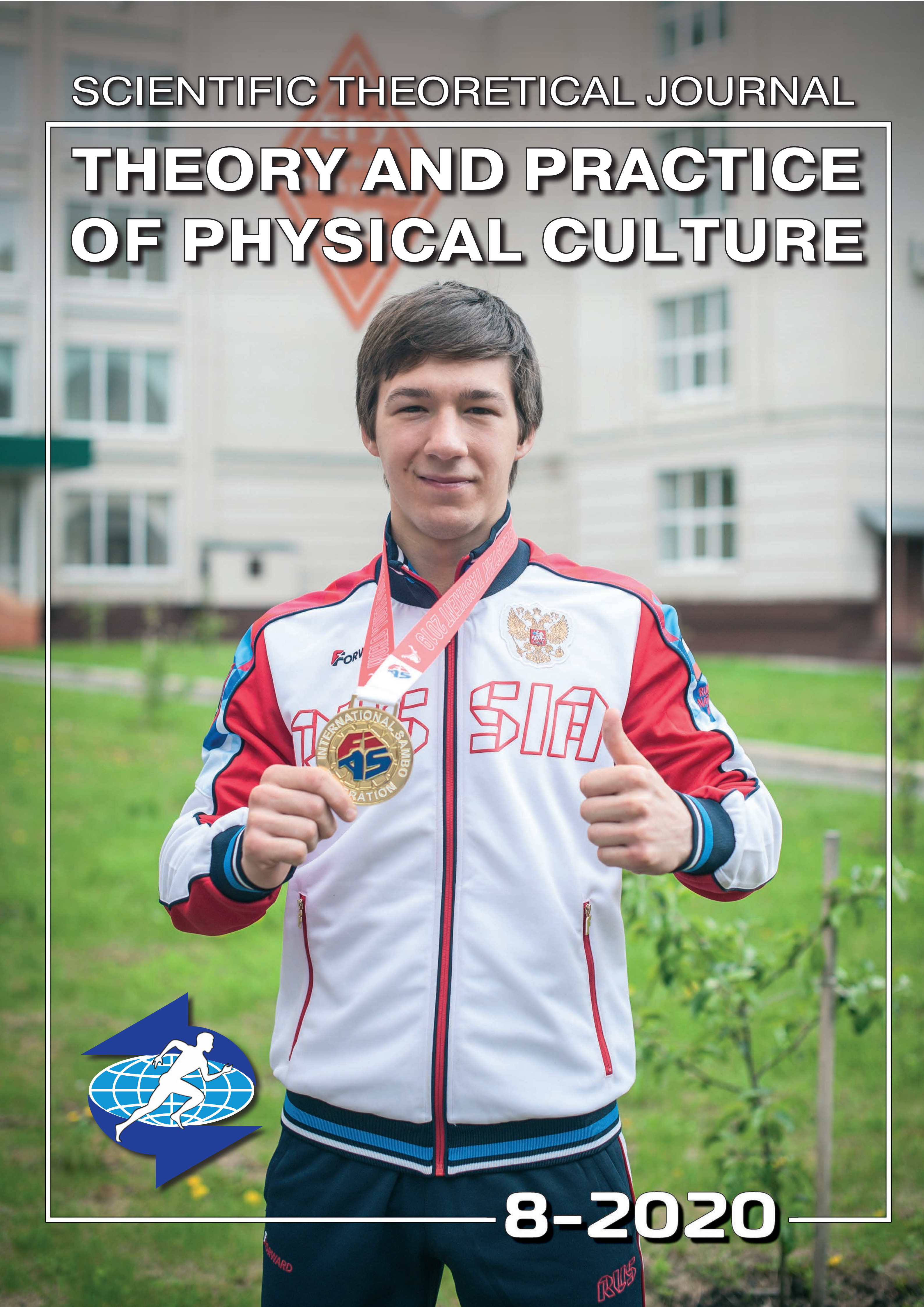

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Theory and Practice of Physical Culture

Contents

V.K. BAL'SEVICH'S ONTOKINESIOLOGICAL APPROACH TO PHYSICAL ACTIVITY OF SENIOR AND ELDERLY PEOPLE

UDC 796.011

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Abstract

Objective of the study was to offer theoretical and practical provisions for and test benefits of a new physical activity model for seniors based on the V.K. Bal'sevich's ontokinesiological theory.

Methods and structure of the study. As provided by the V.K. Bal'sevich theory, physical practices shall be designed on an age-specific basis i.e. the physical activity tools need to be sensitive to the natural variations in the human physicality, psychophysical status, emotionality and adaptability [1, 3]. We run an experiment to test a new V.K. Bal'sevich theory based physical activity model for seniors on a sample of 55-59 years old women (n=24) trained in health groups, with the sample split up into Experimental and Reference Groups (EG, RG) of 12 people each. The RG trainings were dominated by 90-minute fitness aerobics (Pilates and rhythmic gymnastics) twice a week; and the EG trainings were complemented by our new physical activity model with the hereunder described versatile physical practices and training tools.

Results and conclusions. Practical benefits of the training systems for seniors may be largely determined by special theoretical knowledge of the ontogenesis-stage-specific physical fitness basics. The new physical activity model for seniors makes a special emphasis on natural locomotion with an accentuated execution facilitated by favorable psycho-emotional background, motivational, mental and volitional resource mobilizing aspects for physical progress. The progress tests showed great potential benefits of the V.K. Balsevich's scientific heritage based physical education and sports / health systems sensitive to the ontogenesis-specific variations in the human motor resource. Age-specific physical activity models need to be well designed, motivated and encouraged in most efficient forms, as verified, among other things, by our challenging self-isolation experience during the Covid-19 pandemic.

Keywords: *ontokinesiology, integrated knowledge field, physical activity, sports-driven physical education and sports, adaptation to physical trainings.*

Background. Modern challenges we face in the XXI century with the growing dynamism, progress imbalances, new information cultures, environmental disasters, pandemics and social adversities when a special priority is necessarily given to "preserving a human being as a biosocial entity" (as provided by V.S. Stepin with reference to not only the social and professional competencies but also the ability to maintain an optimal lifestyle safe for the natural environment), physical activity will play a growing role as an individual psychophysical and socio-cultural resource building tool.

Today we once again, on the eve of the V.K. Bal'sevich's birthday, appreciate his contribution to the human ontokinesiology theory and practice. In the ontokinesiological terms, physical activity is interpreted as driven by a methodically structured scientific physical-education-and-sports-related knowledge with a special attention to the age-specific kinesiological resource variation logics that make it possible to find new functionality control methods for every progress stage [6]. The fruitful ideas of V.K. Bal'sevich on the individual kinesiological resource control and mobilization by physical activity tools based on the theory of adaptation to training loads and the modern physical activity sportization concept – give the means to increase the active creative, intellectual and physical longevity [1].

With natural age-specific regresses, people are more and more exposed to physical inactivity and gradually give up their running, jumping, weightlifting and other health trainings. As a result, the physical fitness and health tests find regresses in muscle strength, speed, endurance, dexterity and many other physical qualities, with inevitable damages to the healthy lifestyle and health standards. It should be noted that V.K. Bal'sevich emphasizes the individual lifestyle related aspects of physical activity as well as its social implications including the personality physical activity and self-perfection values, motivations and priorities – i.e. ranks healthy physical activity among the key socio-biological phenomena.

Pursuant to the N.A. Bernstein's ideas on the logics of bodily responses to external physical stresses and the relevant research thrusts, V.K. Bal'sevich makes provisions for the theory of adaptation to training loads as a foundation for healthy physical activity with a special attention to adaptive changes in the physiological organs and systems under focused physical efforts viewed as the key training benefits securing mechanism, with the relevant functional and morphological progresses at the cellular level [12].

Objective of the study was to offer theoretical and practical provisions for and test benefits of a new physical activity model for seniors based on the V.K. Bal'sevich's ontokinesiological theory.

Methods and structure of the study. As provided by the V.K. Bal'sevich theory, physical practices shall be designed on an age-specific basis i.e. the physical activity tools need to be sensitive to the natural variations in the human physicality, psychophysical status, emotionality and adaptability [1, 3]. We run an experiment to test a new V.K. Bal'sevich theory based physical activity model for seniors on a sample of 55-59 years old women (n=24) trained in health groups, with the sample split up into Experimental and Reference Groups (EG, RG) of 12 people each. The RG trainings were dominated by 90-minute fitness aerobics (Pilates and rhythmic gymnastics) twice a week; and the EG trainings were complemented by our new physical activity model with the hereunder described versatile physical practices and training tools.

Results and discussion. Practical benefits of the training systems for seniors may be largely determined by special theoretical knowledge of the ontogenesis-stage-specific physical fitness basics. This was the reason for the EG trainings to be complemented by theoretical sessions to help learn the physiological mechanisms of the physical activity and its benefits for the metabolic processes, cardiovascular, respiratory and other systems and intellectual and physical performance with age.

Furthermore, the EG trainings made a special emphasis on the trainees' psycho-emotional health. Emotionality is known to facilitate and control performance by a sort of feedback effects, and this is why the EG trainings included a variety of cooperation and mutual support elements like putting hands on the shoulders to harmonize the joint exercises; or holding hands while making swinging exercises in circles – to improve mood and inspire, support and facilitate the group practices. The EG practices also included games and competitive elements, e.g. the best posture contests in the traditional fitness practices; best squatting routines with ideal static/ dynamic postural controls, etc. [4, 5]. On the whole, the EG trainings may be classified into the following physical activity components:

Component I: morning gymnastics with a special priority to respiration and postural control practices with weights, expanders, benches and other equipment.

Component II: unassisted daily strength-building physical practices including: suspensions on the bar with progress rated by weekly time tests; recumbent straight legs raising practices with the following goals: reach the right angle in a week; sitting right angle keeping by the end of week 1; slow plank-to-prone position with hand resistance to make fall-free progress in strength building by the end of week 2; and at least one prone push-up by the end of week 2 in the plank position, etc.

Component III: standard 90-minute health group practices twice a week, with a special priority to health aspects, with the first four weeks including: mid-pace walking practices for at least 50 minutes; faster walking with the emphasized feet controls; fast walking with the emphasized leg controls; cross-step right/ left-side alternative walking; semi-squatted walking; postural control emphasizing walking practices with varied hand positions and left/ right trunk twists; and the slow relaxed walking practices with breathing exercises.

As required by the V.K. Bal'sevich theory of adaptation to physical trainings, the training loads were stepped up every four weeks with the difficulty levels of the exercises increased as follows: (1) Mid-pace walking practices were followed by a few running strides, and then fast walking followed by the mid-pace walking; (2) Semi-squatted walking was gradually complicated by the deeper-squatting elements with the amplitudes increased on a weekly basis; (3) Chair sitting push-offs with the counts stepped on a weekly basis; (4) Circular movements in the shoulder girdle with bent elbows and fingers touching the shoulder, increased on a weekly basis; etc.

The EG trainings in the next four weeks were complicated by the growing numbers of the running strides and complemented by the legs alternating left-to-right and vice versa jumps, with progress goals set on a weekly basis. Health of the trainees was controlled by the heart rate and blood pressure pre- and post-training tests.

Pre-experimental tests of the sample were as follows: 2000m non-competitive (no time fixed) race; prone push-ups (counts); pull-ups on a 90-cm-high bar (counts); recumbent to sitting (counts); and standing front leans on a gymnastics bench (cm) tests; plus functionality tests.

The pre- versus post-experimental tests showed significantly lower progresses in the RG, with the only exception for the flexibility test; albeit the RG was still tested with progress on the wellbeing test scale. The EG was tested with progresses in the non-competitive 2000m race, walking/ running pace control, prone push-ups and recumbent-to-sitting tests. The EG adaptation to the physical loads for two experimental months was facilitated by the unassisted morning exercises at home plus other practices recommended by the instructor. The EG was tested with the higher physical activity motivations as verified by the lower absenteeism statistics, plus significant progress in the physical fitness and functionality tests.

Conclusion. The new physical activity model for seniors makes a special emphasis on natural locomotion with an accentuated execution facilitated by favorable psycho-emotional background, motivational, mental and volitional resource mobilizing aspects for physical progress. The progress tests showed great potential benefits of the V.K. Balsevich's scientific heritage based physical education and sports / health systems sensitive to the ontogenesis-specific variations in the human motor resource. Age-specific physical activity models need to be well designed, motivated and encouraged in most efficient forms, as verified, among other things, by our challenging self-isolation experience during the Covid-19 pandemic.

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UNIFIED RUSSIAN SPORTS CLASSIFICATION SYSTEM AND FEDERAL SPORTS TRAINING STANDARDS CORRELATION ANALYSIS: CASE STUDY OF CYCLING AND SWIMMING SPORTS

UDC 796.015.865.22

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Abstract

Objective of the study was to run a correlation analysis of the Unified Russian Sports Classification and Federal Sports Training Standards systems in application to the special physical fitness qualifications, with the swimming and cycling sports taken for the case study.

Methods and structure of the study. The study was run under the cyclic sports (swimming and cycling, hereinafter referred to as selected sports) research project at the St. Petersburg Scientific Research Institute of Physical Culture in 2019. We used a theoretical and historiographic analyses and mathematical statistics methods for the purposes of the study. The Unified Russian Sports Classification and Federal Sports Training Standards data array for the study covered the period of 2013-2020, with the data analyzed for correspondence of the regulatory frameworks, contents, requirements, norms and standards in both of the systems.

Results and conclusions. Our comparative analysis of the Federal Sports Training Standards and Unified Russian Sports Classification standards for the special physical fitness required for the top sports mastery stage qualifications in the selected sports disciplines found multiple disagreements and mismatches in these systems of standards. The study demonstrates that the regulatory agencies in charge of both standards systems development process obviously failed to duly coordinate their efforts when establishing a regulatory framework for the sports reserve training system in our country.

Keywords: *swimming, cycling sport, sports reserve training system, physical education and sports, standard, regulatory provision, physical fitness, Unified Russian Sports Classification, Federal Sports Training Standards, sports training programs, top sports mastery stage, sports excellence training.*

Background. The national sports reserve training system, its operations and performance indicators are always in the focus of attention of the federal, regional and municipal governments. Therefore, the Unified Russian Sports Classification system and the Federal Sports Training Standards need to be effectively harmonized to provide a basis for the coaching and other sports services in the national physical education and sports sector to ensure high training standards for and competitiveness of the national sports reserve on the international sports arenas, plus good physical and psycho-physiological health standards for the sporting youth and, hence, the national sports reserve training system on the whole.

Study of recent publications on the Unified Russian Sports Classification updating issues has shown the system being in growing demand and highly serviceable [1, 2], with many authors mentioning the growing role of the regulatory compliance and standards harmonizing aspects in the context of the physical education and sports sector digitalization processes. Some experts point to the mismatches between the Unified Russian Sports Classification requirements and goals of the sports training programs [4], with a special attention to the alleged close correlation between the Federal Sports Training Standards based PSP samples on the one hand and the Unified Russian Sports Classification on the other hand. In reality, however, both of the systems appear heavily disharmonized due to the lack of synch in the relevant regulatory documents drafting, processing, discussing and approval processes. Therefore, it should be mentioned that the efforts to harmonize the Unified Russian Sports Classification and Federal Sports Training Standards systems should be given a top priority for success of the sports reserve training system in the Russian Federation.

Objective of the study was to run a correlation analysis of the Unified Russian Sports Classification and Federal Sports Training Standards systems in application to the special physical fitness qualifications, with the swimming and cycling sports taken for the case study.

Methods and structure of the study. The study was run under the cyclic sports (swimming and cycling, hereinafter referred to as selected sports) research project at the St. Petersburg Scientific Research Institute of Physical Culture in 2019. We used a theoretical and historiographic analyses and mathematical statistics methods for the purposes of the study. The Unified Russian Sports Classification and Federal Sports Training Standards data array for the study covered the period of 2013-2020, with the data analyzed for correspondence of the regulatory frameworks, contents, requirements, norms and standards in both of the systems.

Results and discussion. The Federal Sports Training Standards requirements for admission to sports training groups and the Unified Russian Sports Classification based special physical fitness qualifications for the relevant sports disciplines assume that both of the systems are highly harmonized in the key standards and requirements. Thus the athletes qualifying for the top sports mastery stage under Federal Sports Training Standards in the selected sports need to be qualified Masters of Sports (MS) under Unified Russian Sports Classification or World Class Master of Sports (WCMS); and the athletes qualifying to the sports excellence training groups shall be qualified Candidate Master of Sports (CMS). Therefore, the relevant Federal Sports Training Standards for the special physical fitness shall be harmonized with the Unified Russian Sports Classification both in the sport disciplines and qualification ranks.

Our analysis of the Unified Russian Sports Classification and Federal Sports Training Standards for the special physical fitness qualifications in swimming sport has found that the valid "General and special physical fitness standards for qualifications for training stages" offer no one special physical fitness standard in fact. Thus, the Unified Russian Sports Classification and Federal Sports Training Standards in application to swimming sport were found to match only in the CMS entitled to qualify for the sports excellence training service and MS for the top sports mastery stage service. This is the only issue where the Unified Russian Sports Classification and Federal Sports Training Standards were found to be relatively harmonized.

At the same time, as provided by the federal statistical report Form 5-FC, in 2019 the national swimming sport community was estimated at 221,194 people [5], including 93,723 qualified and titled athletes that account for 42.37% of the total; with more than 57% having no formal qualifications or titles. It should be mentioned that 110,417 people are reported being

Table 1. Comparative analyses of the special physical fitness standards applied in the men's track cycling sport for the MS qualification for the top mastery training service: Unified Russian Sports Classification (URSC) versus Federal Sports Training Standards (FSTS)

№	Standards systems	Federal Sports Training Standards standard or Unified Russian Sports Classification sport discipline	Standard
1	FSTS	200m track race from stand	under 11.6 s
	URSC	No entry	–
2	FSTS	500m track race from stand	under 35.0 s
	URSC	500m git from stand	33.30
3	FSTS	1000m track pursuit from stand	under 61 s
	URSC	1000m git from stand	1:03,0
4	FSTS	Individual 4km race	under 3 min 45 s
	URSC	4km pursuit race	4:31,0
5	FSTS	4 km team pursuit race	under 4 min 20 s
	URSC	4 km team pursuit race	4:12,0

trained in the swimming sports training groups – that is 16,694 more than the qualified and titled group. If we assume that all the qualified and titled athletes are trained under swimming sports programs, then the remaining 110,777 people (221,194 minus 110,417) are beyond the swimming sports programs, nobody of them is formally qualified Class I-III athlete and compete in the formal events. Such a ratio in the formally reported statistics cannot but be questionable, since the junior swimming population trained under the swimming sports programs appears overqualified under the Federal Sports Training Standards system.

Our analysis of the Federal Sports Training Standards requirements for the cycling sport versus the relevant Unified Russian Sports Classification qualification and titling standards and requirements showed the classification systems being in conflict both in the titles of sports disciplines and the standards as such. To illustrate this point, we give in the Table hereunder a comparative analysis of the Federal Sports Training Standards based special physical fitness standards for qualifications for the top sports mastery stage service in the men's track cycling sport versus the relevant Unified Russian Sports Classification standards [3].

A comparative analysis of the above data shows that no one Federal Sports Training Standards standard for CPF matches with the Unified Russian Sports Classification standards for the same disciplines. Moreover, the standards are named differently (with only one exception) in both of the systems. We would mention the following typical case of the regulatory inconsistencies: the Federal Sports Training Standards sets for the 'individual 4km race' the norm "under 3 min 45 s" for top sports mastery stage qualifications (whilst the world record in this discipline is 4:10.534 as of 2013) – that is much slower than 25.5 s standard for top sports mastery stage qualifications. As a result, this Federal Sports Training Standards standard for MS or WCMS is obviously unrealistic.

A detailed analysis of the Federal Sports Training Standards for track cycling shows that none of the nine CPF standards matches with the top sports mastery stage qualification standards. It should mentioned that the Federal Sports Training Standards sets no selection criteria for the general and special physical fitness standards for qualifications to both of the training groups. This means that a prospect needs to meet every Federal Sports Training Standards standard, while the enrollment decisions might be governed by some summarized test benchmark set by the corporate regulations/ orders of the sports organizations.

Our analysis of the 2013 top sports mastery stage qualification requirements for the athlete's special physical fitness under the Federal Sports Training Standards for the highway cycling and mountain bike cycling disciplines also found major disagreements in the special physical fitness standards for the top sports mastery stage qualifications both for men and women. The Federal Sports Training Standards for BMX cycling discipline gives no special standards for the special physical fitness.

Conclusion. Our comparative analysis of the Federal Sports Training Standards and Unified Russian Sports Classification standards for the special physical fitness required for the top sports mastery stage qualifications in the selected sports disciplines found multiple disagreements and mismatches in these systems of standards. The study demonstrates that the regulatory agencies in charge of both standards systems development process obviously failed to duly coordinate their efforts when establishing a regulatory framework for the sports reserve training system in our country.

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TECHNICAL REGULATORY SYSTEM FOR SPORTS INFRASTRUCTURE LIFECYCLE: REVISION AND PROGRESS ANALYSIS

UDC 796.56

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Abstract

Objective of the study was to analyze and streamline the existing technical regulatory system in application to the physical education and sports infrastructure and physical education and sports material and technical assets development and operation business and offer recommendations for the technical regulatory system reform.

Methods and structure of the study. The following methods were applied during the study: analysis and systematization of technical regulatory documents in the field of engineering, construction, and operation of swimming pools; comparison; generalization of documents; analysis of practice in the application of normative documents on engineering and construction, as well as generalization and analysis of the domestic practice of operation of swimming pools.

Results and conclusions. The technical regulatory system reforming and complementing initiatives should result in a comprehensive system of regulatory provisions and standards for the physical education and sport sector to cover every stage in the sports infrastructure lifecycle with detailed classification of the regulated/ standardized objects, operations and services.

Keywords: *regulatory provisions, norms, regulations, technical regulatory system, rules, national standards, sports infrastructure, physical education and sports, material and technical assets, sports facility.*

Background. A key mission of a technical regulatory system is to provide a sound basis for legal business practices by setting and ensuring compliance of obligatory requirements/ standards for the relevant products/ processes/ operations/ services. The national technical regulatory system applied to the sports infrastructure development and operation projects for the last 20 years has been designed to balance the lawful interests of the developers and clients on the national and foreign markets [1]. The Federal Law "On technical regulation" put into effect in 2003 gave a green light to the sports infrastructure standardization and certification system reform – albeit the standardization management system building phase is still in progress at this juncture. This study was intended to optimize the existing technical regulatory system with its normative documentation for the physical education and sport sector, with a special priority to the physical education and sports material and technical assets. The physical education and sports infrastructure (buildings and installations) development business has long reported a need for the technical regulatory system reform for progress.

Objective of the study was to analyze and streamline the existing technical regulatory system in application to the physical education and sports infrastructure and physical education and sports material and technical assets development and operation business and offer recommendations for the technical regulatory system reform.

Results and discussion. The valid technical regulatory for the physical education and sports infrastructure design, development and operation projects are designed on an inclusive modular basis (see Figure 1), with each regulatory module controlling the relevant limited regulatory field.

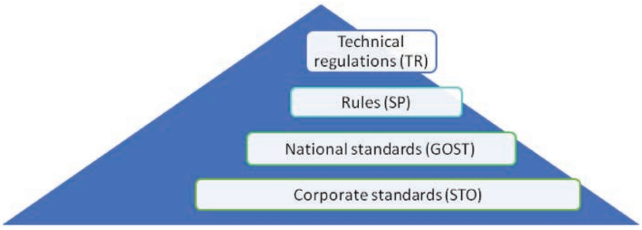

Figure 1. *Existing technical regulatory system for the physical education and sports infrastructure development business*

Mandatory technical standards, as provided by the valid Law "On technical regulations", shall be set only in compliance with the Technical Regulations. Thus, the Technical Regulations: Safety of Buildings and Installations (FL 384 dated 31.12.2009) cover every stage of every building/ installation lifecycle to regulate, among other things, engineering/ technical service networks/ infrastructure and the relevant design projects (including survey works) plus the construction, installation, erection, operation and disposal (demolition) operations thereof [2]. The relevant sets of rules are applicable to the sports infrastructure design and operations; whilst the national standards (GOST and GOSTR) regulate the safety of equipment, systems and services.

The regulatory system is composed of interrelated provisions with their scopes of reference in the sport asset lifecycle – e.g. a capital construction object (sports facility design rules); operation unit (sports facility operation rules); service location (national service standards); processes and procedures classified by the sports facility operations regulated by the relevant internal regulations by the corporate manager/ operator (corporate standards, codes, regulations, norms, procedures, etc.). Note that every stage in the sports facility lifecycle (see Figure 2) is regulated, in addition to the frame Technical Regulations, by the relevant specific procedures/ rules/ regulations.

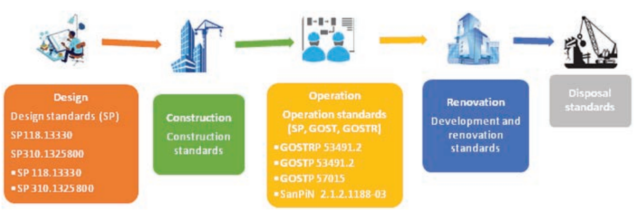

Figure 1. *Sport facility lifecycle elements with the relevant regulatory sets*

The recent initiatives to revise the existing national technical regulatory system and standards for the sports infrastructure design, development and operation may be illustrated by the new Swimming Pools Design Rules put in effect on June 27, 2018 upon approval by the Ministry of Construction, Housing and Utilities Order No. 1716/pr dated December 26, 2017 (SP 310.1325800.2017 Swimming Pools Design Rules). These Rules comprise a "basic document" applicable to the newly constructed/ reconstructed indoor/ outdoor swimming pools with the relevant buildings, installations and services of any ownership, with classification of the swimming pools by the service/ functionality classes. Moreover, the Rules offer a list of recommended design solutions for the pool structures including the reinforced concrete; welded steel; and prefabricated steel structures with the cladding options.

The inclusive regulatory framework (with the swimming pools taken as a case in point) shall be built up on a systemic basis to cover in detail every stage in the swimming pool lifecycle beyond the SP 310.1325800 (swimming pool design rules) scope of reference. Such a regulatory framework should include the swimming pool operation rules/ standards plus the regulations/ national standards applicable to the relevant technologies, equipment and engineering service systems to ensure every operation in the lifecycle.

Conclusion. The technical regulatory system reforming and complementing initiatives should result in a comprehensive system of regulatory provisions and standards for the physical education and sport sector to cover every stage in the sports infrastructure lifecycle with detailed classification of the regulated/ standardized objects, operations and services.

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NOTION OF "COMPETITIVE MOBILIZATION EFFICIENCY" IN ENDURANCE-INTENSIVE SPORTS: VERSIONS OF DEFINITIONS AND MEANINGS

UDC 796.011

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Abstract

It is not unusual to find in the sports research literature evidence of exceptional functional qualities demonstrated by some outstanding athletes – for example, top maximal oxygen consumption rates in the endurance-intensive cyclic sports. However, it should be emphasized with confidence that such cases are exceptional rather than normal since there are numerous reported cases when ranked on top are the athletes with not necessarily highest functionalities and fitness rates.

Objective of the study was to analyze definitions and meanings for the notion of ‘competitive mobilization efficiency’ indicative of the individual ability to win in the situations when the competitors’ motor potentials are the same.

Results and conclusions. The article discusses the content of the concept of "realizable efficiency" in endurance sports. It is believed that, in addition to the high level of motor potential, sports result is associated with the formation of a biomechanically efficient structure of an exercise. The latter refers to the movement construction system enabling to most closely demonstrate the morphofunctional properties of the athletes' neuromuscular system and the vegetative systems that maintain its functionality. It is noted that multi-year trainings help top-class athletes quickly reach the limit of adaptation of the main functional systems, while increasing the movement speed. This is due to the increased mechanical power of the muscles in the key movement phases. It is assumed that an increase in the output power in terms of stabilization of the functional performance rates can be associated with an increase of the specificity of manifestations of the neuromuscular system qualities under the biomechanical conditions of the muscle work during a competitive exercise, but within the individual movement system, which, in turn, depends on the innate or acquired features of the body’s morphological structures.

The notions of competitive mobilization efficiency and sports-specific technical skills need to be interpreted in the context of the efficient movement biomechanics formation process – that means a motor skill design that facilitates the individual morphology and functionality resource of the athlete's neuromuscular apparatus and the relevant autonomic systems being mobilized in full for success of the competitive performance biomechanics.

Keywords: *elite athletes, motor functionality system, energy efficiency, motor potential, competitive mobilization efficiency.*

Background. It is not unusual to find in the sports research literature evidence of exceptional functional qualities demonstrated by some outstanding athletes – for example, top maximal oxygen consumption rates in the endurance-intensive cyclic sports [1]. However, it should be emphasized with confidence that such cases are exceptional rather than normal since there are numerous reported cases when ranked on top are the athletes with not necessarily highest functionalities and fitness rates. These facts cannot but raise a few questions of special importance for the training and competitive practices, like: how should we define the individual ability that makes it possible for the athletes to win even when their motor potential is not different from the rivals’? What this ability depends on? What basic paradigm should be chosen for the train-

Table 1. Multiannual average MOC and AnT (anaerobic threshold) rates, knee flexion angles (KF) and push-off time of two elite biathletes

Push-off types	Aerobic functionality		Push-off	
	MOC, ml/ kg/ min	AnT, ml/ kg/ min	KF, degrees	Time, s
Power	82	73	117	0,38
Speed	72	61	125	0,22

ing system design and management to effectively excel this ability, particularly in the situations when the functionality building reserves are virtually exhausted?

Objective of the study was to analyze definitions and meanings for the notion of 'competitive mobilization efficiency' indicative of the individual ability to win in the situations when the competitors' motor potentials are the same.

Results and discussion. The relevant issues have been actively discussed since the 1970ies. We believe that it was Yu.V. Verkhoshansky [2] who crowned the discussions by accurately defining a competitive success as "the product of such movement culture and motor skills that makes it possible to mobilize and employ the individual power and motor potential with the top efficiency for specific motor mission". This definition fairly mentions every element of a competitive success including the motor potential and movement culture and motor skills i.e. the sport-specific routine or movement sequence with its biomechanics; and, the last but not least, the motor potential mobilizing and employing capacity for success of the trained motor skills. D.D. Donskoy and V.M. Zatsiorsky [3] proposed in this context a notion of 'competitive (motor skills) mobilization efficiency'; and Y.V. Verkhoshansky [2] complemented it by the notion of the 'sport-specific technical mastery' that appears the most accurate. Later on, however, these notions have been often misinterpreted in such a way as if they refer to a specific version of optimal technical execution/ skills which an athlete is expected to master in trainings to automatically acquire the ability to mobilize the motor potential in the most effective manner at the same time. This misinterpretation implies that, having mastered such an optimal technique, the athlete may rest assured that his competitive progress is guaranteed mostly by the motor potential that only needs to be built up year to year. In case when the execution technique differs from the ideal 'sample' the training system should be designed to improve the individual competitive mobilization potential at the same time.

This conception has proved not always correct in fact. It is true that, as provided by the-then training concepts supported by many prominent scientists (D.D. Donskoy, Yu.V. Verkhoshansky, V.M. Dyachkov, V.V. Kuznetsov, I.P. Ratov), trainings should secure progress in the technical athletic mastery interpreted as the biomechanically perfect motor skills. The biomechanical perfection rating criteria, however, implied the best movement design system that facilitates the individual morphological and functional qualities of the neuromuscular apparatus (NMA) and the servicing autonomic systems being effectively mobilized – rather than the "external picture" of the motor skill as such. For example, the world leading biathletes are known to significantly differ in the ski push-off techniques (see Table 1 hereunder) in many aspects dominated by the knee flexion angles and ground contact time – that are shorter for one type and longer for the other. Coaches well know both push-off types and commonly call them "speed" and "power" types, respectively.

The above data may be interpreted in such a way that the athletes attain the motor goals in different ways due to their natural differences in the aerobic functionality. Does this mean, however, that the athletes have different competitive mobilization efficiency? Formally, if the competitive mobilization efficiency is calculated by dividing the competitive success rate on the summarized "motor qualities" test rates, then yes. However, the fact that the athletes are equally ranked having the 15-year track records being trained by the best national coaches – makes the conclusion questionable. We believe that it makes much more sense to assume that the athletes' bodies "learn" the optimal muscle work biomechanics (muscle work magnitudes and time control) to employ the inborn and trained qualities and skills in the most efficient manner.

Therefore, the competitive mobilization efficiency may be rated by the degree of correspondence of the athlete's movement system to the individual morphological and functional structures. In other words, the movement system should be biomechanically efficient in the context outlined above by the national sports science leaders. This idea is visualized on the Figure 1 hereunder. For example, some sags in laboratory performance tests with age may be interpreted as one of manifestations of the growing bodily adaptation to competitive stressors, with the competitive motor skills (motor functionality system, motor functionality system [1, 4, 5]) formed by the body "getting rid" of motor inefficiencies.

It should be also mentioned that a competitive progress may be secured by the following processes: (a) Adaptation (growing specification) of the motor functionality system to the competitive muscle performance biomechanics; (b) Gradual adaptation of the whole individual movement control system with a special input from the most conservative (limiting) morphological structures that cannot be fully specialized for the required motor functionality system due to genetic limitations or drawbacks of the training method applied; and (c) CNS adaptation with the growing stability of the nervous centers and their stronger connections with the motor-functionality-system-specific bodily structures. These processes are well studied and profiled by the technical performance energy-efficiency, mechanical quality and stability test rates and their variations – e.g. under fatigue.

Of special interest for the practical training systems is the question of how the competitive mobilization efficiency may be improved, and whether or not it is fully predetermined by the individual motor functionality system formation logics. In other words, can the competitive mobilization efficiency be trained by growing training workloads and distances run with the competitive/ maximal speeds, or there are some other competitive mobilization efficiency building methods?

It is beyond doubt that an individual racing speed may still grow even when the functionality comes to a plateau – due to mostly the growing focused mechanical muscle strength applied in the key movement phases/ points. How then the focused muscle strength can be increased when the traditional aerobic, cardio-respiratory, strength, explosive strength, alactate energy demand and other functionality/ fitness test rates stay the same? Based on the Y.V. Verkhoshanskiy findings and analyses of the modern national and foreign research data, we would assume that this factor may be defined as the ‘specific adaptation of the neuromuscular apparatus to the competitive movement patterns’. Thus the relevant neuro-physiological studies and comparative analyses have demonstrated [6, 7] that such adaptation, normally facilitated by special strength-building exercises, results in the focused muscular performance and/ or competitive performance improvements in the endurance-intensive sports on an energy-efficient basis – without special efforts to improve the traditional aerobic performance test rates.

Conclusion. The notions of competitive mobilization efficiency and sports-specific technical skills need to be interpreted in the context of the efficient movement biomechanics formation process – that means a motor skill design that facilitates the individual morphology and functionality resource of the athlete's neuromuscular apparatus and the relevant autonomic systems being mobilized in full for success of the competitive performance biomechanics.

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PHYSICAL QUALITIES VERSUS COMPETITIVE PERFORMANCE IN ELITE WOMEN TENNIS: CORRELATION ANALYSIS

UDC 796.342

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Abstract

Objective of the study was to analyze the physical qualities / functionality versus competitive performance test rates and their correlations for the women's tennis elite.

Methods and structure of the study. We sampled for the study a few elite women tennis players and tested their functionality and physical qualities by a staged progress test program. Thus the aerobic capacities of the sample were tested by a load-stepping treadmill test till failure, with the load stepped every 2 minutes. The anaerobic alactate capacities were tested by a 6-second top-intensity cycle ergometer test. And the physical fitness of the sample was tested by a standard set of 12 tests traditional for the national tennis sport.

Results and conclusions. The study found the physical fitness / functionality test rates statistically significantly correlated with the competitive performance rates, with percentage contributions of the individual physical qualities/ functionality rates to the competitive performance – and thereby recommend the priority physical training elements for women's tennis elite. The study also found deficiencies and inefficiencies in the training systems in the competitive progress securing domain, to offer recommendations on how the women's tennis elite training systems should be revised.

Keywords: *women's tennis, correlation analysis, physical fitness, functionality tests, competitive performance, sport excellence stage, top mastery stage, physical qualities.*

Background. Externally estimated individual performance and training workload rates in the women's and men's tennis are largely different in many aspects including the match times, each point play times, motor intensity rates etc. In our prior study [5] we found correlations of the key physical qualities test rates with the individual competitive performance rates. Due to the significant gender differences in the externally metered workload rates, it may be incorrect to expect the physical qualities versus competitive performance correlations found for the men's tennis being the same for the women's tennis.

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Results and discussion. We found the competitive performance rates being highly statistically correlated with the functionality rates (maximal oxygen consumption, oxygen pulse and vital capacity), aerobic capacity (AeT), alactate anaerobic capacity (AnT,

Table 1. Mean competitive performance-specific physical fitness / functionality test rates

№	Test rates	x̄	±σ
1	Maximal oxygen consumption, MOC, l/ min	3,14	0,36
2	Oxygen pulse, OP, ml/ beat	16,8	2,13
3	Vital capacity, VC, l/ min	101,0	15,62
4	Oxygen consumption on aerobic threshold OC AeT, l/ min	1,54	0,23
5	Oxygen consumption on anaerobic threshold OC AnT, l/ min	2,5	0,34
6	Response rate, s	0,5	0,12
7	Single move speed, s	0,27	0,04
8	Acceleration rate, s	1,06	0,12
9	Top power reach time, rt, s	3,36	0,72
10	Standing high jump, cm	30,3	5,71

rt), three speed test rates (response time, single move speed and acceleration rate) and the speed-strength test rate (standing jump test): see Table 1 hereunder.

Competitive performance of the modern tennis elite is highly demanding to every physical quality, with a special priority to those in statistically significant correlations with the competitive performance. Since every physical quality was rated by a few tests under the study, we rated the percentage contributions of every physical quality in the competitive performance by the relevant correlation factors – i.e. the higher is the statistical correlation of the physical qualities and competitive performance, the higher is the physical qualities percentage: see Figure 1 hereunder. The above Table demonstrates that the key role for competitive progress in women's elite tennis is played (without diminishing the importance of the other qualities) by aerobic capacity as a basis for overall endurance; with speed and speed-strength qualities ranked 2nd and 3rd, respectively, followed by anaerobic capacity, movement coordination and flexibility rates.

The R. Schonborn study [1] of 1987 (republished by ITF in 2007) gives a special priority to coordination qualities and ranks the physical qualities by their contributions to the competitive performance as follows: coordination 90%; acceleration 80%; response rate 70%; aerobic endurance 55%; anaerobic endurance 50% and speed 50%. Note that aerobic endurance is ranked only fourth on the physical qualities list.

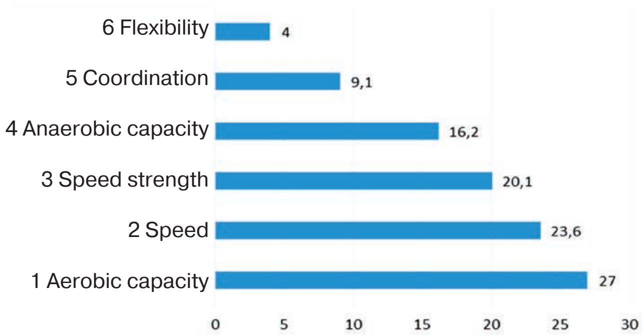

Figure 1. Percentage contributions of the physical qualities / functionality test rates to competitive performance rates by the correlation factors

Our study data on the subject may be particularly important in view of these issues being still disputable – as demonstrated, among other things, by the questionnaire survey of the Russian and Chinese tennis coaches (n=134) [1] that ranked the competitive-performance-specific physical qualities as follows: speed 53%; flexibility 21%; strength 12%; endurance 7%; and 7% of the respondents put on top quick-wittedness – that has nothing to do with physical fitness in fact. The survey data reported by Yu Gui [1] showed the majority of the tennis coaches giving special attention to speed qualities in the training systems.

It is beyond doubt that success in modern tennis largely depends on the speed qualities. Fast responses are needed to effectively trace and control the ball direction, speed and landing point to start the striking sequence. The single move speed is critical is some game situations; and the acceleration rate is necessary in the others – the far ball chasing ones, for instance. The movement frequency controls are mobilized to reach the best point for a strike. Every of the above physical qualities may be claimed to win a point, with their contributions to competitive performance being the highest. The tennis games, however, are won ideally by 4 successive points, with every match including at least 12 games. As reported by the relevant statistical reports [3], an average tennis match includes more than 120 points. This means that the speed qualities are claimed for 2-3 match hours and, hence, need to be reinforced by high endurance.

Depending on every point play time, the competitive performance is secured by anaerobic energy sources with ATP re-synthesis on the run and aerobic mechanism of the ATP re-synthesis in the rest breaks. To have the ATP reserves being effectively restored in short and strictly limited breaks in points and games, tennis players need to develop highest aerobic capacities. This may be the reason why 6 out of 10 test rates significantly correlated with the competitive performance are directly linked to aerobic capacity and efficiency: see the above Table. Therefore, we would disagree with findings of the above coaches' survey and recommend a special priority in the training systems being given to the aerobic capacity and efficiency improvement elements. By the average age of the tennis elite, speed qualities should reach their peaks and the training systems need to mostly maintain the speed qualities – since the sensitive periods for their improvements progress are far back.

We would agree with R. Schonborn in the belief that an active competitive performance is secured by three energy sources, with the alactate anaerobic source accounting for 70%, lactate anaerobic for 20% and aerobic for 10% [6]. It should be noted that an active play takes less than 20% of a total match time, and 80% of the activity is secured by aerobic sources. As has been found by our studies, anaerobic energy sources account for 16.2% of the physical qualities critical for the competitive performance. R. Schonborn reported the lactate energy sources accounting for 22.2% of the total anaerobic energy sources. This finding actually agrees with the externally metered match workloads including 16.8% of net time on the slow courts and 13.8% on the fast courts, with the energy supply contributed by glycolysis [4].

Every modern training system gives a special priority to the competitive-performance-critical physical qualities and progress tests to profile the physical fitness growth versus the training tools and methods applied [2]. Our studies found the share of glycolysis in anaerobic energy sources being under 1% - that is indicative of the training systems being inefficient for the competitive progress needs, and needs to be revised. We recommend 1-2 training session in every training micro-cycle being focused on the lactate anaerobic endurance improvement elements, methods and tools from the modern general and special physical fitness toolkits.

Conclusion. The study found the physical fitness / functionality test rates statistically significantly correlated with the competitive performance rates, with percentage contributions of the individual physical qualities/ functionality rates to the competitive performance – and thereby recommend the priority physical training elements for women's tennis elite. The study also found deficiencies and inefficiencies in the training systems in the competitive progress securing domain, to offer recommendations on how the women's tennis elite training systems should be revised.

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SKATE SKIING STRIDE ENERGY EFFICIENCY: BENEFITS OF PROGRAMMED DYNAMIC ELECTRICAL MYOSTIMULATION

UDC 796.922

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Abstract

Objective of the study was to rate and analyze the skate skiing stride (quadriceps femoris push-off phase) energy efficiency with/ without programmed dynamic electrical myostimulation.

Methods and structure of the study. We sampled for an experiment 20.3±0.5 year-old 69.4±1.6 kg heavy and 179.6±2.6 cm tall skilled ski racers (n=6) tested with sub-maximal oxygen consumption = 69.4±3.2 ml/ kg/ min rated by Cosmos Venus treadmill. The training workload protocol was complemented by a synchronized gas exchange test data generated by Cortex MetaLyzer II-R2 gas analyzer and processed by Metasoft 3 software. The athletes, upon a prior warm-up, were tested with/ without programmed dynamic electrical myostimulation while running the treadmill on ski rollers at 3 m/s with the run angles varying from 4% to 10%; and with the heart rate read by Polar H10 M-XXL pulsometer system.

Results of the study and conclusions. It was found that the economical efficiency, estimated by oxygen consumption per meter of track with programmed dynamic electrical myostimulation, was 6.3-4.7% higher than during the usual movement. Distance pulse with programmed dynamic electrical myostimulation (meters covered per a tick of the blood) was 2.2-5.2% higher. It is discussed that the increase in RE was due to the redistribution of the muscle electrical activity and the improvement of the biomechanics of the skating stroke.

The study data and analyses showed that the programmed dynamic electrical myostimulation method may be highly beneficial for the instant energy efficiency improvement purposes in the modern skate skiing sport, with the energy efficiency and distance heart rate recommended as highly informative tests rates applicable in the endurance, technical progress and muscle control/ relaxation tests.

Keywords: *energy efficiency, programmed dynamic electrical myostimulation, smart shorts, cross-country skiing, oxygen consumption, distance heart rate, key movement phase*

Background. Electrical myostimulation may be defined as the method of muscle activation by electrical impulses. Programmed dynamic electrical myostimulation may be described as its version applicable on the move in a training process. In case of the cross-country skiing sport, the programmed dynamic electrical myostimulation (PEMS) method uses a programmed microprocessor fixed in smart shorts to energize the core muscle group in the key movement phase to improve the movement energy control [1], particularly in cycling, skating and cross-country skiing sports, with the core muscles stimulated in the push-off phase [5]. Energy efficiency may be interpreted as the ability to control the energy demand of the core muscle groups so as to minimize the energy costs. In cyclic sports, energy efficiency may be rated by sub-maximal oxygen consumption or distance heart rate i.e. the distance covered for one heart beat, with distance heart rate = (V, m/ s x 60): heart rate, m/ beats).

Table 1. Oxygen consumption and heart rate data yielded by skate skiing stride (quadriceps femoris push-off phase) energy efficiency rating PEMS/ PEMS-free tests, M±σ

№	PEMS-free test				PEMS test		
	Angle, %	Oxygen consumption, ml/ kg/ min	RE ml/ kg/ min	Heart rate, beats/ min	Oxygen consumption, ml/ kg/ min	RE ml/ kg/ min	Heart rate, beats/ min
1	4	27,52	0,152	128,9	25,32*	0,143*	125,2*
		±1,79	±0,008	±2,61	±1,66	±0,008	±1,86
2	6	31,29	0,174	141,2	28,53*	0,164*	139,8*
		±1,71	±0,007	±2,63	±1,50	±0,006	±1,69
3	8	35,65	0,198	154,6	31,56*	0,185*	150,3*
		±1,81	±0,006	±3,41	±1,67	±0,006	±3,24
4	10	38,83	0,216	167,2	34,34*	0,206*	164,9*
		±1,92	±0,007	±3,41	±1,71	±0,008	±3,24

Note: *p≤0.05

Objective of the study was to rate and analyze the skate skiing stride (quadriceps femoris push-off phase) energy efficiency with/ without PEMS.

Methods and structure of the study. We sampled for an experiment 20.3±0.5 year-old 69.4±1.6 kg heavy and 179.6±2.6 cm tall skilled ski racers (n=6) tested with sub-maximal oxygen consumption = 69.4±3.2 ml/ kg/ min rated by Cosmos Venus treadmill. The training workload protocol was complemented by a synchronized gas exchange test data generated by Cortex MetaLyzer II-R2 gas analyzer and processed by Metasoft 3 software [10]. The athletes, upon a prior warm-up, were tested with/ without PEMS while running the treadmill on ski rollers at 3 m/s with the run angles varying from 4% to 10%; and with the heart rate read by Polar H10 M-XXL pulsometer system. The PEMS equipment included the smart shorts with a portable electrical myostimulation stimulator wired by silicone electrodes to the electrical myostimulation control unit (100Hz frequency, 80V amplitude, 150ms impulse), with the electrical myostimulation impulses synchronized with the key movement phase as provided by Patent of the Russian Federation No. 2546421 [6] and described in [5]. Significance of the differences in the data arrays were rated by the Student's t-test for paired data.

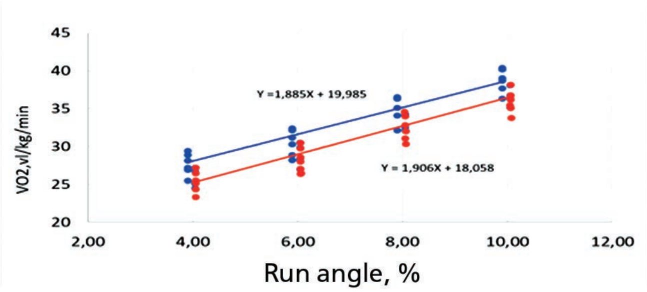

Figure 1. PEMS/ PEMS-free tests (red and blue, respectively): oxygen consumption at the run speed of 3 m/s oxygen consumption, ml/ kg/ min

Results and discussion. The test data and given in Table 1 hereunder.

The PEMS tests found the oxygen consumption and heart rate being significantly lower (regardless of the angle) versus the PEMS-free tests.

The PEMS tests showed in every of the 4 load steps the oxygen consumption being lower than in the PEMS-free tests, with the oxygen consumption difference of 2.20±0.15 to 4.49 ± 0.17 ml/ kg/ min (p≤0.05), i.e. 4.4-6.7%; and heart rate difference of 3.7±0.8 to 2.3±0.6 beats/ min (p≤0.05), i.e. 2.9-1.3%. It should be noted that every tested athlete rated positively the PEMS running mode. In PEMS-free test, RE averaged 0.152±0.008 to 0.216±0.007 ml/ kg/ m or 3.18-4.51 J/ kg/ m. In PEMS tests, the oxygen consumption per meter was 6.3-4.7% lower (p≤0.05). The distance heart rate in the PEMS tests averaged 1.44-1.09 m/ beat that was 5.2-2.2% higher than in the PEMS-free tests.

Generally the energy efficiency improvement strategies give a special priority to the high-intensity long trainings at the lactate threshold, motor skills improvement and other aspects [7]. In the PEMS-assisted case, the energy efficiency improvement is likely to be achieved by redistribution of the muscle electrical activity and improved skate skiing stride technique biomechanics. As we have demonstrated in our prior studies, PEMS redistributes the energy flows to increase them in the thigh muscles in the push-off phase in speed skating and cross-country skiing sports – and reduce in the electrical activity in the secondary muscle groups [3, 4]. Therefore, the total electrical activity of the muscles in the key movement phase tends to fall to reduce the oxygen consumption, increase the knee joint extension speed, cut down the push-off phase time and, hence, the mechanical work on the whole [2] – to scale down the energy cost per meter as a result. It should be also noted that the energy cost per meter was lower for the roller ski run on the Di Prampero treadmill versus the run exercise (RE = 3.72±0.238 J/ kg/ m) [8] and higher for the steeper ascends.

Conclusion. The study data and analyses showed that the programmed dynamic electrical myostimulation method may be highly beneficial for the instant energy efficiency improvement purposes in the modern skate skiing sport, with the energy efficiency and distance heart rate recommended as highly informative tests rates applicable in the endurance, technical progress and muscle control/ relaxation tests.

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ARMWRESTLING SKILLS RANKING MODEL STRENGTH TEST RATES FOR KEY MUSCLE GROUPS

UDC 796.012.11

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Abstract

Objective of the study was to find armwrestling-skills-ranking model strength test rates, with the 80kg weight class taken for the case study.

Methods and structure of the study. The study involved 29 armwrestlers (aged 20-41 years), who were divided into three groups depending on their level of expertise. Group I (n=5) was made of the winners and medalists of the World and European Championships, having the title World Class Master of Sport of Russia. Group II (n=12) included the winners and medalists of the All-Russian competitions, Moscow Championships and Moscow University Championships. Group III was made of the athletes with up to one year's experience (n=12). The athletes' maximum effort was registered in nine major anatomic movements of the topography of muscle strength using the tensodynamometry method. The indicators were recorded at the relevant point for making an effort with automatic estimation of the maximum strength.

Results and conclusions. The top-skilled group was tested with significantly higher strength test rates than the moderately-and low-skilled ones in 8 tests out of 9. The strength topography was found dependant not only on the skill rank but also on the technical specialization and genetic giftedness. The key armwrestling skills ranking model strength test rates were ranked as follows in descending order: (1) Hand and grip strength; (2) Shoulder pronator strength; (3) Sport-specific muscle group (forearm supinator and pronator) strengths; hand abductor strength; and (4) supine and neutral-point forearm flexor strength. It should be emphasized that the shoulder extensor strength was found less important for the armwrestling skills ranking purposes. The hand and shoulder pronators are recommended to be given a special priority as the key muscle groups for success in armwrestling, whilst the hand flexor strength was found the main limiting factor for the strength trainings and competitive progress in modern armwrestling.

Keywords: *armwrestling, model strength test rates, strength topography, arm muscle strength, muscle group, hand flexors, forearm flexors.*

Background. Modern armwrestling may be defined as the power combat sport that gives a special priority to the sport-specific strength topography, since the competitive success in this sport depends on the muscle group strength rates critical for the bio-kinematic chains claimed by specific armwrestling techniques [1, 2]. Armwrestlers' competitive fitness largely depends on the arm muscle group strength rates with a special priority to the forearm and hand muscle groups [3]. It has been found that the muscle group strength test rates shall be in certain correlation with anthropometrics [4-6] i.e. the muscle groups sizes, body builds, provisional moments of strength in the limb segments – with such correlations widely used as the key competitive success predictors in modern armwrestling [7]. The muscle group strength topography for the key sport-specific anatomical movements is ranked among the main tools for the skills ranking model strength rates profiling purposes.

Objective of the study was to find armwrestling-skills-ranking model strength test rates, with the 80kg weight class taken for the case study.

Methods and structure of the study. We used the tensodinamometric test to rate the efforts claimed by different sport-specific physical exercises to test the top strength for the following nine main muscle groups and anatomical points to obtain the individual strength topography: shoulder pronator; hand flexors, hand abductor muscles, forearm supinators, neutral-point forearm flexors, shoulder extensors, supine forearm flexors, forearm pronators, and finger (grip) flexors, with every test applied to the relevant strength focusing point.

To rate the hand flexors, forearm pronator and supinator strengths, we used the same test system with a special adjustable rest to fix and isolate the relevant muscle groups for the tests (see Figure 1). The hardware and software for this test method was developed by a research group headed by A.S. Margorin, and A.V. Antonova offered practical recommendations for the test method.

We sampled for the study the 20-41 year-old armwrestlers (n=29) trained at Bauman Moscow State Technical University (Moscow) and split them up into the following skill groups: Group I (n=5) of the World/ European Championships winners and runner-ups qualified World Class Masters of Sports; Group II (n=12) of the National, Moscow Municipal and Moscow University Championships winners and runner-ups; and Group III of beginners with less than 1 year training records (n=12).

Results and discussion. We found the top-skilled group leading in the maximal mean arithmetic strength test rates; plus found a direct correlation between strength topography and competitive accomplishments, with the differences between the top-skilled and low-skilled groups found significant in 8 tests out of 9 ($p < 0.05$). The intergroup differences were tested insignificant only in the shoulder extensor strength test – probably due to the strength focusing point in this case being unimportant for competitive progress.

The following test rates were significantly different for the low- versus moderately-skilled and low- versus top-skilled groups and insignificantly different for the top- versus moderately-skilled groups: hand abductor, forearm supinator, forearm flexor (‘hammer’ and ‘biceps’ test versions), and forearm pronator strength test rates. These tests were found skills-sensitive as they are (1) highly sport-specific and (2) sensitive to the armwrestling technique/ specialty.

For example, hand abductors, forearm pronators and forearm flexors (in ‘hammer’ test version) were tested critical for success in the Toproll armwrestling technique; whilst the forearm flexors (in ‘biceps’ test version) and forearm supinators are dominant in the Hook technique [1, 2, 6]. This means that a moderately-skilled athlete may still be tested even higher in his special/ habitual muscle groups / moves than a top-skilled athlete specialized in a different wrestling technique. Since the above test rates are not always dependable, they may unlikely be recommended as model test rates – albeit may be highly sensitive in the wrestling-technique-specific test domains. We may presume that these movements are limited by the hand flexor strength.

The finger flexor (grip) strength test rates were significantly different only for the top- versus low-skilled groups. It may be due to the fact that the grip strength, unlike the other muscle groups strengths, is not that trainable being largely genetically predetermined. The higher finger flexor strength test rates in the top-skilled group may be indicative both of the high physical fitness and the genetically predetermined gifts in the group. Therefore, this model test may be beneficial for the primary selections, although the relatively weak grip may be countered by the hands with tied up with a special belt in practical bouts when the grip is broken.

The shoulder pronator and hand flexor tests produced the most beneficial, significantly different group test arrays – since these muscle groups are critical for success in modern armwrestling. The highest intergroup (top- versus low-skill group) differences were

Muscle group strength	Starting position for the test	Strength focusing/ test point
Hand flexors		Bout start-up posture, with the forearm kept tight to the special rest for the hand isolation

Figure 1. *Tensodinamometric test version for the hand flexors and forearm pronator/ supinator muscle group strength tests*

found by the forearm supinator (77.9%), forearm pronator (52.4%), hand flexors (51.2%), shoulder pronator (44.3%), hand abductor (37.3%), supine forearm flexors (34.0%), grip (32.1%), neutral-point forearm flexors (29.0%) and the shoulder extensor (‘back’ test version) strength tests. The high intergroup (top- versus low-skill group) differences in these muscle group strength tests show that these muscle groups are sport-specific i.e. important for success in armwrestling. Based on the test data and analysis, we made a topographic map of the armwrestling-skills-specific model strength test rates: see Figure 2.

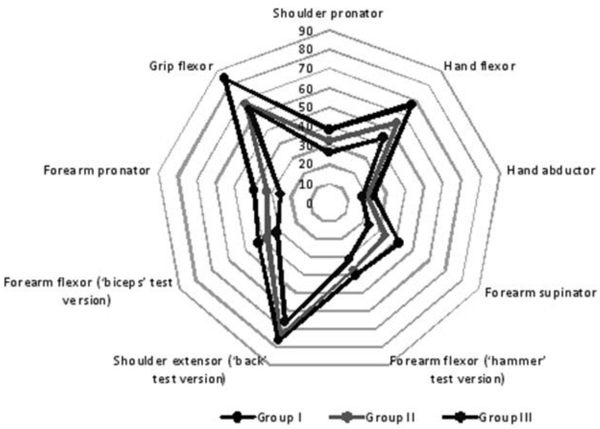

Figure 2. *Armwrestling skills-specific model strength test rates (kg): topographic map*

Conclusion. The top-skilled group was tested with significantly higher strength test rates than the moderately-and low-skilled ones in 8 tests out of 9. The strength topography was found dependant not only on the skill rank but also on the technical specialization and genetic giftedness. The key armwrestling skills ranking model strength test rates were ranked as follows in descending order: (1) Hand and grip strength; (2) Shoulder pronator strength; (3) Sport-specific muscle group (forearm supinator and pronator) strengths; hand abductor strength; and (4) supine and neutral-point forearm flexor strength. It should be emphasized that the shoulder extensor strength was found less important for the armwrestling skills ranking purposes. The hand and shoulder pronators are recommended to be given a special priority as the key muscle groups for success in armwrestling, whilst the hand flexor strength was found the main limiting factor for the strength trainings and competitive progress in modern armwrestling.

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3D ANALYSIS OF TWO DIFFERENT DIFFICULTY ELEMENTS (ILLUSIONS) IN AEROBIC GYMNASTICS

UDC 796.058

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Abstract

Biomechanical considerations as reflected in correct or incorrect technique, particularly in aerobic gymnastics with still not enough scientifically approved knowledge are more than undoubted. The aim of the study was to identify and evaluate by the Simi Motion 3D system the kinematic characteristics in the specific phases of two different aerobic gymnastics difficulty elements: Free illusion to vertical split (FIVS) and Free illusion to free vertical (FIFVS), performed by the female athlete and Slovakian national team member (age = 21 years, sport age = 16 years, height = 159 cm, body weight = 52 kg). The indicators that appeared to be the key in terms of correct technique were detected: duration of phases, angular variables, height of center of mass and acceleration and velocity of the leading leg. The results showed the major error in the second phase of FIFVS where the minimum requirement (at least 170° between the legs in the split position) has not been reached and gymnast showed only 161.31° range. Additionally, a mistake in the position of standing leg, which must be perpendicular to the floor in the vertical split, was detected in both elements (FIVS = 83.04°; FIFVS = 77.58°).

Keywords: *biomechanical analysis, time and spatial characteristics, free illusion to vertical split, free illusion to free vertical split.*

Introduction. The Aerobic Gymnastics (AG) as a competitive sport claims many specific assumptions. Therefore, the training process has high demands to the volume, intensity, and technical elements with a high difficulty level. Aerobic gymnasts continuously perform high-intensity and complex movements following music patterns, which require coordination, anaerobic endurance, power and explosiveness, strength and flexibility. Certainly, such qualities give value and excitement to this sport. However, gymnasts in motor abilities that reflect on the quality of performance, accuracy of techniques and movements are different [2, 5].

The correct "model" technique and difficulty element forms are specified in the AG Code of Points, updated for each Olympic cycle [1]. Judges evaluate technical skills of all movements in the routine – difficulty and acrobatic elements, aerobic movement patterns, transitions, links and many more. Perfect technique means performing movements without errors, with high precision, correct posture, body alignment and recognizable shapes of the elements performed. Small, medium, large or unacceptable errors have to be identified by the gymnasts and coaches, who will focus on whether the error is caused by a lack of concentration or by an inadequate physical training level [7, 8]. Importance of a correct technique is also shown in case of a tie at any place in qualifications or finals, where the tie is broken by the athlete with higher execution score. In addition, difficulty elements serve as means of challenging, as well as attesting the acquisition of targeted physical qualities and strings of movements.

Despite the growing popularity of AG, there is still a lack of biomechanical analyses in literature, regard-ing the techniques of the specific difficulty elements [2, 4]. Biomechanical analysis is very efficient in order to improve, describe and develop specific technique. Moreover, it gives us the possibility to calculate various aspects of motion such as velocity, acceleration, displacement, time and further allows to analyze the angles of body segments relative to its reference frame or angles relative to different body parts [3]. Understanding the movement patterns allows us to uncover errors and specially to find ways to make the movement more effective and optimal from the view of correct technique.

For the purpose of the study we analysed the routines of individual women category from previous European and World Championships and selected one of the most frequently occurred difficulty elements – free illusion in two different variations: 1) *Free illusion to vertical split, 2) Free illusion to free vertical split.* The aim then is to evaluate the temporal and spatial characteristics in the specific phases of the selected elements with the aspect of correct technique.

Research methods and organization. A senior Slovakian team member female aerobic gymnast (age = 21 years, sport age = 16 years, height = 159 cm, body weight = 52 kg) was involved in the investigation. After being informed on the procedures and methods, the gymnast signed the consent form to participate in the study. The experimental protocol was performed in accordance with the Declaration of Helsinki for human experimentation and was approved by the university ethical committee. Two difficulty elements Group D (balance & flexibility) have been investigated: *Free illusion to vertical split* (FIVS, Fig. 1), difficulty value of 0.6 points and *Free illusion to free vertical split* (FIFVS, Fig. 2), difficulty value of 0.7 points. The only difference in execution of the elements is in the second phase, where the vertical split is performed with or without the support of both hands to the floor.

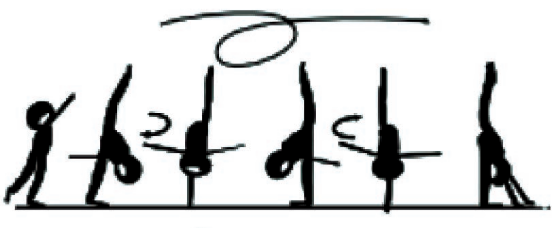

Figure 1. *Free illusion to vertical split (FIG 2017)*

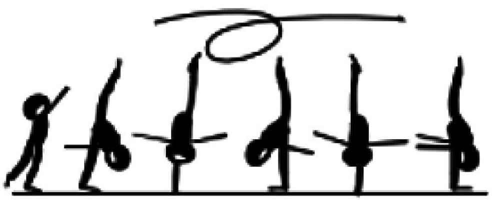

Figure 2. *Free illusion to free vertical split (FIG 2017)*

Data recording and collecting were processed via SIMI Motion 3D system, version 8.5 German company SIMI Reality Motion Systems GmbH [3, 4] by 8 synchronized high-speed infrared cameras. 20 anthropometric points were assigned and marked by passive retrospective stickers (Fig. 3). Temporal and spatial variable were observed: *duration* of selected phases of the elements, *acceleration (a) and velocity (v)* of the leading leg., *height of the centre of the mass* (CM). For easier analysis of the elements we select 2 phases for each: 1st phase represents "illusion", 2nd phase depict "vertical split".

Figure 3. *Anthropometric points & marker placements*

Results and discussion. *Temporal variables.* We assumed that *duration* of the 1st phase of FIFVS will be affected by more difficult position in the unsupported vertical split, and thus it will be longer than the 1st phase of FIVS. However, in both elements, the performance time of the 1st phase was exactly equal (1.30 s). Comparison of the 2nd phase shows only 0.02 s difference in favour of a faster executed vertical split in FIVS. Flexibility and balance are dominant qualities of the illusion elements. However, they do not guarantee the correct execution with the necessary range and intensity as the importance of velocity and acceleration has been approved in several gymnastic studies [6, 8, 9, 10]. In our investigation *maximum acceleration* (a) and *maximum velocity* (v) of the leading leg was measured on the malleolus point. More detail values of both elements are described in Table 1.

Table 1. Maximal acceleration (a_{max}) & maximal velocity (v_{max})

	1st phase of the elements		**2nd phase of the elements**	
	a_{max} [m.s^{-2}]	**v_{max} [m.s^{-1}]**	**a_{max} [m.s^{-2}]**	**v_{max} [m.s^{-1}]**
FIVS	64.14	7.72	42.39	6.06
FIFVS	65.13	8.02	45.07	5.70

Angular variables. The most important parameter could be seen in the maximum range between legs in vertical split, where the angle of 170˚ was expected as minimum requirement given by the rules. In FIVS a sufficient range of 177.77˚ was reached, however, only 161.31˚ in FIFVS.

Height & trajectory of CM. In the starting position of FIVS the CM was at 0.94 m. The highest point of the CM was detected at the end of the first phase at 0.98 m, unsurprisingly higher than the starting position as the gymnast performed on tiptoe. The lowest point of the CM was determined while entering the second phase (0.61 m). As expected, in the FIVSF there were no significant differences between height of CM during the performance of the element, all values were almost similar (table 2).

The biggest advantage of biomechanical analysis is the improvement of gymnast's performance. One of the important factor evaluated by judges is the fluency of the illusions. Figure 4 represents comparison of both illusions. While entering the illusion there are no mistake in fluency either FIVS or FIFVS. However, at end of the 1st phase (finishing the "illusion part") mistakes in balance could be seen and continuously detected in the 2nd phase as well.

Table 2. *Height of the CM*

		CM height [m]	
		FIVS	FIFVS
Starting position		0.94	0.94
1st phase	Part 1	0.65	0.65
	Part 2	0.98	0.97
2nd phase	Part 1	0.61	0.61
	Part 2	0.92	0.91

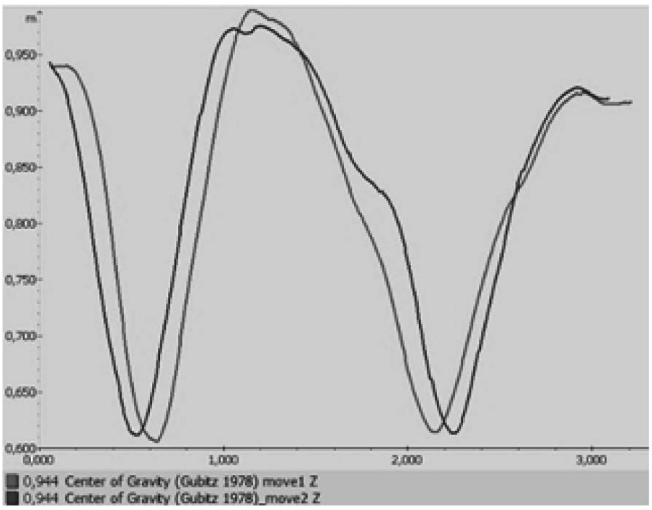

Figure 4. *Trajectory of the CM*

Based on the results of our investigation we were able to analyze errors in technique that occurred while performing both elements. All minimum requirements were met in FIVS, however the element was not performed without a mistake. Figure 5 shows the error in the body posture. Another major mistake can be seen while transferring from the 1st to the 2nd phase: gymnast's trunk is moving faster than the leg causing closed angle between the leading leg and torso (Fig. 6).

Serious errors in technique could be detect also in FIFVS. Figure 7 demonstrates incorrect body posture (similar to FIVS) of the 1st phase, as rigid body is required. Due to insufficient range between the legs - 161.31˚ in the free vertical split (Fig. 8), minimum requirement for the difficulty value (of at least 170˚) has not been accomplished as well. Additionally, a small mistake in the position of standing leg, which must be perpendicular to the floor in the vertical split, was detected in both elements (FIVS = 83.04˚; FIFVS = 77.58˚).

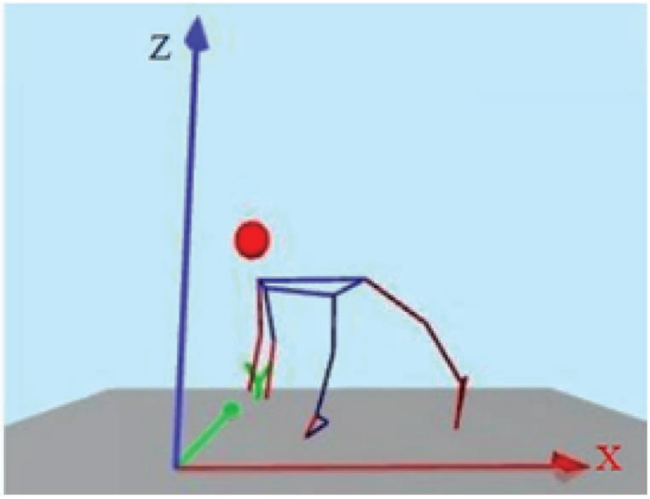

Figure 5. *Error in the first part of FIVS*

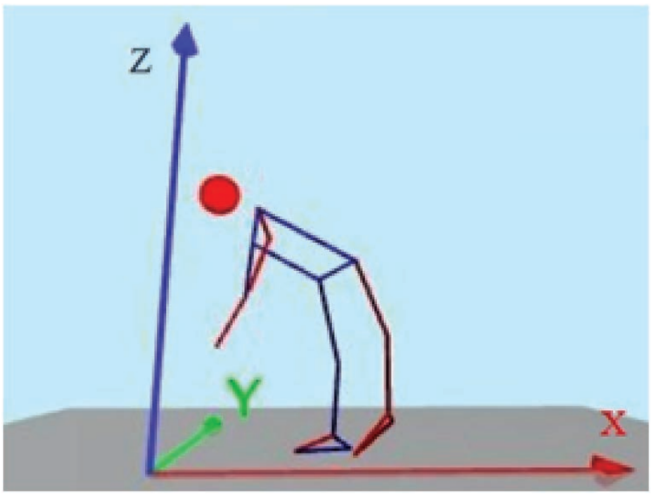

Figure 6. *Errors in transfer from 1st to 2nd phase in FIVS*

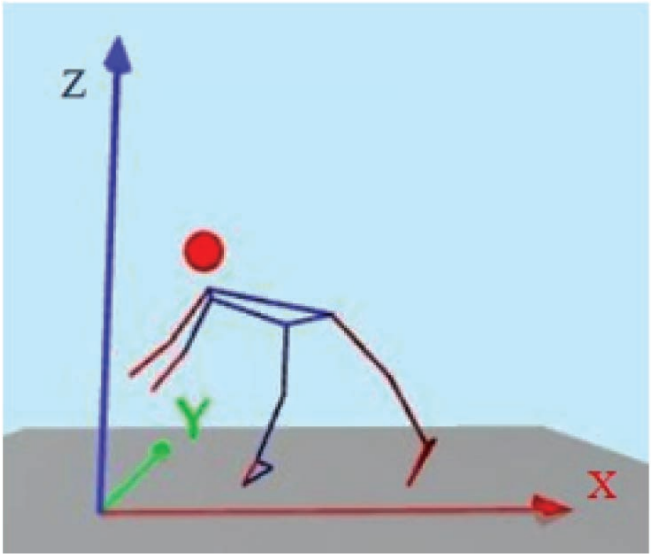

Figure 7. *Incorrect body posture in FIFVS*.

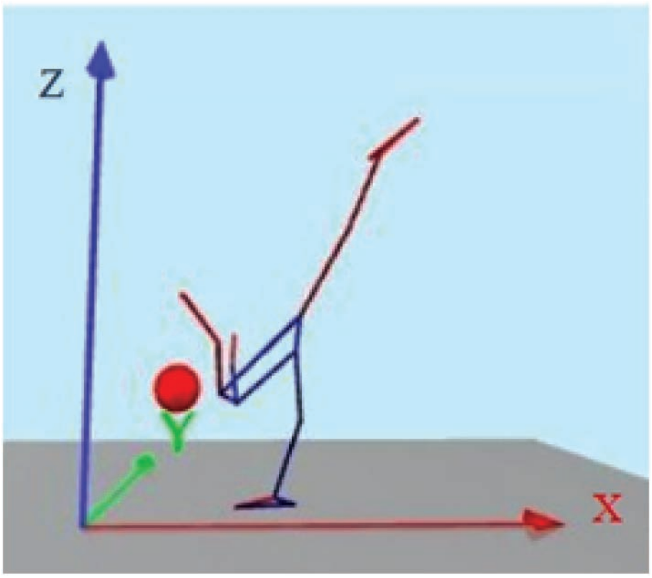

Figure 8. *Insufficient range between the legs*.

Conclusions. The present study evaluates the kinematic characteristics of two types of difficulty elements in AG with the aspect of correct technique. The kinematic analysis demonstrates that the illusions possess all the characteristics of body rotation dynamics and flexibility as fundamentals. Despite the limitation of this case study the investigation helped to ease the identification of the key phases, movement of the limbs and the CM, resulting in elimination of the errors and further improvement of gymnast´s technical preparation.

Aknowledgment

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CORRELATION RELATIONSHIP BETWEEN MAXIMAL ALACTATE WORK EFFICIENCY AND ATHLETIC PERFORMANCE OF HIGHLY-SKILLED FEMALE RACING SKIERS AT STAGES OF OLYMPIC TRAINING CYCLE

UDC 796.01:612

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Abstract

Objective of the study was to identify the dynamics of correlation relationship between maximal alactate work efficiency and athletic performance of highly-skilled female racing skiers in individual sprint skiing at different stages of the annual and Olympic training cycles.

Methods and structure of the study. We analyzed the results demonstrated by 22 female athletes aged 22-27 years, specializing in different types of competitive activity and having different sports qualifications (from CMS to WCMS). The maximal alactate work efficiency (speed ability and ability to display maximum alactate power) was analyzed at the beginning and at the end of each preparatory period throughout the 2015-2018 Olympic cycle. The list of main starts of the Olympic cycle included: All-Russian Competitions in cross-country skiing in Tyumen held at the end of the snowless preparatory period and associated with the completion of the basic stage of the snowless period (late September), Russian Cup Finals, World Championships and Olympic Games, World Cup stages (2015-2016 sports season) held in the middle of the competitive period and associated with the achievement of the peak level (February, March) at the main start - Russian Championship in Tyumen at the end of the competitive period - and with the possibility to qualify for further centralized training for the next sports season (April).

Results and conclusions. The correlation analysis made it possible to identify the most informative indicators of maximal alactate work efficiency determining the effectiveness of competitive performance in sprint races, which formed the basis for the nomenclature of model characteristics (by year of the Olympic cycle) of the speed ability and ability to display maximum alactate power in the highly-skilled female racing skiers preparing for the XXIV Winter Olympic Games (Beijing 2022).

Keywords: *cross-country skiing, females, physical qualities, speed ability, maximum alactate power, athletic performance, sprint races, correlation relationship.*

Background. The priority area for the modern sports science is the search for rational ways to improve the effectiveness of the athletic training process adjusted to the specific characteristics of the competitive activity against the background of high competition in the international sports arena [6, 7]. Among such ways is to analyze the correlation relationships and identify the most relevant indicators of changes in the major physical fitness components, in particular, the speed ability and the ability to display maximum alactate power, at various stages of the Olympic training cycle. Therefore, scientifically grounded management of the process of training of highly-skilled athletes should be based on the specialists' awareness of the extent to which the sport result is determined by the selected indicators, and of its dynamics over both a one-year training cycle and a multi-year one [2, 5].

Objective of the study was to identify the dynamics of correlation relationship between maximal alactate work efficiency and athletic performance of highly-skilled female racing skiers in individual sprint skiing at different stages of the annual and Olympic training cycles 2015-2018.

Methods and structure of the study. The study was carried out by the experts of the laboratory of Olympic cyclic sports of the Federal State Budgetary Institution Federal Science Center of All-Russian Scientific and Research Institute of Physical Culture and Sports (Moscow) as part of the research work "Individual-typological peculiarities of formation of physical fitness of highly-skilled female racing skiers at the stages of 2018-2020 Olympic training cycle".

The methodological basis of evaluation of the highly-skilled female racing skiers' speed ability and ability to display maximum alactate power was formed by the programs that had been specially developed for the women's Russian national teams and included short-term muscle loads of maximum power provided by the phosphagen energy sources [1, 3, 4].

We analyzed the results demonstrated by 22 female athletes aged 22-27 years, specializing in different types of competitive activity and having different sports qualifications (from CMS to WCMS). The maximal alactate work efficiency (speed ability and ability to display maximum alactate power) was analyzed at the beginning and at the end of each preparatory period throughout the 2015-2018 Olympic cycle. The subjects were offered to perform a series of accelerations on the specialized cycle ergometer "Monark Ergomedic 894E Peak Bike" (Sweden) for 6 sec with the workload stepped up as follows: 0, 2, 4 kP, and maximal load, calculated based on quadratic approximation, which stipulated the automatic achievement of the extremum of function F(x). In this test procedure, the highly developed speed ability of the subjects (peculiarities of speed qualities display) was identified by the maximum pedaling rate (PRmax6) at zero resistance (LM=0), which primarily reflects athletes' genetic predisposition to muscular contractility [2, 4, 8]. The measure of development of their maximum alactate power was the rate of mechanical power achieved under one of the resistance scenarios, close to the maximum as a rule, which itself indicated the realization of the female athletes' power potential [4].

The study objective was achieved through the analysis of the correlation coefficient values and trends based on the nature of relationship between "the chosen indicator" and "the importance of the competition". The nature (dynamics) of the correlation relationship was determined based on the results of assessment of the level of development of the subjects' speed ability and maximum alactate power (on the one hand) and their competitive performance rates in the qualifying individual sprint races of the 2015-2018 Olympic sports seasons at the following stages of the annual cycle (on the other hand): at the end of the snowless stage of the preparatory period, including the national competitions (late September), the middle and end of the competitive period, including the Russian Cup Finals, World Championships or Olympic Games, World Cup stages (the 2015-2016 sports season) held in the middle of the competitive period and associated with the achievement of the peak levels (February, March) at the main start of the season, as well as the Russian Championships in cross-country skiing at the end of the competitive period and associated with the opportunity to try out for the team and get involved in the centralized training for the next sports season (April).

Results and discussion. The correlation analysis covered the following initial indices: maximum pedaling rate at zero resistance (PRmax6; HM=0), rate of load tolerance (LM) at maximum power, maximum pedaling rate at maximum load tolerance (PR6), absolute and relative rates of maximum power (W6abs and W6rel, respectively), coefficient of realization of the power potential (CRP), and the sports result demonstrated at the main start of the season.

The dynamics of changes in the correlation coefficients throughout the study period is presented in Table 1.

For the study purposes, we analyzed the dynamics of changes in the correlation coefficients for the key indices we had selected.

The dynamics of the maximum pedaling rate at zero resistance (PRmax6), which reflected the subjects' speed ability and contractile muscle function, was characterized by the unidirectional changes in the strength of relationship within the range from 0.458-0.801 in the 2014-2015 sports season and up to 0.222-0.783 in the 2017-2018 sports season. The peak level of correlation relationship (Rtk) between the test item and the sports result demonstrated in the 2014-2015 sports season was reached at the Russian Cup Final (Rtk=0.801) and World Championship in Falun (Rtk=0,786), in the 2015-2016 sports season - at the Summer All-Russian Competitions in cross-country skiing in Tyumen (Rtk=0.778) and World Cup stage in Stockholm (Rtk=0.552), in the 2016-2017 sports season - at the World Championship in Lahti (Rtk=0.611), and in the 2017-2018 sports season - at the Olympic Games in Pyeongchang (Rtk=0.783) and All-Russian Competitions in Tyumen (Rtk=0.650), indicating a great impact of the speed ability on the outcome of sprint races at all stages of the Olympic cycle.

The dynamics of the coefficients of correlation between the load moment (LM) and strength component of the maximum power was characterized by the multidirectional (according to Rtk "+/-") changes in the strength of relationship within the range from -0.604-0.471 in the 2014-2015 sports season to 0.450-0.794 in the 2017-2018 sports season. The peak level of correlation relationship in the 2014-2015 sports season was achieved at the Russian Champi-

Table 1. Correlation relationship between maximum anaerobic capacity rates and competitive performance rates in sprint races of 2015-2018 Olympic cycle.

Competition	Speed ability	Maximum power of work				
	PRmax6	HM	PR6	W6abs	W6rel	CRP
2014-2015 sports season						
1,4 CL, 08.09.2014 – All-Russian Competitions, Tyumen	0.672	0.368	0.686	0.663	0.584	0.215
1,3 CL, 28.02.2015 – Russian Cup Final, Rybinsk	0.801*	0.372	0.728	0.729*	0.620	0.232
1,4 CL, 19.02.2015 – World Championship, Falun	0.786	-0.614*	0.789*	0.331	0.738*	0.589*
1,2 FS, 22.03.2015 – Russian Championship, Kononovskaya	0.458	0.471	0.356	0.604	0.671	0.499
2015-2016 sports season						
1,4 FS, 03.09.2015 – All-Russian Competitions, Tyumen	0.778*	0.422	0.264	0.556*	0.622	0.459
1,4 CL, 26.02.2016 – Russian Cup Final, Syktyvkar	0.483	0.186	0.487	0.064	0.204	0.136
1,2 CL, 11.02.2016 – World Cup stage, Stockholm	0.552	0.011	0.656*	0.440	0.670*	0.229
1,4 FS, 24.03.2016 – Russian Championship, Tyumen	0.102	-0.166	0.203	0.227	0.248	0.146
2016-2017 sports season						
1,4 CL, 22.09.2016 – All-Russian Competitions, Tyumen	0.427	0.753	-0.076	0.534*	0.424	0.585
1,4 FS, 26.02.2017 – Russian Cup Final, Syktyvkar	0.226	0.427	-0.060	-0.513	0.566*	0.652
1,4 FS, 23.02.2017 – World Championship, Lahti	0.611*	0.647	0.238	-0.186	0.405	0.685
1,6 CL, 26.03.2017 – Russian Championship, Khanty-Mansiysk	0.409	0.789*	0.129	0.401	0.396	0.787*
2017-2018 sports season						
1,4 CL, 08.09.2017 – All-Russian Competitions, Tyumen	0.650	0.794*	-0.148	0.720*	0.442	0.542
1,4 FS, 25.02.2018 – Russian Cup Final, Kononovskaya	0.553	0.464	0.542	0.248	0.596	0.745
1,14 CL, 13.02.2018 – Olympic Games, Pyeongchang	0.783*	0.450	0.899*	0.717	0.894*	0.871*
1,4 FS, 24.03.2018 – Russian Championship, Syktyvkar	0.222	0.717	0.363	0.598	0.539	0.360

** – correlation coefficients conforming to the significance level p<0.05*

onship (Rtk=0.471), during the final selection for the team - at the World Championship in Falun, with the correlation being negative (Rtk=-0,614), which indicated the methodical direction of the training process design using the frequency of movements (movement rate) and consequently the high level of development of the functional component of muscle work, in the 2015-2016 sports season - at the Summer National Competitions in Tyumen (Rtk=0.422), in the 2016-2017 sports season - at the Russian Championship in Khanty-Mansiysk (Rtk=0.789) during the team selection, at the Summer National Competitions in Tyumen (Rtk=0.753) and at the World Championship in Lahti (Rtk=0.647), and in the 2017-2018 sports season - at the Summer National Competitions in Tyumen (Rtk=0.794), Russian Championship in Syktyvkar (Rtk=0.717), which indicated the preservation of the positive vector of the correlation relationship (at the average Rtk level) for the next two years of preparation for the Olympic Games, as well as the apparent significance of this indicator in the qualifying races (Summer National Competitions and Russian Championships at the end of the season - team selection).

The dynamics of the coefficients of correlation between the maximum pedaling rate (PR6 LMmax) and the speed component of maximum power was characterized by the multidirectional (according to Rtk) changes in the strength of relationship within the range from 0.356-0.789 in the 2014-2015 sports season to -0.148-0.899 in the 2017-2018 sports season. The peak level of correlation relationship in the 2014-2015 sports season was reached at the World

Championship in Falun (Rtk=0.789), in the 2015-2016 sports season - at the World Cup stage in Stockholm (Rtk=-0.656), in the 2016-2017 sports season - at the World Championship in Lahti (Rtk=0.238), and in the 2017-2018 sports season - at the Olympic Games in Pyeongchang (Rtk=0.899), thus indicating the high level of significance of the speed component (at the peak tolerance level) in the achievement of the final result in sprint races.

The dynamics of the coefficients of correlation of the absolute maximum power rate (W6abs) was characterized by the unidirectional (except for the sprint races at the Russian Cup Final and World Championship of 2016-2017) positive ("+" in sign) changes in the strength of relationship at the level of the average and high values of Rtk within the range from 0.331-0.729 in the 2014-2015 sports season to 0.248-0.720 in the 2017-2018 sports season. The peak level of correlation relationship in the 2014-2015 sports season was reached at the Russian Cup Final in Rybinsk (Rtk=0.729), in the 2015-2016 sports season - at the Summer All-Russian Competitions in Tyumen (Rtk=0.556), in the 2016-2017 sports season - at the Summer All-Russian Competitions in Tyumen (Rtk=0.534), and in the 2017-2018 sports season - at the Summer All-Russian Competitions in Tyumen and Olympic Games in Pyeongchang (Rtk=0.720-0.717), which indicated the high level of significance of this indicator in the achievement of the final result at the main start of the Olympic cycle.

The dynamics of the coefficients of correlation of the relative maximum power rate (W6rel) was characterized by the unidirectional positive ("+" in sign) changes in the strength of relationship within the range from 0.584-0.738 in the 2014-2015 sports season to 0.442-0.894 in the 2017-2018 sports season. The peak level of correlation coefficients in the 2014-2015 sports season was reached at the World Championship in Falun (Rtk=0.738), in the 2015-2016 sports season - at the World Cup stage in Stockholm (Rtk=0.670), in the 2016-2017 sports season - at the Russian Cup Final in Syktyvkar (Rtk=0.566) and World Championship in Lahti (Rtk=0.405), and in the 2017-2018 sports season - at the Olympic Games in Pyeongchang (Rtk=0.894), thus indicating the high level of significance of this indicator in the formation of the final result. The characteristic feature of relative maximum power is the unidirectional vector of the correlation coefficients in terms of the sign ("+") and stability of the strength of relationship at average and high level at all stages of the Olympic cycle.

Conclusions. The correlation analysis of the maximal alactate work efficiency and competitive performance rates at the important Olympic starts revealed that successful performances at the main starts of the sprint race season were due to the high level of development of the speed ability associated with the achievement of the high pedaling speed (in our case, the equivalent of movement speed, including the ability to quickly accelerate and reach the peak maximum rate both load-free and under maximum load) and the level of development of maximum alactate power (absolute and relative values) against the background of the high level of realization of the athletes' power potential.

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RATING ELECTROMYOGRAPHIC COST OF TECHNICAL ELEMENTS IN FREESTYLE BMX

UDC 796.01:612

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Abstract

Freestyle as a variation of BMX racing has been actively developed since the end of the last century. The first freestyle competitions will take place at the Tokyo 2020 Olympic Games. Bicycle acrobatics includes various tricks (stunts): rotations relative to the longitudinal and vertical body axes, flips, barspins. All the technical elements are performed in the air during the 1.5-sec flight. The body orientation in the airborne phase imposes special requirements on the athletes' vestibular and neuromuscular systems, as regardless of the complexity of the acrobatic figures, they must land on the back wheel of the bicycle. The physiological basis for the successful execution of the technical elements in freestyle is formed by the intra- and intermuscular coordination skills. The athletes' muscular system functionality was rated by the method of bipolar telemetric electromyography.

Objective of the study was to determine the electromyographic cost of technical elements in freestyle depending on the level of difficulty of the jump performed.

Methods and structure of the study. Electromyographic activity of the muscles was recorded using the hardware and software complex "SportLab" (Russia), consisting of the 8-channel telemetric electromyography, video camera, and a synchronization device. We registered the surface electromyographic activity of the muscles on the right side of the body. Sampled for the study was a highly-skilled athlete, who performed 11 technical elements.

Results and conclusions. Depending on the level of difficulty of the freestyle jump performed, the electromyographic cost in m. brachioradialis, m. biceps brahii, and m. rectus abdominis increased.

An increase in the activity of m. rectus abdominis during the execution of complex technical elements led to a decrease in the activity of the antagonist muscles m. trapesius and m. latissimus dorsi.

The electromyographic cost of work of m. vastus lateralis and m. biceps femoris caput longus was not affected by the element's complexity, but by the jump height, as these muscles perform a shock-absorbing function on landing.

Keywords: *freestyle, jumping, technical elements, muscle activity.*

Background. Freestyle as a variation of BMX racing has been actively developed since the end of the last century. The first freestyle competitions will take place at the Tokyo 2020 Olympic Games. Bicycle acrobatics includes various tricks (stunts): rotations relative to the longitudinal and vertical body axes, flips, barspins. All the technical elements are performed in the air during the 1.5-sec flight. The body orientation in the airborne phase imposes special requirements on the athletes' vestibular and neuromuscular systems, as regardless of the complexity of the acrobatic figures, they must land on the back wheel of the bicycle. The physiological basis for the successful execution of the technical elements in freestyle is formed by the intra- and intermuscular coordination skills. The athletes' muscular system functionality was rated by the method of bipolar telemetric electromyography.

Objective of the study was to determine the electromyographic cost of technical elements in freestyle depending on the difficulty level of the jump performed.

Table 1. Technical elements in freestyle BMX

№	Technical element	Description
1	Bunny hop	The rider jumps the bike into the air to gain maximum height
2	Bunny hop 360˚ + spin	The rider and bike spin 360˚ in the air along the vertical body axis
3	Quad barspin	The rider jumps the bike into the air while performing a quad barspin
4	Cork 720	The rider and bike spin 720˚ in the air along the longitudinal body axis
5	Cork 720 barspin	The rider and bike spin 720˚ in the air along the longitudinal body axis while spinning the handle bars one full rotation
6	Cork 720 no hander	The rider and bike spin 720˚ in the air along the longitudinal body with both hands off the handle bars, arms to the sides
7	Backflip no hander	Both the rider and bike do a backward flip while in the midair with both hands off the handle bars, arms to the sides
8	Flip bar	Both the rider and bike do a backflip while taking the hands off the handle bars doing a barspin
9	Frontflip	Both the rider and bike do a forward flip while in the midair
10	Flair tailwhip	The rider throws the bike out to one side while still holding onto the handle bars so that the frame goes 360˚ around the steering tube along the vertical axis
11	Flair	Both the rider and bike do a backflip while spinning along the transverse body axis

Methods and structure of the study. Electromyographic activity of the muscles was recorded using the hardware and software complex "SportLab" (Russia), consisting of the 8-channel telemetric electromyography, video camera, and synchronization device. The technical characteristics of "SportLab" and recording procedure are presented in the study [1]. We registered the surface electromyographic activity of the muscles on the right side of the body:

– upper limb: *m. brachioradialis (1)*[1] ; *m. biceps brahii (2); m. deltoideus (3);*

– upper limb: *m. brachioradialis (1); m. biceps brahii (2); m. deltoideus (3);*

– core: *m. trapesius (4); m. latissimus dorsi (5) и m. rectus abdominis (6);*

– lower limb: *m. vastus lateralis (7) и m. biceps femoris caput longus (8);*

Sampled for the study was a highly-skilled athlete, who performed 11 technical elements (Table 1).

Peculiarities of the research procedure. The athletes performed each jump at least 3-4 times; their performance was rated based on the expert assessments - only good attempts were considered. The EMG was recorded in three phases: repulsion, flight, and landing. We accepted that the repulsion phase began 120 ms before the rear wheel was detached from the support (end of repulsion). The flight phase ended at the moment of landing, when the rear or both wheels touched the support. The landing phase ended 120 ms after the flight phase (Fig. 1).

[1]For ease of graphing, the muscles are numbered

Processing of the study results. The EMG signal was inverted and smoothed by the method of a moving average (50 ms averaging window) [2]. The following indicators were calculated:

– electromiographic cost ($A^{j,K}_{EMG}$) of technical elements:

$$A^{j,K}_{EMG} = \int_{t=0}^{t=T} SmdEMG_i^{j,K}\, dt \quad , \qquad (1)$$

where – $SmdEMG_i$ smoothed EMG; j – technical element (j=1-11); K – muscle (K=1-8); t=0– beginning of the repulsion phase (position 1 in Fig. 1); t=T – end of the landing phase (position 6 in Fig. 1).

Results and discussion. The EMG amplitude depends on the functioning and anatomical position of the muscles. The lower limb and core muscles are to resist gravitational and inertial forces and thus are in constant tension. The upper limb muscles perform complex coordination and highly-accurate movements with little effort: for example, writing or typing, picking up different objects and similar motor actions. Accurate movements require rapid recruitment and synchronization of motor units, which affects the amplitude of the myogram. If the amplitudes of the upper and lower limb muscles are compared, the upper limb muscle amplitude turns out to be higher than that of the lower limb ones at the same effort. Therefore, it is incorrect to evaluate the role of muscles in the execution of technical elements only by the myographic amplitude (or electromechanical work). Technical el-

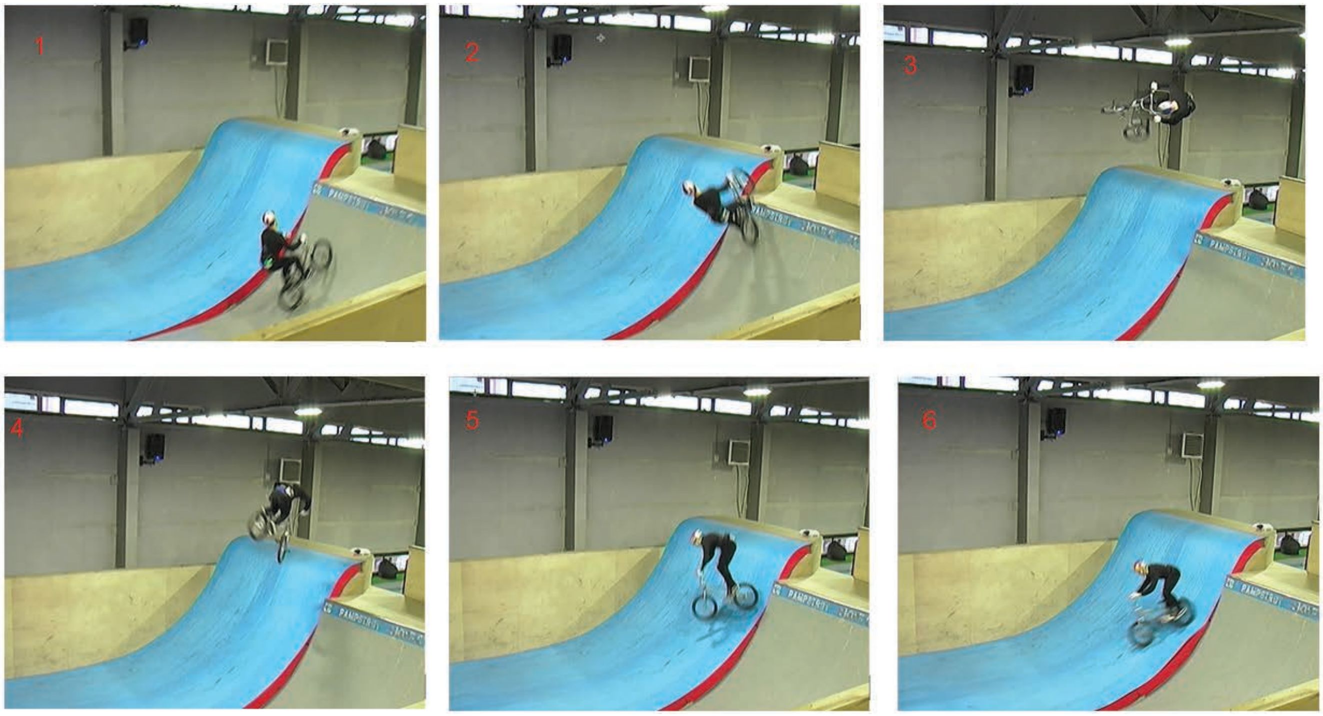

Fig. 1. *Phase composition of technical elements on the example of "Flair tailwhip". Repulsion phase: beginning (1), end (2). Flight phase: start (2), end (5). Landing phase: beginning (5), end (6)*

ements 2-11, presented in the table, were normalized by $A^{j,1}_{EMG}$ of "Bunny Hop" as the "simplest" element, i.e. we assessed the influence of the level of difficulty of jump on the changes in the electromyographic cost ($\Delta A^{j,K}_{EMG}$) of the upper limb, lower limb and core muscle work. The calculations were based on the formula:

$$\Delta A^{j,\hat{E}}_{EMG} = \frac{\int_{t=0}^{t=T} SmdEMG_i^{j,\hat{E}}\,d - \int_{t=0}^{t=T} SmdEMG_i^{1,\hat{E}}\,d}{\int_{t=0}^{t=T} SmdEMG_i^{1,\hat{E}}\,d} * 100 \quad , \qquad (2)$$

where the upper index 1 relates to the 1st technical element (see the table), j=2-11; the upper index K relates to the muscle K=1-8.

The *calculation data* are presented in Figure 2. Compared to the 1st technical element, the 50-90% increase in the electromyographic cost of *m. brachioradialis* and *m. biceps brahii* were observed during such jumps as "Cork 720", "Frontflip" and "Flair tailwhip» that are associated with rotational movements of the body. When performing Type 9 technical element ("Frontflip"), the athlete performs a forward flip in the midair while holding on the handle bars; when performing Type 10 jump 10 ("Flair tailwhip"), the rider rotates the bike in the air and, as a consequence, the work of the arm muscles increases. When performing "Cork 720 no hander" (6), the rider does not hold on the handle bars for some time when in the air, and the work of the arm and core muscles consequently does not differ much from that during

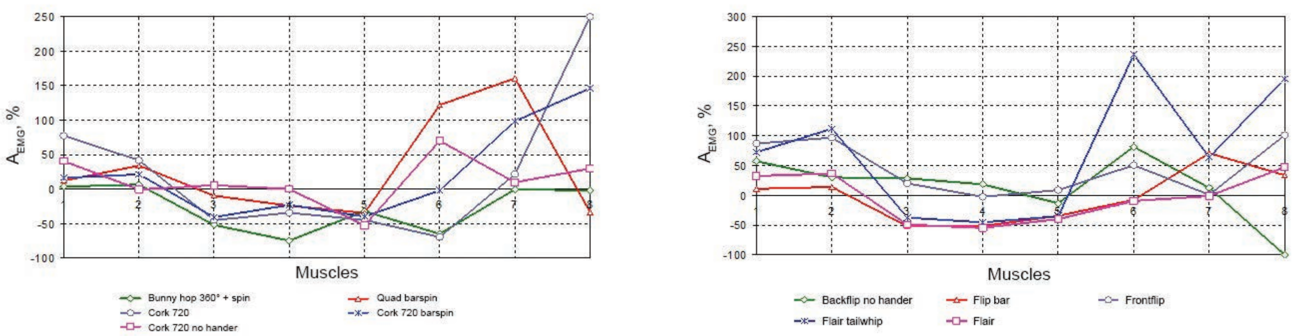

Fig. 2. *Normalized electromyographic cost of technical elements*

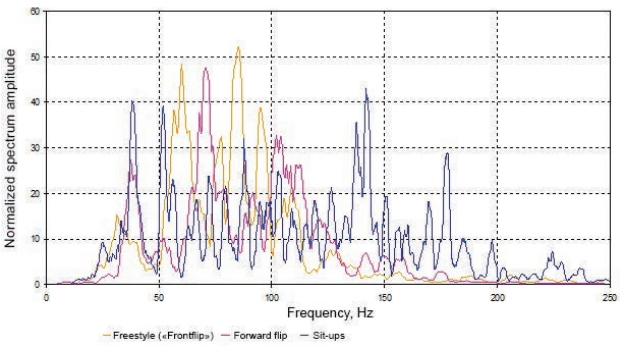

Fig. 3. Smoothed spectrum of m. rectus abdomis

the first jump, which indicates a correct registration of EMG (as presented in the upper graph of Fig. 3). A similar downward trend was observed for Types 2, 5, 8, 10, and 11 jumps, respectfully. It should be noted that in the execution of some technical elements related to the performance of a flip (7, 8) or rotation of the handle bars or bike itself (3, 10), there was a significant increase of $\Delta A^{j,K}_{\mathrm{EMG}}$ in *m. rectus abdominis* (Fig. 3). The increase in the electromyographic cost during Types 3, 5, 7, 9, and 10 jumps (see the table) was 50-240% (see Figure 3). In the airborne position, the abdominal muscles (estimated by the EMG activity of *m. rectus abdominis*) help hold the torso in the inclined position parallel to the bicycle frame, which reduces the moment of body inertia and enables to perform rotational movements. Given the flight time, *m. rectus abdominis* has to contract very quickly, which is reflected in the shape of the EMG spectrum. Figure 3 illustrates the smoothed spectra of m. rectus abdomis in the following exercises: a frontflip (9), a frontflip while simulating a jump into water[2], sit-ups. The abdominal muscles are actively involved in work during these exercises. The first spike in the spectrum amplitude within the 14-27 Hz band indicates the recruitment of motor units. During the air tricks, the spectral width of *m. rectus abdomis* did not exceed 125 Hz; during the sit-ups, the spectral width of *m. rectus abdomis* increases to 200 Hz. The more narrow the EMG spectrum, the faster the recruitment of motor units with simultaneous synchronization of their contraction.

Consequently, to successfully perform the complex elements of air tricks it is necessary to develop the speed-strength capabilities of the abdominal muscles.

Conclusions. Depending on the level of difficulty of the freestyle jump performed, the electromyographic cost in *m. brachioradialis*, *m. biceps brahii,* and *m. rectus abdominis* increased.

An increase in the activity of *m. rectus abdominis* during the execution of complex technical elements led to a decrease in the activity of the antagonist muscles *m. trapesius* and *m. latissimus dorsi*.

The electromyographic cost of work of *m. vastus lateralis* and *m. biceps femoris caput longus* was not affected by the element's complexity, but by the jump height, as these muscles perform a shock-absorbing function on landing.

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TRAINING PROCESS IMPACT ON VERTEBRAL COLUMN STATE OF JUNIOR ATHLETES

UDC 611.711: [796.88:796.015.62]- 053.6

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Abstract

Determining the impact of training process of 15-16 year old weightlifters on the functional and structural state of their vertebral column represented the main objective. In this regard, radiological and other clinical methods of studies were used. The results showed clinical manifestations of dorsopathies in 21% of girls and 15% of boys, whereas some athletes also had radiological manifestations of remodeling vertebrae bone tissue and cartilaginous tissue of the intervertebral discs. The findings allow to suggest that a certain training process orientation probably envisages the development of degenerative-dystrophic changes in the spine of young athletes. This requires methodological and preventive measures to preclude the development of vertebral osteochondrosis signs at a young age.

Keywords: *training process, spine, dorsopathy, weightlifters.*

Introduction. The number of studies on the development and diagnosis of the locomotorium degenerative-dystrophic diseases is constantly growing. The socio-economic importance of this problem is noted by WHO, announcing a decade from 2000 to 2010 dedicated to this issue. However, despite numerous studies, the causes and mechanisms of development of degenerative changes to the locomotor system have not been fully identified. This refers to sports activities to the full extent. As early as in 1984, experienced specialists in this field G.E. Yumashev and M.E. Furman [4] pointed out that the problem of spine degenerative lesions has been studied for a century, but the etiology questions are still awaiting final resolution. According to some authors, today the identification of key factors for the development of these changes at the molecular level seems to be the most efficient approach to the diagnosis, clinic and treatment of syndromes of damage to the locomotor and peripheral nervous system. Recently, the influence of low-molecular metabolism bioregulators on the structure and function of tissues has been emphasized. It has been established that substances of a peptide nature can influence many metabolic components and physiological processes of the body, as well as that degenerative-dystrophic processes in the connective tissue are systemic and develop as a result of imbalance between synthesis and catabolism of cartilaginous and bone tissue components.

Based on the results of our previous studies, it was demonstrated that during degenerative-dystrophic processes in the locomotor system, marked changes in the concentration of the pool of non-essential and essential amino acids are observed both in connective tissue and almost all physiological fluids of the body and muscular tissue [1]. This allowed to supplement the well-known concepts of degenerative-dystrophic changes development. Unfortunately, it should be noted that the incidence of degenerative-dystrophic diseases in childhood and adolescence tends to increase. Therefore, the diagnosis of osteochondrosis and related dorsopathies in young people should be no surprise. These issues are even less studied in sports practice. The reasons for the development of degenerative processes in cartilaginous and bone tissue of young athletes have not been fully identified. It is beyond argument that at the initial stage of development, these changes are compensatory in nature, and it is important to determine the stage when they become pathological. We usually talk about this when a patient develops pain syndrome and other clinical manifestations. The pain syndrome issue is also ambiguous and requires study [3]. In this regard, the importance of early diagnosis of such changes for improving training and recovery processes with account for the peculiarities of high physical and emotional load influence on the physiological development of the locomotor system in young athletes is on the rise.

Objective of study was to determine the impact of training process of young weightlifters on their spine functional and structural state.

Methods and structure of study. A group of 152 young weightlifters (19 girls and 133 boys) aged 15-16 years and doing sport for 3-5 years was examined. They were thoroughly surveyed about the back pain presence during training process; their spine motor function was determined and spine X-ray pictures, done according to indications to clarify the diagnosis, were examined.

Results of study and discussion. The study identified back pain complaints in four girls (21%) and twenty boys (15%). Different manifestation degree of the tension of spine extensors and spine motor function limitation, especially in the lumbar and thoracic regions were clinically determined. Radiograph examination revealed changes in the bone tissue of the vertebral bodies in the form of the so-called osteophytes that were characteristic of degenerative-dystrophic processes. Endplate sclerosing was also determined indicating their blood supply disturbance (Fig. 1). Decreased height of the intervertebral discs allowed to assume that structural changes peculiar for osteochondrosis development occur in the cartilaginous tissue as well. During pain syndrome aggravation, athletes underwent complex conservative treatment, including medication and physiotherapy, massage, manual therapy, etc. Sports activity includes all human capabilities granted by nature and their development as a result of intensive and long-term physical training. Currently, the level of sports achievements depends on a number of factors, primarily on the volume and intensity of training loads. It should be noted that children of an increasingly young age begin to practice sport, becoming the Olympic champions at the age of 16. As a result of this, physical loads on still immature locomotor system significantly increase. At the same time, as noted by well-known American experts in sports medicine, L. Micheli and M. Jenkins [3], it would be unreasonable to ignore the serious negative aspect of sport and physical activity hey-day, namely injuries. What is more, the greatest concern at present is not caused by acute injuries, but a relatively new category – overuse injuries. Most worrisome is the fact that in the face of a growing number of injuries among athletes, repeated injuries become common, which indicates the inadequacy of measures aimed at recovering from injuries. A large number of people are forced to withdraw from training due to the occurrence of long-term complications, such as dorsopathies and others. Therefore, the study of this problem with the purpose of improving diagnostics, early preventing and rendering qualified assistance in such conditions assumes a greater importance. In this regard, it should be noted that radiologic investigations and computed tomography utilized to diagnose changes in the spine, cannot be used often or several times in a row due to negative impact of ionizing radiation on the body. There is much concern about the dynamic monitoring of spine condition and functioning in athletes at different stages of training process. Such an opportunity exists in various centers, including the laboratory of the Warsaw Academy of Physical Education and Sports using the Rasterstereographs (rasterstereography) technique [5]. It allows making a photogrammetric assessment of the condition of the spine and its connection with the pelvis. The spinal model obtained during the study is assessed in three projections at once. Anatomical and biomechanical assessment of standard anatomical criteria and comparison of indices with normal values are also possible. Among them, one may determine the level of the pelvis standing, its rotation, the angle of kyphosis and lordosis, evaluate posture and other indices. The technique is non-invasive, safe for the patient and staff. This is a quick, non-contact and automatic method enabling precise assessment of spine condition in various projections.

Thus, the causes of changes in the spine may be different. They are also noted in persons involved in the development of strength capacities at a fairly young age. In this regard, an acute question of early diagnosis of these changes and dynamic observations of them arises. Such observations of structural and functional changes in the spine and locomotor system enable a more efficient training process and prevention of damages.

Conclusions. Prolonged and intensive physical loads aimed at strength development of young athletes first lead to functional and compensatory changes in the locomotor system, which may be followed by the development of degenerative-dystrophic processes peculiar for spinal osteochondrosis. Timely and dynamic diagnosis and prevention of revealed changes allow to reduce the risk of developing clinical manifestations during sports engagement and to extend the time of an active training process.

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ACTIVE REHABILITATION MEASURES TO TRAIN MOBILITY IN DISABLED CHILDREN

UDC 796.034.2

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Abstract

Objective of the study was to design and test by experiment the effectiveness of the rehabilitation course with the use of active physical exercises to develop motor abilities in disabled children.

Methods and structure of the study. The study involved 50 children with disabilities aged 3-16 years. Depending on the level of development of their gross motor functions within the international Gross Motor Function Classification System (GMFCS), out of 50 disabled children, 6 were categorized into the 1st level of GMFCS, 15 - to the 2nd, 6 - to the 3rd, 10 - to the 4th, 13 - to the 5th. The program consisted of 16 individual one-hour training sessions conducted 2-3 times a week. The active physical exercises were performed using the training simulators adapted to the disabled children's physical abilities.

Results and conclusions. Children with disabilities of all degrees of difficulty have great potential, which should be realized in a timely manner through active physical exercises.

The study found that out of 142 exercises mastered, 26.1% were directed towards the development and correction of walking skills, 15.5% - towards the development of balancing skills and ability for balance maintenance in the sitting and standing positions, 8.5% - towards the adaptation to physical loads, 5.6% - towards the formation of step movements and the ability to stand up from the sitting position, increasing the subjects' overall endurance to physical loads.

The children in the most difficult Levels 4 and 5 on the Gross Motor Function Classification System scale were able to master 29 and 35 exercises, respectively, no less than in other groups.

Individual training sessions with the use of active physical exercises and pedagogical tests increase the effectiveness of rehabilitation measures.

Keywords: *children with disabilities, motor disabilities, physical exercises, level of development of motor functions on Gross Motor Function Classification System scale.*

Background. Among the numerous types of diseases in children, locomotor disorders take a significant place, thus leading to a decreased motor activity, changes in the cardiovascular and respiratory systems functionality, disruption of metabolic processes, reduced working capacity, changes in the psyche, and negative effects on the quality of life. As a result, long-term akinesia aggravates children's social adaptation [3-5, 8]. Therefore, it is promotion of motor activity of children with disabilities through the use of physical education means in an environment that takes into account their individual characteristics and in exercise rooms conformed to their activities, that has the potential for rehabilitation measures efficiency enhancement. The modern scientific literature contains a great deal of evidence in that physical loads have a positive effect on the development of motor abilities of disabled children [1, 2, 5, 7, 8]. However, the lack of consistency, guidance on the organization of training sessions for children with disabilities, as well as the lack of opportunities for early rehabilitation determine the delayed formation of motor skills. Proper formation and consolidation of the disabled children's motor skills can be achieved through the selection of physical loads that are adequate to their functional state and motor abilities, as well as through the prolongation of the uninterrupted training process. If the proposed exercises are consistent with the physiological capabilities of the children's body, they start to play a formative role and contribute to the development of their motor skills. Inadequate loads cause various pathological changes and exacerbate motor problems [3, 5, 8]. It is therefore particularly important to select physical exercises that would target the development of motor abilities of children with disabilities, taking into account their individual capabilities and the level of development of gross motor functions.

Objective of the study was to design and test by experiment the effectiveness of the rehabilitation course with the use of active physical exercises to develop motor abilities in disabled children.

Methods and structure of the study. The study involved 50 children with disabilities aged 3-16 years. Depending on the level of development of their gross motor functions within the international Gross Motor Function Classification System (GMFCS), out of 50 disabled children, 6 were attributed to the 1st level of GMFCS, 15 - to the 2nd, 6 - to the 3rd, 10 - to the 4th, 13 - to the 5th. The program consisted of 16 individual one-hour training sessions conducted 2-3 times a week. The training sessions with the use of active physical exercises were carried out with the extensive use of training simulators adapted to the disabled children's physical abilities and "Gross's simulator", in which the child was in a vertical position, protected from falling, could move, rotate, jump, learn to exercise. The functional state of the children's body was assessed based on their HR and blood pressure, as well as was visually assessed by the instructor. The changes in the subjects' motor abilities were determined in the pedagogical tests conducted at the beginning and at the end of the course. The test exercises were selected according to the children's motor abilities. The total number of exercises that caused positive changes was 142. They were grouped into 14 variations. Each child could be tested in two or three different exercises. The expert evaluation given by the adaptive physical education instructors was carried out according to a points system: 0 points - cannot perform at all; 1 point - tries to perform with the help of the instructor or with the use of "Gross's simulator"; 2 points - performs with the help of the instructor or with the use of "Gross's simulator"; 3 points - tries to perform independently; 4 points - performs on his own.

Results and conclusions. The table presents the study results indicating the number of mastered exercises grouped into different variations by the level of development of gross motor functions according to GMFCS scale for the course of 16 training sessions with the use of active physical exercises.

As a result of the experiment, 50 disabled children were subjected to 14 different exercise variations and were able to perform or partially perform 142 exercises

Table 1. *Number of exercises mastered by disabled children in each variation and according to GMFCS scale*

№	Exercise variations and their number	Levels on GMFCS						
		1	2	3	4	5	Total	%
1	Walking in various variations	8	13	9	3	4	37	26.1
2	Ability to stand up from the sitting position	-	5	1		2	8	5.6
3	Jumping training	1	1		2	1	5	3.5
4	Arm work	-	4	1	1	-	6	4.2
5	Roller skate and cycle training	2	1	1	-	-	4	2.9
6	Ability for balance maintenance in the sitting and standing positions	-	7	3	5	7	22	15.5
7	Improvement of overall endurance	-	7	1	-	-	8	5.6
8	Improvement of movement coordination	-	2	2	5	1	10	7.0
9	Ability to execute the instructor's commands	1	3	1	1	-	6	4.2
10	Crawling	-	-	-	3	2	5	3.5
11	Adaptation to physical loads	3	-	-	3	6	12	8.5
12	Formation of support on both arms	1	-	-	-	6	7	4.9
13	Ability to hold the head straight	-	-	-	-	4	4	2.9
14	Formation of step movements	-	-	-	6	2	8	5.6
	Total exercises	16	43	19	29	35	142	100

in total. The children (13 individuals attributed to the 5th level of GMFCS scale), who had previously been unable to change their body position, mastered 10 different exercise variations, a total of 35 exercises, 7 of which aimed to develop the disabled children's balancing skills while holding the standing or sitting position.

The children in Level 4 on GMFCS scale (10 individuals), who could sit on their own but could not walk, mastered 9 different exercise variations, 29 in total, of which 6 exercises aimed to form step movements.

The children in Level 3 on GMFCS scale (6 individuals), who were able to walk using a hand-held mobility device, mastered 8 different exercise variations, 19 in total, 9 of which aimed to develop the walking skills and 3 - to develop their ability for balance maintenance in the sitting and standing positions.

The children in Level 2 on GMFCS scale (15 individuals), who were able to walk with limitations, mastered 9 different exercise variations, 43 in total, 13 of which aimed to develop their walking skills.

The children in Level 1 on GMFCS scale (6 individuals), who were able to walk without limitations, mastered 6 different exercise variations, 16 in total, 8 of which aimed to improve their walking skills.

Thus, out of 142 exercises mastered, the largest number - 37 (26.1%) - aimed to develop and correct the children's walking skills. 22 exercises (15.5%) aimed to develop the balancing skills and form the ability for balance maintenance in the sitting and standing positions. In 12 cases (or 8.5%), we noted the subjects' adaptation to physical loads. 8 exercises (or 5.6%) aimed to form the children's step movements and their ability to stand up from the sitting position. In 5.6% of cases, there was an increase in overall endurance.

It should be noted that the children in the most difficult Levels 4 and 5 on GMFCS scale (10 and 13 subjects, respectfully) were able to master 29 and 35 exercises, no less than in other groups. This indicated the children's potential to improve their motor activity through regular physical activities [5, 6, 8,].

The findings brought out clearly that the rehabilitation of disabled children is becoming more effective through regular individual trainings with the use of active physical exercises. They get involved in motor activity and, as a result, succeed to master the exercises, which they were previously unable to perform; their functional state improves, which in turn contributes to the improvement of their health. Given that active physical exercises involve many mental processes, children also enhance behavioral control, emotional responses, and socialization, as well as increase their interest in sports.

Conclusions. Children with disabilities of all degrees of difficulty have great potential, which should be realized in a timely manner through active physical exercises.

The study found that out of 142 exercises mastered, 26.1% were directed towards the development and correction of walking skills, 15.5% - towards the development of balancing skills and ability for balance maintenance in the sitting and standing positions, 8.5% - towards the adaptation to physical loads, 5.6% - towards the formation of step movements and the ability to stand up from the sitting position, increasing the subjects' overall endurance to physical loads.

The children in the most difficult Levels 4 and 5 on the Gross Motor Function Classification System scale were able to master 29 and 35 exercises, respectively, no less than in other groups.

Individual training sessions with the use of active physical exercises and pedagogical tests increase the effectiveness of rehabilitation measures.

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PHYSICAL DEVELOPMENT AND PHYSICAL FITNESS RATES AS MARKERS OF EFFECTIVENESS OF CHILDREN'S MOTOR ACTIVITY

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Abstract

Objective of the study was to rate and analyze the age-and sports-specific physical development / physical fitness progresses of the 6-10 year-olds.

Methods and structure of the study. Sampled for the study were 365 boys aged 6-10 years with different levels of motor activity: 150 non-sporting children (hereinafter referred to as NS); 106 footballers; 109 wrestlers with different sports experience (from 8 months to 1.5 years). The number of children in the age groups was as follows: 25 to 39 - among the non-sporting subjects; 20 to 27 - among the footballers, and 20 to 29 - among the wrestlers. The tests were run with the consent of the subjects' parents.

The testing program was developed with due regard to the relevant GTO Complex standards and physical development and physical fitness tests for pre-school institutions and general education schools.The methods applied were as follows: anthropometry, caliperometry, physiometry, pulsometry, pedagogical observations, and graphical analysis.

Results and conclusions. The physical fitness / physical development sports- and age-specific progress tests of the 6-10 year-olds with comparative analysis found these physical qualities underestimated by the valid physical education curriculum – namely the carpal strength and flexibility (for the whole period) followed by the leg strength and dexterity to a lesser degree (that need to be prioritized in the 9-10 year period). The age-specific athletic training programs, particularly in wrestling, are recommended making an emphasis on the flexibility training elements, whilst the football trainings should additionally prioritize harmonized strength practices, with a focus on the carpal strength in the 7-9 year period in the balanced physical fitness progress models.

Keywords: *physical fitness, physical development, wrestling group, football group, unsporting group, 6-10 year-olds' growth rate.*

Background. Sports and other physical activity are commonly ranked among the key external factors of influence on the children's progress in anatomical, physiological and physical fitness aspects [3]. Physical fitness of the 6-10 year-olds is traditionally secured by the school/ kindergarten physical education and sports service variable in the physical education and sports tools and focuses. The age-specific athletic training programs are regulated by the relevant Federal Sports Training Standards with a special priority to the staged athletic/ health progress aspects in every physical exercise and sport skill mastering practice, with the athletic trainings taking on average 3-4 times more time than the standard physical education classes [8].

Underage sports are commonly known to have multiple benefits and form a basis for specific/ unilateral progress in different physical fitness elements [2, 9]. The recent negative trends reported by the young people's health/ physical fitness statistics urge the national research community to analyze the physical education and sport system drawbacks and offer new the physical activation/ sporting models for the 6-10 year-olds based on sports-specific physical development / physical fitness progress rating tests and comparative analyses.

Objective of the study was to rate and analyze the age-and sports-specific physical development / physical fitness progresses of the 6-10 year-olds.

Methods and structure of the study. A set of physical fitness / physical development tests for the study was formed based on the key progress rates provided by the valid age-specific GTO Complex test systems [6, 4]. We used the following test methods: anthropometrics, caliperometry, physiometry, heart rate tests; school progress and graphical test [1, 5, 7] to obtain the following functionality data: body length

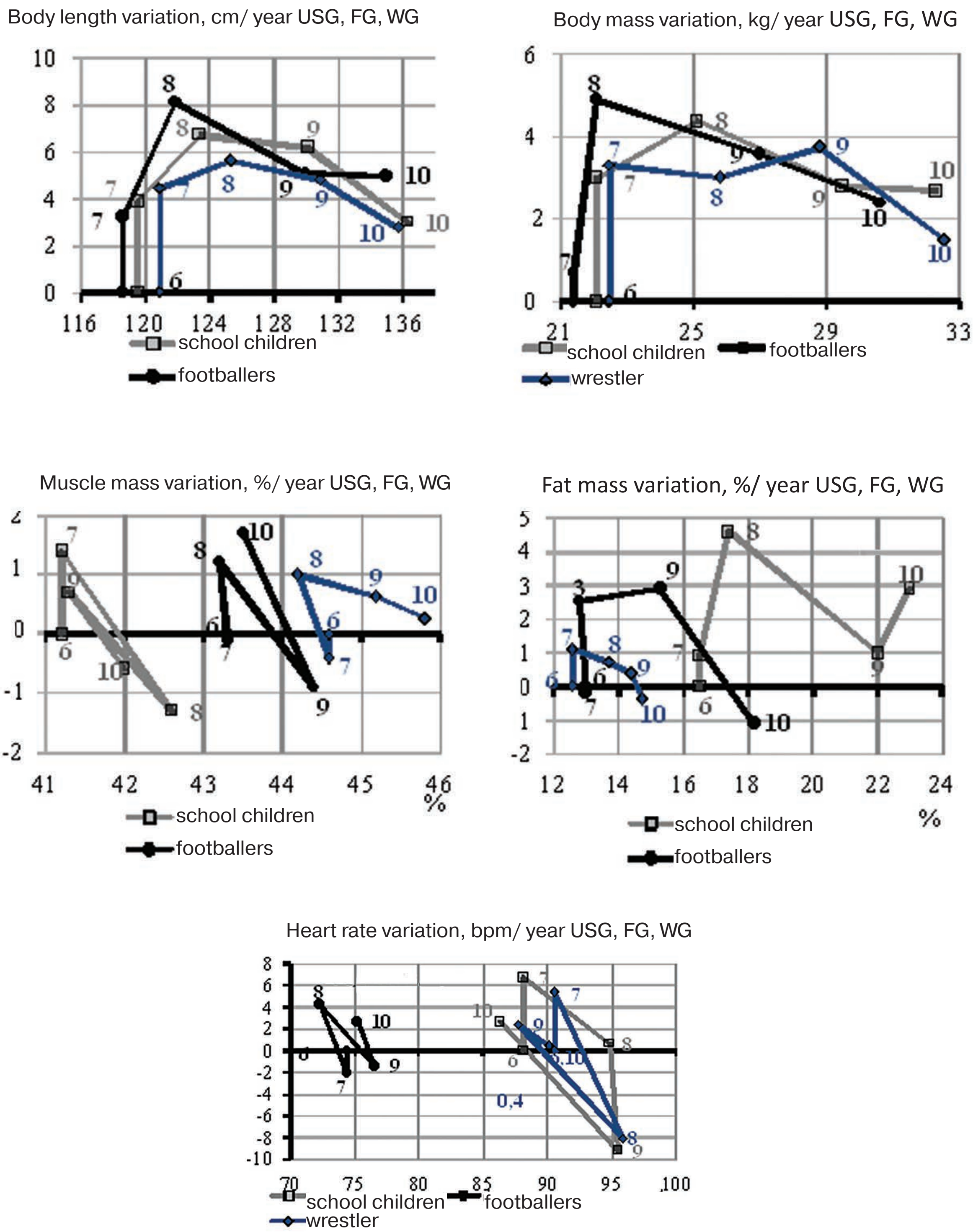

Figure 1. *Age- and sports-group-specific morphology and functionality test rates of the 6-10 year olds (with y axis showing variations, and x axis showing values, with ages indicated by dots)*

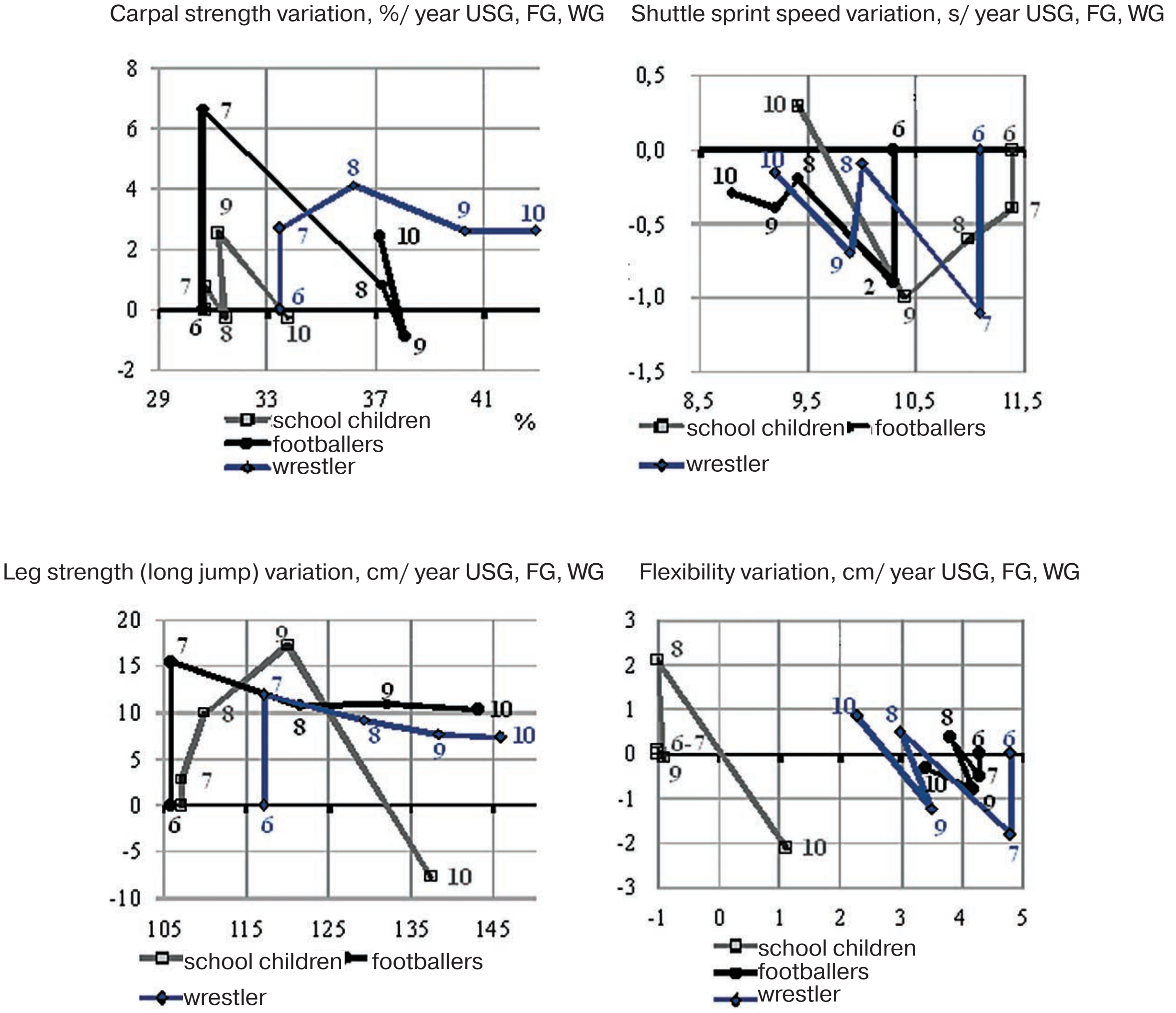

Figure 2. *Age- and sports-specific physical fitness variaions in the sample (with* y *axis showing variations, and x axis showing values, with ages indicated by dots)*

and mass; limb sizes; fat mass; vital capacity (VC); heart rate; and carpal strength; and the following physical fitness tests: 10x3m shuttle sprint; standing long jump; and flexibility rating front lean (on a gymnastic bench) tests. The graphical test used a geometric representation of dynamic movement trajectories on a phase plane with two variables – an independent variable and its variation rate – referred to as the 'phase portrait' indicative of the general logics of the system's behavior. The graphical method applies the qualitative theory of differential equations of dx / dt = F (x1... xn) type, where x is an independent variable, and dx/ dt is the variation rate [7].

We sampled for the study, on a parental consent, the 6-10 year old boys (n=365) including an unsporting group (USG, n=150); football group (FG, n= 106) and wrestling group (WG, n=109) with the training experiences of 8 to 18 months. The groups were further split up for the tests into unsporting, football and wresting subgroups of 25-39, 20-27 and 20-29 people, respectively.

Results and discussion. The tests and studies of age-related morphological and functional variations and physical fitness showed the following (see Figures 1 and 2). Intergroup differences in the body length were statistically insignificant and dependent on the age-related physical development patterns. The body length growth rates were generally the natural progress and sport selection dependent and tested at 16.6% for 4 years in the unsporting group (maximal and minimal in the 7-9 and 9-10 year periods, respectively); 18.4% in the football group (maximal and minimal in the 7-8 and 6-7 year periods, respectively); and 14.6% in the wrestling group (uniformly growing and minimal in the 6-9 and 9-10 year periods, respectively).

Body mass was also found group-unspecific, with the football group tested with the lowest body mass, with the minimal differences around 6 years of age (within 1 kg) and growth to 2-3 kg in the 7-10 year period. The body mass growth rates across the sample were close albeit the highest for the unsporting group (58.8%), minimal in the wrestling group (51.3%) and medium (54.2%) in the football group. The unsporting group was tested with the highest body mass progress in the 6-8 year period (30%); versus the 7-8 year period in the football group (22%); and 6-9 year period in the wrestling group (12-15% per annum). Every group was tested with the minimal body mass progress in the 9-10 year period (5-9%), with the lowest progress found in the wrestling group. The close group physical development rates made it possible to run the physical fitness tests on a relatively equal ground.

The most significant intergroup physical activity differences are manifested in variations of the labile components of the body mass i.e. age-specific phased muscle mass and fat mass variations. Fat mass phase portraits show the minimal variations in the unsporting group in the 6-10 year period (41.2% and 41.4% at 6 and 10 years of age, respectively); whilst the muscle mass phase portrait showed growth in the 6-7 and 8 -9 year periods with the maximal growth in the 7-8 and 9-10 year periods. The wrestling group was tested with the muscle mass maximum and fast progress in the 7-10 year period with a significant drop in the 6-7 year period (44.6% and 46.1% at 6 and 10 years of age, respectively). The football group was tested with the muscle mass growth (43.3% and 45.2% at 6 and 10 years of age, respectively) and some fall in the 8-9 year period. The fat mass phase portrait showed minimums for the wrestling group and football group in the 6-10 year period (12.6% and 14.4% at 6 and 10 years of age, respectively); versus the fat mass maximum and fast growth in the unsporting group in the 7-8 (26.4%) year period (16.5% and 25.9% at 6 and 10 years of age, respectively). The football group was tested intermediate on the fat mass scale (13.0% and 17.1% at 6 and 10 years of age, respectively). On the whole, the sporting groups were tested with the fat mass falls and the unsporting group with the fat mass growth for the test period.

The age-specific physical fitness variations showed the football group standing lower on the HR variation scale than the wrestling group and unsporting group – that may be interpreted as indicative of the effects of sport trainings. Generally the sporting lifestyles were found to improve the physical fitness in both sporting groups – versus the slower and poorer physical fitness progresses in the unsporting group.

Carpal strength was tested to fast progress in the sporting groups (by 35% for 4 years), with the wrestling group tested with a uniform annual progress for the period – versus the football group tested with the highest growth in the 6-7 year period and a regress to zero point in the 7-9 year period – that may be indicative of the lower priority to this physical quality in trainings. The unsporting group was tested with no progress in the 7-8 and 9-10 year periods (with a total growth of only 12.6% for 4 years).

The speed and dexterity rating shuttle sprint tests showed the highest progress in the wrestling group in the 6-7 and 8-9 year periods (10% and 7%, respectively; with total growth by 18.6% for 4 years). The football group was tested with the highest progress in the 6-7 year period (9%) and the total growth by 18% for 4 years. And the unsporting group was tested with progress in the 8-9 year period (10%) and regress in the 9-10 year period, with the total growth by 15% for 4 years.

The leg strength rating long jump test showed the highest progress in the football group in the 6-7 year period (14.6%), with the total growth by 45% for 4 years. The wrestling group also showed the highest progress in the 6-7 year period (7%), with the total growth by 31% over 4 years. And the unsporting group was tested with the highest progress in the 8-9 year period (14%) and some regress in the 9-10 year period, with the total growth by 21% for 4 years. The age-specific flexibility was tested to fall in the 6-10 year period in every group, with the unsporting group and wrestling group tested with the highest and lowest regresses, respectively.

Conclusion. The physical fitness / physical development sports- and age-specific progress tests of the 6-10 year-olds with comparative analysis found these physical qualities underestimated by the valid physical education curriculum – namely the carpal strength and flexibility (for the whole period) followed by the leg strength and dexterity to a lesser degree (that need to be prioritized in the 9-10 year period). The age-specific athletic training programs, particularly in wrestling, are recommended making an emphasis on the flexibility training elements, whilst the football trainings should additionally prioritize harmonized strength practices, with a focus on the carpal strength in the 7-9 year period in the balanced physical fitness progress models.

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PEDAGOGICAL CONTROL AND SELF-CONTROL OF PHYSICAL FITNESS LEVEL OF YOUNG POPULATION DURING PHYSICAL ACTIVITY

UDC 796.011.3

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Abstract

Objective of the study was to develop and substantiate a system of pedagogical control and self-control of the physical fitness level of the young population during physical exercises and sports activities.

Methods and structure of the study. The study was carried out on the basis of higher educational institutions of Moscow and the Moscow region in 2015-2019. Sampled for the study were 1,284 students aged 17-22 years. During physical exercises, various methods were applied to monitor the subjects' body state: pedagogical observation; questionnaire survey of the students; keeping of a diary of self-control of the current body state.

Results and conclusions. The article presents the results of the control tests designed to study the levels of morphofunctional development and physical fitness of student youth. The girls and boys were found to have a pronounced right-sided asymmetry in the run test. The rest of the control tests revealed varying degrees of left-sided asymmetry in the random distribution curves. The prevalence of negative values in the density of distribution curves for the empirical data on the students' motor fitness rates indicated a relatively flattened distribution as compared to the normal one. Therefore, there was a moderate decline in the level of physical development and the motor fitness of the examined university students. Yet, most of the indicators corresponded to the mean values for the surveyed population, with little variation in the individual data.

The results obtained made it possible to optimize the process of physical education and selection of sports and exercises aimed to improve health and motor fitness of the young population.

Keywords: *young population, pedagogical control, self-control, physical fitness, physical exercise, sport.*

Background. The theory and methodology of physical education contain a large number of control exercises (tests) to be used by specialists to obtain objective data on the physical state of young people [1, 6].

The appropriate test procedure ensures the correct assessment of students' physical state. Test control is one of the most important professional skills that enable a specialist to dose physical loads more accurately and give more precise tasks aimed to increase the physical fitness level [2, 3]. The use of a well-chosen battery of tests, in particular those provided for monitoring, makes it possible to monitor changes in the indicators and results in the academic physical education process in terms of the same parameters [4, 5].

Objective of the study was to develop and substantiate a system of pedagogical control and self-control of the physical fitness level of the young population during physical exercises and sports activities.

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The pedagogical control of the subjects' physical development included the measurements of their body length (height) and body mass, vital capacity (VC), chest and waist circumferences, and hand dynamometry. The pedagogical control of their physical fitness included the following tests: 10x10 m shuttle run; standing long jump; sit-ups for 30 sec; bent suspension; sitting toe touches; 1,000 m run.

Results and discussion. The level of man's physical development and physical fitness is one of the informative health level rating criteria.

Within its commonly accepted meaning, physical development is understood as a complex of morphofunctional features characterizing the age-specific level of biological development of the body.

With regard to the generalized understanding of physical fitness, it is viewed as the outcome of physical training, expressed in a certain level of development of physical qualities and motor skills and abilities that are necessary for the successful performance of any type of activity (labor activity, athletic activities, etc.).

From a monitoring survey standpoint, students' physical development is to be evaluated by the anthropometric measurements that reflect the general morphological development of the human body - height, body mass, body fat, circumferential body dimensions of the main body segments.

The height to body-weight ratios in the university students of Moscow and Moscow region are presented in Table 1.

As the table shows, in recent years, there has been a positive trend in the dynamics of statistical characteristics in students, given that they are in line with the due averages. In the girls, the height rate increased by 1.9 cm and their body mass - by 2.8 kg. In the boys, the growth rate increased by 2.3 cm and their body mass - by 2.0 kg.

It is highly significant that there has been a moderate and pronounced right shift in the height and body mass rates for both girls and boys. The unequal degrees of the right-side asymmetry in the distribution curves indirectly indicate the stabilization of the acceleration process and the strengthening of the gracialization process in university students.

The analysis of the percentage of adipose tissue revealed that this body component value averaged between 23.9% and 24.6% in the girls (against a norm of 24%) and did not exceed the average of 15.4% in the boys (against a norm of 18%).

In general, it can be noted that the circumferential dimensions of the main body segments corresponded to the due age-sex values of the students' physical development. The trend data, with their slight variation, did not exceed 1% and were not statistically significant ($p>0.05$).

The main feature of the dynamics of physical fitness in both girls and boys is the regressive trend in the level of development of practically all the physical qualities under study. In percentage terms, this was especially noticeable when the girls performed the tests with the predominant manifestation of the speed and speed-strength abilities, as well as the static and aerobic endurance. The decrease averaged between 3.2% and 9.6%. In contrast to the girls, there was less regression in the boys, except for the results of the control tests: abdominal strength exercise and 1,000 m run. The average decrease in the test rates was equal to 4-5% (Table 2).

The study of the characteristic features of the students' physical fitness relative to the notional age-sex values showed that throughout the entire study period, the results demonstrated by the girls in the shuttle run, standing long jump, sit-ups, and sitting toe touches tests were within the conditional norm. With the due flexibility test results, there was

Table 1. *Dynamic changes in height to body-weight ratio in students*

Statistical characteristics	Girls (n=632)						Boys (n=652)					
	Height, cm			Body mass, kg			Height, cm			Body mass, kg		
	2013	2015	2017	2013	2015	2017	2013	2015	2017	2013	2015	2017
M	164.1	165.2	166.0	55.0	57.4	57.8	176.4	177.7	178.7	67.7	68.4	69.5
± m	0.40	0.42	0.36	0.55	0.51	0.63	0.57	0.46	0.34	0.67	0.69	0.54
Mo	170.0	168.0	170.0	52.0	54.4	53.0	181.0	183.0	181.0	62.0	65.0	65.0
Me	164.0	165.0	166.0	53.0	55.7	56.0	177.0	178.0	178.0	67.0	67.5	68.5
As	-0.32	-0.12	0.19	0.59	0.78	0.99	-0.20	0.13	0.19	0.19	0.46	0.75
Ex	-0.40	0.50	-0.02	-0.35	0.43	0.80	-0.22	-0.13	-0.16	-0.78	0.23	0.67

Table 2. *Dynamics of changes in students' physical fitness rates*

Statistical characteristics		SR, sec		SLJ, cm		SU, reps		BS, sec		STT, cm		R1,000, sec	
		2013	2017	2013	2017	2013	2017	2013	2017	2013	2017	2013	2017
Girls (n=632)	M	29.1	30.0	177.0	171.0	24.5	23.9	26.5	20.5	17.1	16.2	295.0	303.8
	±m	0.2	0.2	2.2	2.3	0.5	0.5	1.8	2.1	1.0	1.1	4.6	4.1
	Mo	28.1	29.1	190.0	173.0	28.0	24.0	40.0	36.0	15.0	10.0	310.0	322.0
	Me	28.8	29.4	178.0	172.0	25.5	24.5	38.5	35.0	16.0	14.5	305.5	316.0
	As	0.55	0.41	-0.51	-0.13	-0.31	-0.22	-0.46	-0.42	0.01	-0.13	0.36	0.47
	Ex	-0.12	-0.28	-0.41	-0.94	0.12	-0.33	-0.88	-0.62	-0.29	-0.24	-0.47	-0.55
Boys (n=652)	M	27.0	27.1	230.3	228.7	27.7	26.5	46.3	44.5	11.0	11.0	225.2	229.8
	±m	0.2	0.2	2.7	2.8	0.5	0.5	1.9	2.3	0.8	0.9	2.5	2.5
	Mo	26.8	26.7	231.0	230.0	28.0	25.0	46.0	45.0	10.0	10.0	222.0	225.0
	Me	26.9	26.8	230.5	230.0	28.0	26.0	45.5	45.5	11.0	10.5	223.5	226.5
	As	0.26	0.56	-0.20	-0.19	0.13	0.27	-0.18	0.00	0.06	0.10	0.50	0.40
	Ex	-0.43	-0.20	-0.18	-0.55	-0.28	-0.64	-0.86	-0.57	-0.63	-0.59	0.33	0.89

Note. SR - 10x10 m shuttle run; SLJ - standing long jump; SU - sit-ups for 30 sec; BS - bent suspension; STT - sitting toe touches; R1,000 - 1,000 m run.

a slight lag in motor development as shown in the bent suspension test and 1,000 m run. The static and aerobic endurance rates matched the indices of the zone of moderate hypodeviations.

Among the boys, the results in 4 motor tests corresponded to the due values: in the shuttle run, standing long jump, sit-ups, and bent suspension tests. The insufficient level of physical development was evident in the tests that characterize spine flexibility and aerobic endurance.

Conclusion. Summing up, the girls and boys were found to have a pronounced right-sided asymmetry in the run test. The rest of the control tests revealed varying degrees of left-sided asymmetry in the random distribution curves. The prevalence of negative values in the density of distribution curves for the empirical data on the students' motor fitness rates indicated a relatively flattened distribution as compared to the normal one. Therefore, there was a moderate decline in the level of physical development and the motor fitness of the examined university students. Yet, most of the indicators corresponded to the mean values for the surveyed population, with little variation in the individual data.

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PHYSICAL EDUCATION AND SPORTS IN ARAB COUNTRIES: SOCIAL ASPECT

UDC 796.011

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Abstract

Objective of the study was to conduct a theoretical analysis of the publications devoted to the development of the physical education and sports sector in the Arab countries in the social context.

Methods and structure of the study. One allotment of the analyzed material was developed by Arab authors, the other - by Russian experts. The study covers the period from the mid 20th to the early 21st century. We analyzed the publications devoted to the changes in the physical education and sport sector in the Arab countries during the study period in the social context. The information was drawn from the electronic library of Russian State University of Physical Education, Sport, Youth, and Tourism.

Results of the study and conclusions. For the study purposes, we analyzed the topics related to: development of the physical education and sport sector and the state administration system in this field in Algeria; problems of professional activities of physical education teachers at universities of the USSR and Iraq; sociological research on the physical education system in Iraq; identification of the social determinants of physical education and sports in Palestine, etc.

The authors conclude that the development of the physical education and sport sector in the Arab countries has its own peculiarities related to the religiousness of the society, gender inequality, and insufficient development of sports infrastructure. There has been very little scientific information on the social aspects of development of the physical culture and sports sector in the Arab countries since the mid 20th to the early 21st century. The available scientific information generally contains a wide range of issues related to physical education and sports.

Keywords: *physical education and sports, Arab countries, Soviet and Russian publications.*

Background. The Arab countries made their first steps to independence in different historical periods and within different – socialist or capitalist – progress models with the relevant religious/ secular priorities. These progress formats have effectively predetermined some contradictions in the interpretation of the basic logics of the physical education and sports progress in the Arab countries [9, 14].

Objective of the study was to make a theoretical analysis of the modern research publications on the physical education and sports progress in the Arab countries in the relevant social contexts.

Methods and structure of the study. Some part of the materials analyzed hereunder and covering the period since the mid-XX to the early XXI century was studied by the Arab authors and the rest by the Russian analysts.

Results and discussion. Of special interest for us was the analysis by Zhukovsky [6] of the physical education and sports sector progress in the Algerian People's Democratic Republic and the government regulatory system for the sector. The analysis shows that Algeria was successful in training highly skilled athletes, tennis players, football players and boxers since the French colonial time although the sports in the country were cultivated to mostly support the French ideological, military- political, commercial and foreign policy agenda. It is emphasized, however, that the opposition used virtually every football match for the anti-French political demonstrations, although the authorities encouraged the Algerian sports clubbing movement in the attempt to distract young people from the social protest movement as the sport club activity was limited by the sporting and entertainment goals only. The analyst still believes that sports in Algeria were accessible only for the French colonialists and a limited number of Algerian nationals – apparently confusing the elite sports with the mass sports.

After the liberation from colonial dependence, the new Algerian government established new physical education and sports sector management agencies with a special priority to: repatriation of the Algerian national sport elite from the foreign commercial professional clubs; physical education and sports movement democratization and popularization aspects; and cooperation with the USSR to facilitate solutions for multiple problems in the physical education and sport sector staffing via development of a new theoretical and practical education system. The government formed a new legal and regulatory framework for the physical education and sport sector to effectively shut down the "still existing liberal sports organizations accessible only for selected population groups and providing irregular physical education and sport services". The new physical education and sport system was outlined at that juncture in a rather declarative manner without concrete figures, progress benchmarks and analyses of the physical education and sports progress situations.

We also analyzed the article by B.I. Novikova and Al Timimi Ahmed Javad Kadom that gives a comparative analysis of the academic physical education service progress in the USSR and Iraq universities based on a survey of the academic physical education teachers. The comparative physical education progress analysis was called by the authors a "focused sociological study" (FSS) with the relevant study data. The authors, however, surveyed the physical education specialists' satisfaction with their service and correlations between the physical education teacher personality and the students' attitudes to the physical education classes; plus the key factors of influence on the academic physical education service quality; although regretfully failed to analyze the correlation between the professional academic physical education service and education quality on the whole with the physical education and sport sector progress in the country [11].

No serious analysis of the social factors of influence on the physical education and sport service in Iraq was made in the study by L.A. Novikova, S. Hormiz; Jalal Al-Abadi with the academic physical education service survey data for the University of Mosul and school sports in Iraq. Social determinants of the survey data were fully omitted by the authors in fact [5, 12].

"The Syrian schoolchildren physical health" study by V.I. Osik and Qudsi Mohamed Marwan Slah reports and analyzes the functionality, physicality and anthropometric characteristics test data of a Syrian schoolchildren sample. The material, however, also fails to put the study data and analysis in the social contexts – despite the fact that the authors mention the ontokinesiological theory by V.K. Bal'sevich that clearly recommends giving a special attention to the psychological and social factors of ontogenesis on top of the purely morphological and physiological ones. It should be also mentioned that the Syrian schoolchildren sample was too limited (59 people only) to consider the test data meaningful [13].

Having analyzed the materials on Palestine (A.R. Nairat), Tunisia (M. Dakhman) and Syria (L.M. Grzhebina, S. Allaban) [1, 3, 10], we found a sound sociological approaches with the theoretically grounded analyses of the social determinants for the physical education and sport sector progress. Thus the A.R. Nairat publication emphasizes the extremely important concept that the physical education-and-sports-regulating government agencies and the legal and regulatory framework shall be designed to form a sound socio-economic foundation for the physical education and sport sector progress. As far as the physical education and sport sector progress hampering factors are concerned, the author mentions the "need for complete and reliable statistics", "instability and unpredictability of the military-political situation in the country and region on the whole" and underlines that "the physical education and sports progress experience of other countries cannot be directly mimicked by the nation" [10].

The materials on Tunisia make the reader feel that the physical education and sport sector in the country is viewed as the health protection and social policy effectuation mechanism only. It is emphasized, among other things, that "the civil life disorders, shortage of funds and other factors have been of hampering effect on the progress of elite sports as compared to the mass sports" [3].

The report on Syrian physical education and sport system mentions that the sporting male population of the country is very limited, whilst the Syrian female population has never been allowed to take any physical education and sports activity [1].

The material on Lebanon is even more critical. It agrees with the above studies on the physical education and sport service personnel shortages and underlines the fact that the national physical education and sports infrastructure is underdeveloped being almost exclusively concentrated in the capital. It is very important that the study mentions the sports clubs progress being heavily dependent on the generosity of a bunch of sponsors. It emphasizes that the national preschool education is still in need of a physical education curricula and physical education specialists, with the accessible physical activity being limited by outdoor walking only since every non-commercial sports ground in Lebanese schools is covered with concrete.

Of special interest are the study reports by V.V. Lutkov on the Olympic movement prospects in the Arab countries [7, 8] with the following formal facts on Olympic movement history:

– The first national Olympic committee in the Arab world was established in 1910 in Egypt; and the first Arab athlete qualified for the V Olympic Games in Stockholm in 1912;

– In the interwar period, Egyptian athletes competed in four Olympic Games in 10 sports disciplines to win 4 gold, 2 silver and 3 bronze medals; and

– It was in 1950-60ies upon breakdown of the colonial system that the other Arab countries established their National Olympic Committees.

The author, however, emphasizes the ‘shortage of sporting consciousness" as the main bottleneck for the physical education and sport service progress in the Arab countries – explainable, in his opinion, by the extreme religious constraints in the Arab world.

Conclusion. The development of the physical education and sport sector in the Arab countries has its own peculiarities related to the religiousness of the society, gender inequality, and insufficient development of sports infrastructure. There has been very little scientific information on the social aspects of development of the physical culture and sports sector in the Arab countries since the mid 20th to the early 21st century. The available scientific information generally contains a wide range of issues related to physical education and sports.

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PROVINCIAL PHYSICAL EDUCATION AND SPORT SECTOR IN CANADA: DESIGN AND MANAGEMENT MODELS

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Abstract

Objective of the study was to identify effective models of the education culture and sport sector organization and management at the regional level in Canada.

Methods and structure of the study. An institutional approach was applied to study the organizational structure of physical education and sports in accordance with the specifics of the administrative-territorial structure of Canada. The following research methods were applied: analysis of literary sources, case-study, generalization.

Results of the study and conclusions. The article presents the analysis of the current organization and management system in the sphere of physical education and sports at the provincial and territorial levels of Canada. By the example of the activities of local government and voluntary organizations, we showed the mechanisms for involving various population groups in physical education and sports activities at the local level. Thus, it is specialized organizations that organize and manage sports events and develop elite sports in the Canadian provinces: in British Columbia - «The British Columbia Games Society», in Manitoba - «Sport Manitoba», in Alberta - «Alberta Sport Connection», and in the Northwest territory - Sport North Federation.

Thus, the analysis shows that the development of elite sports through the coordination of regional sports federations in the Canadian provinces is often carried out by the specially established physical education and sports organizations rather than by the field-specific authorities, which is a characteristic feature of organization of physical education and sports in Canada.

Keywords: *physical activity, mass sports, provincial government, physical education and sports.*

Backgroundю As required by the Presidential Decree of May 7, 2018 No. 204 “On the national goals and strategic progress objectives of the Russian Federation for the period up to 2024”, the physical education and sport service should be provided on a regular basis to at least 55% of the total population by 2024 [1]. This mission may be facilitated by studies of the best foreign physical education and sport service modeling and management experiences accumulated by the global sports leading nations – including Canada with its vast experience and progress record in the popular physical activity, mass sports and elite sports promotion domains. We believe it could be beneficial in this context to have overviewed and analyzed the Canada’s physical education and sport sector design and management experience.

Objective of the study was to analyze benefits of the provincial physical education and sport service design and management models traditional for Canada.

Methods and structure of the study. We used for the purposes of the study an institutional structure analysis in application to the provincial physical education and sport sector models existing in the Canadian regional government system; plus analyses of the relevant study reports, case studies and summaries.

Results and discussion. Any national physical education and sport system design analysis needs to factor in the actual regional government system. It should be mentioned in this context that the Canadian constituents (provinces and territories) are widely different in the physical education and sport sector management models – that have been designed on a largely individual basis, with the provincial ministries often being in charge of the local physical education and sport sector and the related services. In Ontario province, for example, the physical education and sport system is controlled by the Ministry of Heritage, Sports, Tourism and Culture [2], with its Sports Department mandated to develop governmental policies for the physical education and sport sector, regulate services of the provincial sports organizations and federations, control implementation of the relevant federal physical education and sport programs and come up with its own public physical activity encouragement/ promotion initiatives.

The Ministry controls a separate Communities Fund for disbursement of grant financing for the physical education and sport / recreation service projects that are generally designed to encourage mass physical activity / health and physical education activity in Ontario, with a special priority to children, youth and senior population groups. The Ministry also disburses the relevant budgetary finance to the provincial sports organizations via the Ontario Amateur Sports Foundation [3]. Top-ranking federal and international sports events hosted by the province are financed by the Ministry under the relevant federal sports support program directly funded by Sports Canada federal agency [4]. The Ministry is also responsible for the organization and management services to Ontario Games, the largest provincial sports event [5] launched back in 1970 to promote amateur sports in the province. Games for senior population groups in Ontario and other provinces are supported by the Canadian Association for Games for Seniors [6].

The physical education and sport sector in Manitoba province is regulated by the Ministry of Sports, Culture and Heritage on the whole and its Sports Secretariat in particular. The latter supervises Sports Manitoba organization [7] in charge of the provincial sports policies implementation initiatives and the Winter and Summer Games in Manitoba. In addition, Sports Manitoba controls the disbursement of finance from the provincial government and private donors including scholarships and grants to the local sports organizations [8].

Physical education and sport systems in many provinces of Canada are administered by special agencies reporting to the relevant ministries. Thus the provincial government of British Columbia includes the Ministry of Tourism, Arts and Culture with its Sports Office responsible for the provincial physical education and sport policies and strategies and supporting the local communal sports organizations. In addition, the Sports Office is responsible for interagency liaison and collaboration in the physical education and sport related matters in British Columbia [9]. The provincial physical education and sport progress policies are implemented by a non-commercial ViaSport organization funded by and reporting to the Sports Office. ViaSport is responsible, among other things, for disbursements of the relevant funds to the local sports organizations [10]. The provincial physical education and sport policies and practices are also facilitated by a non-commercial Sport BC Federation that unites more than 60 provincial sports organizations.

British Columbia is no less active than the above Ontario and Manitoba provinces in hosting the Winter and Summer Games every year, with its regional corporation BC Games Society (reporting to the Ministry of Tourism, Arts and Culture) being directly responsible for the organization and management services to these top-ranking provincial competitions and for trainings of the provincial elite sports teams competing at the national level [11]. It may be pertinent to mention that British Columbia takes special efforts to lure the local indigenous people in habitual physical education and sport / health practices [12].

physical education and sport sector in the Northwest Territory, one more Canada's constituent, is under control of the Ministry of Municipal and Public Affairs' Sports, Recreation and Youth Office – that is responsible for disbursement of the physical education and sport promotion funds – much like the above British Columbia's Sports Office. The Sports, Recreation and Youth Office is supported in its physical education and sport progress mission by the Sport North Federation, an umbrella organization for the sports federations in Northwest Territory with a special responsibility for the territorial elite sports development policies. As of 2019, the Sport North Federation reported incorporating 30 regional sports federations, plus the Association for Parks and Recreation of the North-West Territory [13]. The Sport North Federation management, with support from the Ministry of Municipal and Public Affairs, offers annual grant programs for the leading provincial athletes successful in competitions, with the grants endorsed by a special commission composed of the Sport North Federation members and representatives of the Ministry of Municipal and Public Affairs [14].

The physical education and sport agencies of the Northwest Territory give a special priority to the popular physical activity and mass sports encouragement initiatives. Thus, presently the Sports, Recreation and Youth Office takes special efforts to implement an Extracurricular Physical Activity Program to physically activate the local children and youth. The Office provides funding to local schools and communal organizations to promote the traditional and develop new physical activity models and tools at schools on an off-class basis [15].

Conclusion. The physical education and sport sector control model that implies the responsibilities for the local physical activity and mass sports being separated from the elite sports related ones – is rather typical for many provinces and territories of Canada, with special agencies vested with responsibilities for the top-ranking events and elite sports in provinces - including the British Columbia Games Society, Sports Manitoba, Alberta Sport Connections (in Alberta province), Sport North Federation (in the Northwest Territory) etc. Therefore, as demonstrated by the above analysis, responsible for the elite sports development policies and practices and the relevant support for the provincial sports federations in Canada are rather the special physical education and sport agencies than the relevant local government offices.

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METHODOLOGICAL APPROACH TO UNDERSTANDING SOCIAL BEHAVIOR IN SPORTS

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Abstract

Objective of the study was to rate and analyze the prosocial behavior / antisocial behavior in athletes using the adapted Russian version of the PABSS (prosocial behavior / antisocial behavior) test method (Kavussanu, Boardley, 2009).

Methods and structure of the study. The test method rates the prosocial behavior / antisocial behavior expressions in relations with the opponents/ teammates/ trainees, on a 5-point Likert scale (from 1 'never', to 5 'very often'). The test method applies the following four scales: (1) antisocial behavior in relations with the teammates/ trainees (e.g. 5 points for "verbally insulting a teammate"); (2) prosocial behavior in relations with the teammates/ trainees (e.g. 4 points for "praising a teammate"); (3) antisocial behavior in dealing with the opponent (e.g. 8 points for an "attempted injure to the opponent"); and (4) prosocial behavior (e.g. 3 points for "helping the injured opponent").

We sampled for the tests the 18-40 (M = 25.4) year old athletes (n=126, 42.5% male and 57.5% female sample) from Moscow and Ivanovo, with 47.2% and 52.8% of the sample competing in team sports (volleyball, basketball, football) and individual sports (athletics, chess, table tennis, skiing, powerlifting), respectively, with their sports records of 2 to 25 years (M = 10.1). We used for the online survey purposes the relevant Google Forms service, with the survey data processed using the SPSS 23 and Amos 23 based qualitative and quantitative data processing toolkits.

Results and conclusions. In the majority of the examined athletes, antisocial behavior was situational, in relation to both their opponents and teammates (coaches). Most athletes demonstrated prosocial behavior towards their teammates. Prosocial behavior towards opponents was either frequent or infrequent. Antisocial behavior towards both teammates and opponents was more common in team sports. With increasing sports experience, there was an increase on all the scales of prosocial and antisocial behavior in sports.

The survey showed the growing relevance of the antisocial behavior prevention and prosocial behavior encouragement initiatives for the sport communities. As demonstrated by some foreign study reports, the prosocial behavior in relations with the teammates contribute to the teamwork and team identity thereby consolidating the sport community to effectively prevent potential emotional burnouts. Further progress in the sports-specific ethical behavioral standards will make it possible to fully mobilize the resources of modern sports as a positive socialization and humanization institute for social progress. Therefore, moral and ethical progress aspects should be given a growing priority by the sport communities. Future research may be designed to analyze correlations (on a Russian sample) between the sport-specific social behavior and the priority personality qualities (motivations, self-esteem, emotional/ volitional controls, moral identity, etc.) in the relevant socio-psychological contexts (coaching styles, psychological climates etc.).

Keywords: *prosocial behavior, antisocial behavior, moral standards, sports psychology, psychometric research, physical education and sports.*

Background. Sports as a social institution and a specific socio-cultural activity domain with its traditional competitions and special training practices – give room to multiple social behavioral models. Athletes often face morally challenging situations that may be responded by aggression and egoism or tolerance, responsibility and fairness. It is not unusual that some competitors tend to neglect any morality-driven responsibility to freely vent out the physical and verbal aggression or resort to cheating – with heavy losses for the fair play principles and competitive climates. It should be emphasized in this context that the modern physical education and sports, when they fair, facilitate progress in many personality moral values including respect, honesty, cooperation and help to those in need [2]. The above alternative sport-specific behavioral models with their dichotomous norms are commonly referred to in the western sports psychology as the prosocial and antisocial behaviors (prosocial behavior and antisocial behavior, respectively).

Prosocial behavior may be defined as the actions intended to help or bring benefits to the others, in contrast to antisocial behavior i.e. the actions coming in conflict with the common rules and standards that may be harmful to antisocial behavior others [1, 3]. Prosocial and antisocial behavioral models are more explicit in modern contact/ team sports including football, basketball, rugby, hockey etc. Despite the fact that the antisocial behavior is sports are punishable by the rules, with the sports referees controlling them by removals from the court, penalties and disciplining measures on the one hand, and the sports federations adopting codes of ethics and disciplinary sanctions on the other hand – the statistics of unfair play, unsportsmanlike behaviors and disqualifications in competitions is still high.

Foreign psychology has accumulated valuable practical experience of the antisocial behavior / prosocial behavior tests and research in sports, with analyses of the athletes' moral standards, cheating, fair play and other aspects, and lists of the prosocial behavior predictors in sports including: social identity, moral identity, empathy, sport motivations, sportsmanship, coaching style, psychological climate in the team etc. [5-7]. It was in 2009 that Maria Kavussanu and Ian Bordley, professors of the University of Birmingham, offered the PABSS (prosocial behavior / antisocial behavior) test method [8] later on adopted by many nations (including the USA, Canada, UK, Turkey, China, Singapore, New Zealand, Portugal, Belgium, Lithuania) in different (sports-, age-specific) versions to effectively test and analyze behaviors and morality in sports [6].

In the Russian sports science, ethics of the sports-related behaviors have been analyzed by the athletes' humanistic priorities survey (A.V. Ternavsky, 2008), aggression prevention and correction study (S.O. Zakamorny, 2012), athletes' ethical culture surveys (G.I. Pasmurov, 2012; S.V. Klyuev, 2017), and sports axiology studies (E.A. Litinskaya, 2013).

Objective of the study was to rate and analyze the prosocial behavior / antisocial behavior in athletes using the adapted Russian version of the PABSS (prosocial behavior / antisocial behavior) test method (Kavussanu, Boardley, 2009).

Methods and structure of the study. The test method rates the prosocial behavior / antisocial behavior expressions in relations with the opponents/ teammates/ trainees, on a 5-point Likert scale (from 1 'never', to 5 'very often'). The test method applies the following four scales: (1) antisocial behavior in relations with the teammates/ trainees (e.g. 5 points for "verbally insulting a teammate"); (2) prosocial behavior in relations with the teammates/ trainees (e.g. 4 points for "praising a teammate"); (3) antisocial behavior in dealing with the opponent (e.g. 8 points for an "attempted injure to the opponent"); and (4) prosocial behavior (e.g. 3 points for "helping the injured opponent").

We sampled for the tests the 18-40 (M = 25.4) year old athletes (n=126, 42.5% male and 57.5% female sample) from Moscow and Ivanovo, with 47.2% and 52.8% of the sample competing in team sports (volleyball, basketball, football) and individual sports (athletics, chess, table tennis, skiing, powerlifting), respectively, with their sports records of 2 to 25 years (M = 10.1). We used for the online survey purposes the relevant Google Forms service, with the survey data processed using the SPSS 23 and Amos 23 based qualitative and quantitative data processing toolkits.

Results and discussion. The qualitative analysis found the sample seldom to occasionally prone to antisocial behavior in relations with the teammates, trainees and opponents. Most of the sample reported frequent prosocial behavior to the teammates – and seldom/ occasional prosocial behavior in dealing with the opponents: see Figure 1 hereunder.

Furthermore, to analyze the prosocial behavior /

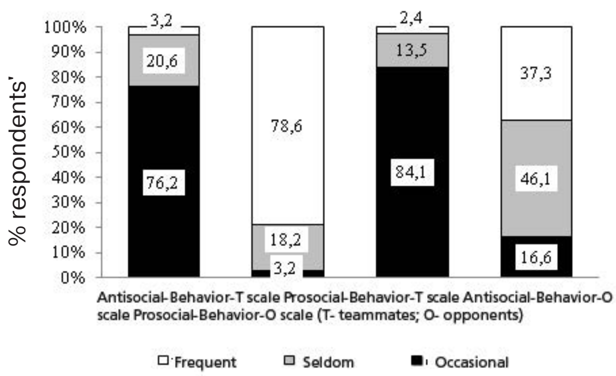

Figure 1. *Prosocial behavior and antisocial behavior test rates, %*

Antisocial-Behavior-T scale Prosocial-Behavior-T scale Antisocial-Behavior-O scale Prosocial-Behavior-O scale (T- teammates; O- opponents)
Frequent Seldom Occasional

Table 1. *Averaged sports-, gender- and record-specific antisocial behavior / prosocial behavior test data*

Scale	Gender				Sport				Sport record, years			
	M n=54	F n=72	U	p	Team n=60	Ind. n=66	U	p	2-10 n=76	11-25 n=50	U	p
Antisocial behavior -T	10,5	10,3	1924,5	0,923	11,3	9,6	1341,5	0,002*	9,3	12,0	1107	<0,001*
Prosocial behavior-T	17,2	16,8	1544	0,046*	17,0	16,9	1868,5	0,582	16,6	17,6	1412,5	0,014*
Antisocial behavior -O	14,5	13,3	1839,5	0,605	15,0	12,7	1195,5	<0,001*	12,5	15,7	1160	<0,001*
Prosocial behavior-O	9,8	10,2	1872	0,721	10,7	9,4	1589,5	0,055	9,6	10,6	1554	0,083

*Note: *significant difference; T- teammates; O- opponents*

antisocial behavior test data in more detail, we run a binary correlation analysis using the Mann-Whitney U-criterion for the following variables: gender, sport (team or individual), sports record (2-10 years, 11-25 years): see Table 1 hereunder.

As demonstrated by the above data, female subsample was found less prone to prosocial behavior in relations with the teammates/ trainees. More prone to the antisocial behavior in relations with the teammates and opponents was the team sport subsample. It should also be noted that the antisocial behavior / prosocial behavior manifestations tend to grow with the sport record on every scale. This finding may mean that that with the growing training and competitive experiences the athletes, on the one hand, make progress in the skills and emotionality – often manifested in the antisocial behavior to teammates/ opponents; and, on the other hand, develop sensitivity with growing prosocial behavior to their teammates.

Conclusion. The survey showed the growing relevance of the antisocial behavior prevention and prosocial behavior encouragement initiatives for the sport communities. As demonstrated by some foreign study reports, the prosocial behavior in relations with the teammates contribute to the teamwork and team identity thereby consolidating the sport community to effectively prevent potential emotional burnouts. Further progress in the sports-specific ethical behavioral standards will make it possible to fully mobilize the resources of modern sports as a positive socialization and humanization institute for social progress. Therefore, moral and ethical progress aspects should be given a growing priority by the sport communities. Future research may be designed to analyze correlations (on a Russian sample) between the sport-specific social behavior and the priority personality qualities (motivations, self-esteem, emotional/ volitional controls, moral identity, etc.) in the relevant socio-psychological contexts (coaching styles, psychological climates etc.).

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TRAINING WORKLOAD OPTIMIZING MODEL FOR STRENGTH SPORTS

UDC 796.8

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Abstract

Objective of the study was to find an optimal training work management model for the muscular strength resource building trainings.

Methods and structure of the study. The optimal training loads were determined during the one-month educational experiment with the involvement of the first-year male students of Yelets State Ivan Bunin University. The sample was made of the students who volunteered to participate in the experiment - a total of 28 subjects, divided into three subgroups based on the rating compiled on the basis of the results of testing of the forearm flexor strength. The rating made it possible to form equivalent groups. The training sessions were conducted twice a week. During the training sessions, the students were asked to perform several series of forearm flexions while setting the shoulders against a vertical platform.

Results and conclusions. The findings confirmed the dependence of the training effect on the amount of training work performed. It was also found that the criterion for assessing the optimal training load is the fatigue rate at the end of work. The optimal fatigue rate was determined. The reason why the same amount of work performed by different people has different training effects is that the muscles being trained have different levels of endurance. In general, the experiment confirmed the importance of implementation of the principle of optimal training load and proved the need for a personalized approach to its definition.

The greatest training effect was detected when the students performed the work resulting in the decreased force of the muscle contraction (fatigue) by 6-7%. The findings indicated the need for a personalized approach to the determination of the training load volumes.

Keywords: *strength trainings, training workload optimizing, training progress, super-compensation, strength resource, rehabilitative resource, forearm flexor strength.*

Background. Strength resource building in muscle fibers is known to be associated with myofibrils growing in volume as manifested by a myofibrillar hypertrophy [1]. It is a common belief nowadays that myofibrils are synthesized in response to metabolites of energy recuperation reactions (possibly creatine) being generated in the sarcoplasm by muscular contractions. The metabolites induce transcription of RNA molecules in the nuclei of muscle cells in the DNA segments that program the myofibrilar protein structures. Myofibrils are actively synthesized for some time after the work is over.

A negative side of the muscular fiber contractions is that the actin and myosin filaments are partially destructed by the acidic sarcoplasm – that is acidified as a result of the energy recuperation chemical reactions initiated by the muscular contractions [3]. The acidification degree is directly dependent on the productivity of oxidative phosphorylation of ADP in mitochondria. It is the destruction of myofibrils that is believed to undermine the strength resource i.e. develop physical fatigue [3].

Activity of the myofibril synthesis upon a training session depends on the amount of work done – i.e.

the harder is the work the more active is the synthesis, albeit this correlation is not linear, since the synthesis is known to reach some peak and fall with further work [4]. Upon completion of the rehabilitation period, activity of the myofibril synthesis will fall until fully stops. It should be noted that the more active is the synthesis prior to the rehabilitation period, the longer the synthesis will go – to not only offset large losses of myofibrils in hard training work but also contribute to the super-compensation process. Knowing the startup rate of myofibril synthesis, one can assess the rehabilitative resource accumulated by the working muscular fibers. (Rehabilitative resource may be defined as the amount of protein that may be synthesized after training) [4].

Since the rehabilitative resource growth with training work tends to fall after some peak value, further excessive trainings may reach the point of abrupt regress. Therefore, the training work that generates the rehabilitative resource in the highest excess of the energy costs may be defined as the optimal training work. The higher are the positive and negative deviations from the optimal training work, the lower are the training process benefits. Strength trainings are particularly sensitive to the training work management along the optimal line [4]. The above considerations urged us to undertake an experimental study to find a set of training work optimizing criteria.

Objective of the study was to find an optimal training work management model for the muscular strength resource building trainings.

Methods and structure of the study. We sampled for the training work management model testing expereiment the 1-year male students (n=28 recruited on a voluntary basis) of Yelets State Ivan Bunin University and split them up into 3 groups using the pre-experimental forearm flexor strength rating tests as follows: Group 1: 27.4±4.37kg; Group 2: 27.7±4.34kg; and Group 3: 26.9±4.39kg.

The monthly experiment was timed to the regular Physical Education classes (2 times a week, 8 trainings in total) and designed as follows. The students made a few series of forearm flexing push-offs with shoulders rested on a vertical platform. The forearm flexor strength was tested by a DES-300D deadlift dynamometer prior to and after every training session to rate the forearm flexor fatigue (strength drops). The Group training works were as follow: Group 1 did 3 rounds of 5 reps; Group 2 did 5 rounds of 5 reps; and Group 3 did 7 rounds of 5 reps, with weights in every group rated at 80% of the maximum. The post-experimental tests to rate group forearm flexor strength training progresses were run 3 days upon completion of the last 8th training session lesson.

Results and discussion. Upon the test data were mathematically processed, we found the group progress averaging 3.45±1.34kg, 5.67±1.51kg and 4.17±1.43kg in Groups 1, 2 and 3, respectively. The Group 2 progress versus Groups 1 and 3 was tested significant by the Student T-criterion; whilst the Group 1 and 3 progresses were found insignificantly different. Therefore, the optimal training work in the experiment was 5 rounds of 5 reps with 80% maximal weight.

The test data were further processed to analyze the post-training forearm flexor fatigue (%) and rate them versus the forearm flexor strength progress data. On the whole, the group forearm flexor fatigue (strength drops) tested to average 5-7%, 6-10% and 8-12% in Group 1, 2 and 3, respectively. We further sampled 10 best individual strength progresses to rate them versus the forearm flexor fatigue data to find the forearm flexor fatigue of 6-7% being correlated with the highest progresses. This finding may mean that the strength training progress depends on the post-training fatigue rather that the training work as such. It is not unusual that the same work may result in different rates of fatigue in different trainees – apparently due to the individual variations in endurance rates of the working muscle groups.

Conclusion. Trainings designed to build up the muscular fibers contraction strength result in growth of the myofibrils volumes with work. The study found the strength training process being the most efficient when the post-training fatigue (strength drop) varies at 6-7%. It is recommended that the strength building training work should be designed and managed on an individualized basis.

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SPECIAL AND OVERALL ENDURANCE RATES IN TEAM ATHLETES OF DIFFERENT SPECIALIZATIONS AND QUALIFICATIONS

UDC 796.33

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Abstract

Objective of the study was to evaluate and compare the special and overall endurance rates in the representatives of various sports games with the qualifications from Class III to Masters of Sport.

Methods and structure of the study. We tested the aerobic abilities and special endurance rates in 128 volleyball players, 127 handball players, 136 basketball players, 140 football players, and 118 rugby players with the sports qualifications from Class III to Masters of Sport. The following research methods were applied: theoretical analysis; pedagogical observations; pedagogical testing; mathematical statistics methods.

Results and conclusions. The studies made it possible to determine the aerobic abilities and special endurance rates in the volleyball players, basketball players, handball players, rugby players and football players with different skill levels - from Class III to Masters of Sports. The improvement of sports skills of the representatives of these sports games takes place simultaneously with the significant ($p<0.05$) improvement of aerobic potential and special endurance. For example, the rugby players qualified from Class III to Masters of Sport showed the following progress in Cooper's test: 2895.7±16.01; 3101.3±15.11; 3177.7±14.38; 3288.5±15.08 and 3411.4±14.05 m, respectively. By the level of development of aerobic abilities, the representatives of various sports games were ranked as follows: 1) football players, 2) rugby players, 3) handball players, 4) basketball players, 5) volleyball players. The best absolute result in the 5x30 m shuttle run test was demonstrated by the rugby and football players qualified Masters of Sport: 19.55±0.03 sec and 20.05±0.05 sec.

The practical use of the data obtained ensures that the principles of proportionality in the development of physical qualities and orientation towards higher achievements are realized in the process of athletic training. The prospects for further research may be focused on the study of strength abilities of the representatives of various sports games.

Keywords: *qualifications, overall and special endurance, rates, competitive activities, sports games.*

Background. The unprecedented pressure from WADA, on the one hand, and increased competition in world sports arenas, on the other, have identified a diverse range of issues in Russian sports. The foregoing necessitates further optimization of the training process in all sports, especially prestigious ones such as sports games. The analysis of recent studies has revealed that, in spite of a sufficient number of publications on the issue, the comparative characteristics of development of different types of endurance of team athletes depending on their specialization and qualification have not been studied well enough [2-5].

Objective of the study was to evaluate and compare the special and overall endurance rates in the representatives of various sports games with the qualifications from Class III to Masters of Sport.

Methods and structure of the study. We tested the aerobic abilities and special endurance rates in 128 volleyball players, 127 handball players, 136 basketball players, 140 football players, and 118 rugby players with the sports qualifications from Class III to

Table 1. *Overall and special endurance rates in team athletes of different specializations and qualifications*

Sports game	Control exercise	Qualification					
		Master of Sport		Candidate Master of Sport		Class I	
		$\bar{x}$	m	$\bar{x}$	m	$\bar{x}$	m
Volleyball	Прыжковая выносливость, раз 5x30 m shuttle run, sec Cooper's run test, m	22.9* 21.44* 2979.5*	0.02 0.05 15.12	17.8* 22.03* 2849.8*	0.01 0.06 15.44	14.5 23.00 2724.9	0.03 0.05 16.17
Basketball	Special endurance, m Cooper's run test, m 5x30 m shuttle run, sec	429.5* 3201.2* 21.03*	3.0 12.07 0.05	416.1* 3122.8 21.77*	3.11 15.55 0.06	406.1 3075.2 22.70	3.21 16.18 0.04
Handball	5x30 m shuttle run, sec Cooper's run test, m	21.17* 3307.5*	0.03 14.02	21.98* 3177.7*	0.04 16.04	22.89 3081.2	0.05 14.27
Rugby	Cooper's run test, m 5x30 m shuttle run, sec	3411.4* 19.55*	14.05 0.03	3288.5* 20.72*	15.08 0.04	3177.7 21.85	14.38 0.05
Football	5x30 m shuttle run, sec 7x50 m shuttle run, sec Cooper's run test, m	20.05* 58.93* 3611.2*	0.05 0.24 14.14	20.87* 61.79* 3494.7*	0.05 0.44 14.22	21.44 64.08 3407.8	0.04 0.33 15.18

Note. * – the differences between the adjacent sports categories are significant at $p<0.05$

Masters of Sport. The level of development of their aerobic capacities was studied in Cooper's 12-minute run test [1]. Special endurance was evaluated using the common 5x30 m shuttle run test and a game-specific exercise [1]. The football players were subjected to the 7x50 m shuttle run test. The volleyball players performed the jump endurance test, which consisted in counting the number of touching jumps at a height of 98% of the maximum. The basketball players were to perform the following exercise: start from one end line and run to the opposite end line, then turn and run in the opposite direction - for 40 sec. Then followed a 1-min rest break, after which the athletes repeated the 40-sec run. We considered the total meters covered in 80 sec.

Results and discussion. The data given in the table indicate that the results of Cooper's run test improved with the growth of sports skills. However, in all types of sports games, there were statistically significant differences ($p<0.05$) between almost all the results demonstrated by the athletes of the adjacent sports categories. For example, the rugby players qualified from Class III to Masters of Sport showed the following progress in Cooper's test: 2895.7±16.01; 3101.3±15.11; 3177.7±14.38; 3288.5±15.08 and 3411.4±14.05 m, respectively. According to the table, in terms of the level of development of overall endurance the representatives of different sports games can be ranked as follows: 1) football players, 2) rugby players, 3) handball players, 4) basketball players, 5) volleyball players. This distribution is obviously due to the specific features of each sports game, which imposes relevant requirements for the athletes' aerobic performance. For example, Masters of Sport in football, who have the highest level of development of aerobic capacities as opposed to the representatives in other sports games, cover an average of 3,611.2±14.14 m in 12 minutes, while Candidate Sport Masters and Class I athletes - 3,494.7±14.22 m and 3,307.8±15.18 m, respectively.

The results of testing of special endurance in the volleyball players, basketball players, rugby players, handball players, and football players and their correlation with the effectiveness of their competitive activities showed an average and high strength of relationship - r from 0.51 to 0.72. At the same time, as in the overall endurance tests, the special endurance rates increased with the growth of the athletes' sports skills by a statistically significant value ($p<0.05$). The 5x30 m shuttle run test results revealed the specificity and expediency of its use in different sports games. It is obvious that this test can be successfully used along with other tests in football, rugby, and handball to solve certain tasks - in basketball and to a lesser extent - in volleyball trainings. Thus, in terms of the 5x30 m shuttle run test results, the representatives of different sports games were distributed as follows: 1) rugby players, 2) football players, 3) basketball players, 4) handball players, 5) volleyball players. The best absolute result in the 5x30 m shuttle run test was demonstrated by the rugby and football players qualified Masters of Sport: 19.55±0.03 sec and 20.05±0.05 sec.

The findings once again confirmed the need to ensure effective control over the parameters of overall and special endurance in all types of sports games [2, 3, 5], as these aspects of fitness often decide the outcome of strenuous sports matches.

Conclusions. The data obtained during the study correlate with those obtained by the leading experts on the close relationship between the overall and special endurance rates and the effectiveness of competitive activities in different sports games, which necessitates the optimization of the athletic training process by improving the relevant components of the athletes' sports skills.

We substantiated the need to consider the parameters of aerobic capacities and special endurance when planning the process of multi-year training of volleyball players, basketball players, handball players, rugby players, and football players at different stages of sports qualification - from Class III to Master of Sports. The practical use of the data obtained ensures that the principles of proportionality in the development of physical qualities and orientation towards higher achievements are realized in the process of athletic training.

The comparative analysis of the overall endurance rates in the volleyball players, basketball players, handball players, football players, and rugby players revealed a significant advantage of the football players. While the highest results in the 5x30 m run test were demonstrated by the rugby and football players. The prospects for further research may be focused on the study of strength abilities of the representatives of various sports games.

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EFFECTIVENESS OF VERBAL FEEDBACK IN COMPLEX MOTOR SKILL LEARNING

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Abstract

The aim of this work was to broaden the knowledge about the influence of verbal feedback related to errors in the performance of the whole motor skill, its phases and key elements on the effectiveness of learning complex motor skills performed on the trampoline. The research included 45 children (n=45) aged 6-8. The experiment and experts' evaluation were applied as the research methods and pike jump performance technique was assessed in terms of kinematics. The study participants were randomly divided into three groups. In the first group (n=15), the subjects received verbal feedback on errors concerning the whole motor skill performance. In the second group (n=15), the participants were provided with verbal feedback on errors made in particular phases of the skill performance. In the third group (n=15), the subjects received verbal feedback on errors that occurred in key elements. In the course of pike jump learning, an increase in mean scores was noted. Both in the post-test and the retention test, the highest mean score was observed in the third group (8.46 pts and 8.36 pts, respectively) ($p<0.05$). In the transfer test, a decrease in mean scores was noted in this group (8.18 pts). The effectiveness of learning complex motor skills is different depending on the type of verbal feedback. Feedback on errors made while performing key elements of the motor skill produces the longest lasting effects when it comes to pike jump learning.

Keywords: *training, verbal feedback, trampolining.*

Introduction. The process of motor learning has fascinated scientists for many years. A lot of motor learning theories have been formulated over this period. A lot of researchers attempted to explain mechanism of motor skill acquisition and factors affecting its effectiveness [2, 4, 5, 8]. The cognitive theory is considered to be the most important theory related to the motor learning process. External feedback constitutes the basis of this process. From the very beginning, the process of learning in each sport ought to be aimed at enabling athletes to develop exercise-related movement habits that would allow them to perform more difficult and more complex motor skills at further stages of training. In particular, it can be related to trampolining, which is a highly complex and difficult sport.

When examining a learning process, simple skills were usually used. In sport, there are more difficult and complex motor skills that make it impossible to implement rules that refer to the learning of simple skills in sports training [9]. Attempts were made at identifying variables that contribute to fast and durable learning the most. The effects of the following variables were analysed first and foremost: verbal feedback, visual feedback and kinaesthetic feedback [3, 5].

The process of learning in sports with complex motor skills can be effective owing to extrinsic feedback. Two types of such feedback can be distinguished, i.e. knowledge of results (KR) and knowledge of performance (KP). KR refers to success in performance in relation to the goal both in quantitative and qualitative terms. KP is defined as kinematic or kinetic information that refers to aspects of the movement pattern. Verbal feedback is the type of KP commonly used in the process of motor learning [3]. A number of researchers claimed that instructions provided prior to, during and after motor skill performance played a significant role in making the learning process effective [6, 7, 8, 10]. Therefore, the question arises whether feedback on all errors or just on key elements should be provided. Despite numerous studies on both simple and complex skills, there is still a scarcity of data that would clearly indicate which type of feedback ought to be provided. It is noteworthy that not enough empirical research has been conducted on learning complex motor skills related to the so-called early sports (including trampolining) as well as to groups at early stages of training.

Objective. This study sought to extend the knowledge about the influence of verbal feedback related to errors in the performance of the whole motor skill, its phases and key elements on the effectiveness of learning complex motor skills performed on the trampoline.

Research methods and organization. The experiment and experts' evaluation were applied as the research methods. Moreover, kinematic assessment of pike jump performance technique was carried out. The study included children aged 6-8 (n=45).

At the beginning of the research, a preliminary experiment that involved 24 training sessions was carried out. The sessions took place three times a week (90 minutes per session). At this stage, the goal was to provide comprehensive conditioning and coordination training. After the preliminary experiment, pike jump (PJ) performance technique was assessed (pre-test).

Next, the main experiment aimed at pike jump learning was performed. The task involved performing five trampoline jumps followed by a vertical jump with the body folding into a pike and both legs lifted off the trampoline to a horizontal position. During the vertical jump, the legs were parallel to or higher than the floor and the arms were extended towards the toes. Landing involved shock absorption using ankle, knee and hip joints.

In the case of the main experiment, the study participants were randomly assigned to one of the three groups. The person who assigned the subjects to the groups was not involved in conducting the main part of the study. In the first group (n=15) (126.7 cm ± 5.7 cm; 23.6 kg ± 1.4 kg), the subjects received verbal feedback on errors concerning the whole motor skill performance (EWS). In the second group (n=15) (126.1 cm ± 5.2 cm; 23.3 kg ± 1.6 kg), the participants were provided with verbal feedback on errors made in particular phases of the skill performance (EPS). In the third group (n=15) (125.8 cm ± 6.0 cm; 22.9 kg ± 1.5 kg), the subjects received verbal feedback on errors that occurred in key elements (EKE). The study involved 18 training sessions. The sessions took place three times a week (90 minutes per session). During each session, the subjects performed 3 sets of 5 repetitions. After each session, they received verbal feedback on errors. The experiment was conducted by one coach. Immediately after the learning process, pike jump performance technique was evaluated (post-test). Afterwards, re-evaluation was performed one week following the process completion (retention test). Also, the transfer test was carried out, during which the participants were asked to perform trampoline pike jump with the trampoline positioned on the ground level. During the pre-test, post-test, retention test and transfer test, the subjects were given no feedback at all.

Technique was evaluated by experts (n=3), i.e. licensed FIG judges. Arithmetic mean was calculated from the three evaluations. The mean was used in the analysis of research results. Prior to rating the performance, the experts got acquainted with assessment criteria. For each minor error they deducted 0.1 pts, for a medium one – 0.2-0.3 pts, while for a major error they deducted 0.5 pts from the maximal score. The judges focused on errors that occurred during the take-off, flight and landing, e.g. horizontal displacement, pulling bent knees to the chest, pulling the legs to the chest at the end of the ascending phase, opening at the end of the descending phase, not standing upright after landing or uncontrolled movements in the out-bounce.

In addition, kinematic assessment of pike jump performance technique was conducted. The analysis included joint angles as well as resultant velocities of body biolinks and the centre of gravity. The APAS 2000 analysis system was applied to measure, record and analyse movement in three planes. One 100 Hz camera was used to record the jumps. The camera was positioned 8 m away at an angle of 45^0 relative to the perpendicular line going through the centre of the trampoline, above the level of the trampoline surface. The films were recorded and analysed in AVI (Audio Video Interleave) format.

The normality of distribution and homogeneity of variances were tested with the Shapiro-Wilk test. One-way ANOVA was used to estimate statistically significant differences between the measurements. Statistical significance was set at $p<0.05$. The Fisher post-hoc test was applied to assess significance of differences between mean results. The results were analysed with the use of Statistica (STATISTICA, version 12) software.

Results and discussion. Kinematic analysis of pike jump performance technique

In order to identify key technical elements that mainly determine the effectiveness of learning complex motor skills, a kinematic analysis of the phases of movement structure was performed. Two indices were analysed, i.e. joint angles and resultant velocities. Sadowski et al. [7] singled out the following phases in the movement structure: preparatory phase, main phase and final phase.

The so-called key elements of sports technique were identified in particular phases. In the preparatory phase, a launching body posture was distinguished (fig. 1 A), in the main phase involved multiplication of the body posture (fig. 1 B) and in the final phase, a landing body posture was distinguished (fig. 1 C).

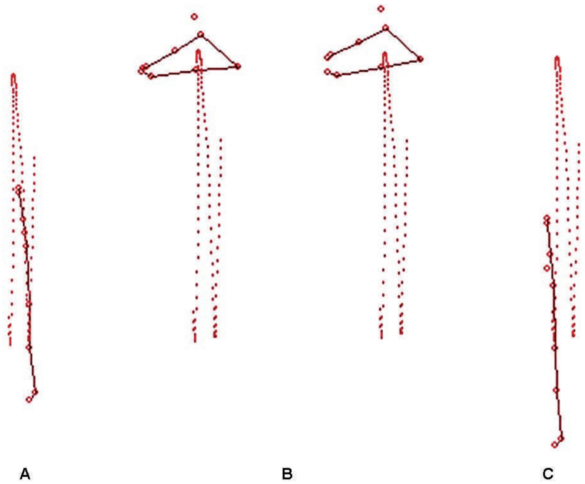

Figure 1. *Three key elements: A - Launching body posture when performing pike jump, B - Multiplication of the body postures when performing pike jump, C - Landing body posture when performing pike jump*

The launching body posture (fig. 1 A) involved standing with arms upward. The research results made it possible to distinguish the most characteristic kinematic indices of this posture. The following joint angle parameters were observed: shank-thigh angle – 175°, thigh-trunk angle – 180°, trunk-shoulder angle – 173°. Resultant velocity of the gravity centre (GC) was 4.872m/s, whereas that of the ankle joint was 4.578m/s. Such kinematic indices of the launching body posture ensured proper performance of the jump and tucking.

When it comes to the multiplication of the body postures (fig. 1 B), the following joint angle parameters were noted: shank-thigh angle – 178^0, thigh-trunk angle – 46^0, trunk-shoulder angle – 109^0. Resultant velocity of the GC at the time of grabbing the ankle joints was 1.285m/s, while the velocity of the ankle joint was 1.780m/s.

The landing body posture (fig. 1 C) when performing pike jump on the trampoline revealed the following joint angle parameters: shank-thigh – 176^0, thigh-trunk – 179^0, trunk-shoulder – 176^0. Resultant velocity of the GC at the time of landing was 0.718m/s, while that of the ankle joint was 0.533m/s.

The influence of verbal feedback related to errors in the performance of the whole motor skill, its phases and key elements on the effectiveness of learning pike jump

In the pre-test, the differences noted were not significant – F(2.42)=.148, p=.863. The findings point to similar levels of motor skills in learners prior to commencing the process of learning pike jump (fig. 2).

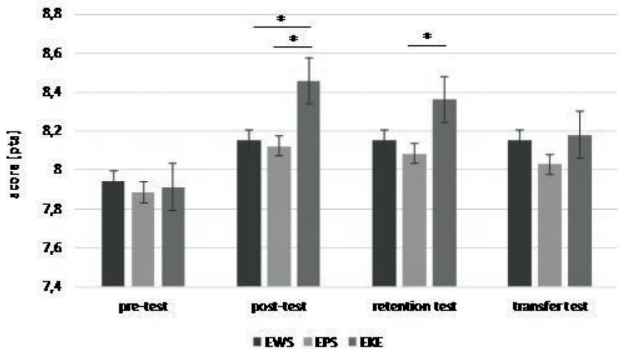

Figure 2. *Mean values of experts' evaluation [pts] obtained for performing pike jump in the pre-test, post-test, retention test and transfer test*

ANOVA confirmed that different types of feedback provided during the post-test resulted in statistically significant differences between groups EWS, EPS and EKE – F(2.42)=5.869, p=.006. In the post-test, the highest mean values were obtained by group EKE (8.46 pts), while the lowest scores were achieved by group EPS (8.12 pts). The differences between mean scores of groups EKE and EPS were statistically significant in favour of group EKE (p<.05). Significant differences were also noted between groups EKE and EWS (p<.05). In the retention test carried out one week after completing the process of learning, differences between mean scores of groups EWS, EPS and EKE were found – F(2.42)=3.445; p=.0411. Group EKE retained the highest mean score (8.36 pts), whereas the lowest one (8.08 pts) was noted in group EPS. The difference between these mean scores in these groups was statistically significant in favour of group EKE (p<.05). In the transfer test, differences between mean scores obtained by groups EWS, EPS and EKE were not statistically significant (F(2.42)=.949, p=.395) (fig. 2).

Based on the research results, it was stated that verbal feedback on errors in key elements was the most effective in the post-test and in the retention test. It may point to the fact that at an initial stage of learning, verbal feedback on the most important body positions may produce more effective outcomes. At this stage, learners may focus on correcting errors they were informed about. On the other hand, too general feedback may obstruct the process of learning. Similar observations were made by Tzetzis and Votsis [8]. Niźnikowski et al. [5] noted that providing feedback on key technical elements in the learning of complex motor skills is crucial in terms of performance quality. They also added that too much feedback may be overwhelming to the learner who, consequently, will be incapable of making full use of the received feedback. It is in line with the findings of the present study. In the transfer test, a decrease in the mean score was noted in the group that had obtained the highest mean values in the previous tests. Verbal feedback on errors in the whole motor skill performance helped to retain similar mean scores. It may indicate that feedback on key elements did not affect motor skill performance in changed conditions. On the other hand, feedback on errors in the whole motor skill performance provided during training sessions may disturb the process of learning. However, this type of feedback may lead to improved performance if motor skill performance conditions have been changed and if there is not any extrinsic feedback. In this case, the learner may make use of intrinsic feedback. Therefore, it is believed that future studies ought to include more and more complex skills, which may improve training processes considerably [1, 6, 9].

Conclusions. Effectiveness of learning complex motor skills is different depending on the type of verbal feedback (feedback on errors in the performance of either the whole motor skill or its phases or key elements). In the case of pike jump, feedback on errors in key elements results in more durable learning outcomes. Understanding the types of feedback may lead to better comprehension of its role in the process of learning complex motor skills. The study revealed that the effectiveness of pike jump learning depends on the type of verbal feedback concerning errors. The study does not exhaust this issue, so further research is needed to examine the effectiveness of various types of verbal feedback used in complex motor skills.

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FEEDBACK DURING LEARNING GYMNASTIC EXERCISES

UDC 796.012.68

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Abstract

Objective. Studying the impact of two different types of verbal cues in the process of teaching complex gymnastic exercises – double salto backward piked to dismount from uneven bars.

Material and methods. The study involved skilled female artistic gymnasts (n = 16). Their average indices of height, body mass and age ($x \pm \delta$) constituted: 157.5 ± 2.85 cm; 51 ± 2.25 kg; 20 ± 2.35 years, respectively.

Pedagogical experiment was conducted to evaluate the efficiency of training and improving sports technique of gymnastic exercises through the use of two types of verbal cues. The subjects (n = 16) were randomly divided into experimental (E) (n = 8) and control (C) (n = 8) groups.

Results. Statistically significant differences were revealed between the average results of the E and C groups (F (2, 28) = 49.724, p =, 00000). The differences between the average results of each group were statistically significant ($p < 0.001$) both before and after the test of memory strength.

Keywords: *female gymnasts, feedback, kinematic structure, sports technique, double salto backward, dismount.*

Introduction. Problems of motor action training have been and continue to be of interest to scientists for many years. Numerous different theories have been formulated, and many means, methods, and forms of motor action training have been developed. The most efficient is cognitive theory, in which the main role boils down to the notion of feedback. Training with the use of feedback has been shown to provide optimal results.

Feedback may be provided to the athlete before, during and after the task performance in oral, visual, kinesthetic or combined form. Each type of feedback plays an important role in determining the rate and efficiency of learning [1, 2].

Let us dwell upon studies in which the effectiveness of using various feedback options has been tested. A number of specialists have tried to explain the learning process and the factors contributing to its efficiency [3, 4]. The following aspects are usually analyzed in this respect: feedback types - verbal, visual and kinesthetic, in particular [5], organization of feedback - the frequency and time of information conveying to students [6]; task complexity and contextual interjection [7].

Most studies were conducted with the use of simple motor actions, which limits their transfer to the conditions of real-life physical education or sport, where complex motor tasks tend to dominate. In these works, it was shown that an oral explanation significantly facilitates the execution of a specific motion, since the teacher focuses the student's attention on those aspects of the task that can be omitted during the visual form of feedback [8]. According to another conclusion, if oral instructions containing information about errors and ways to correct them were used at the beginning of the learning process, then their impact on learning outcomes was effective [9].

There are few scientific works on the impact of various types of feedback on learning complex motor tasks in practical conditions of elite sport.

Despite the fact that the feedback influence on the process of learning motor movements has been the subject of numerous studies, many issues directly related to sport need to be addressed [6].

As of today, there is a relative lack of studies on the role of different feedback types (verbal, visual, kinesthetic information) in teaching complex motor tasks.

Objective. Studying the impact of two different types of verbal cues in the process of teaching complex gymnastic exercises – double salto backward piked to dismount from uneven bars.

Tasks. 1. To conduct biomechanical analysis of the key elements of connecting move sports technique "double salto backward piked to dismount from uneven bars".

2. To study the effect of two different feedback types in the process of learning double salto backward piked to dismount from uneven bars.

Methods of study. Skilled and highly skilled female gymnasts participated in the study. Their average indices of height, body mass and age ($x \pm \delta$) constituted: 157.5 ± 2.85 cm; 51 ± 2.25 kg; 20 ± 2.35 years, respectively. Gymnasts were randomly assigned to one of two groups: experimental E (n = 8) and control C (n = 8), the differences between the groups were insignificant ($p > 0.05$). In the course of training, the experimental group (E) athletes received urgent verbal information about the errors committed in the key elements of the mastered motor action, whereas those of the control group (C) - about all the faults made during performing double salto backward piked to dismount from uneven bars.

1. To determine the technique key elements, two digital cameras JVS 6R-DVL 9800 NTSC were used for video-recording the performance of connecting move "double salto backward piked to dismount from uneven bars".

2. The efficiency of two types of verbal instructions was determined experimentally. After completing the task, the subjects of E group were informed of errors committed in the key elements and how to correct them in a subsequent attempt. Other errors were ignored. Subjects of C group received information about all the faults made in each attempt and the ways to correct them (100% feedback). The approach used in C Group is common in gymnastics training sessions. Each of the two corrective impacts was evaluated on the basis of three tests before and immediately after the training process as well as six days after its completion. Technical fitness of female gymnasts was assessed by three (n=3) highly qualified artistic gymnastics judges. The consistency of experts opinions was determined by the coefficient of concordance (r=0.848). In the process of training, the gymnasts made 240 attempts to perform double salto backward piked to dismount from uneven bars.

Statistical analysis methods: the normality of distribution and the uniformity of deviation were verified by the Shapiro-Wilk test. Differences in the use of two types of verbal instructions were determined by means of ANOVA variance analysis. The probability level $p < 0.05$ was used as critical. Fisher's test was used to reveal significant intergroup differences. Statistical analysis of the results was made using the STATISTICA computer software package (version 12.0).

Results of study. Figure 1 illustrates the effect of training double salto backward piked to dismount from uneven bars.

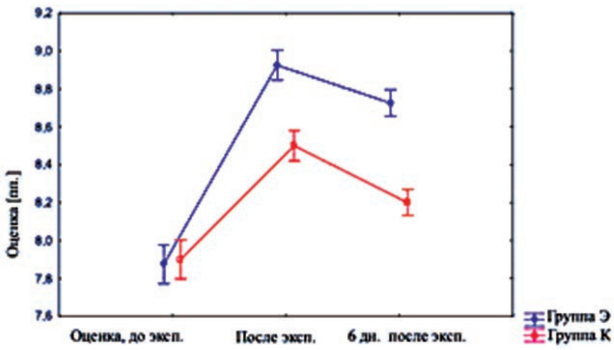

Figure 1. *Average group scores for execution of double salto backward piked to dismount from uneven bars.*

The average results of groups E and C were found to be statistically significant ($F(2, 28)=49{,}724$, p=00000) (Table 1).

It was found that before the experiment the differences between the average results of groups E and C were statistically insignificant ($p>0.05$). At the end of the experiment, the average values increased in both groups. The increase of indices was statistically significant ($p<0.001$) in both groups. On the other hand, 6 days after the end of the experiment a decrease in mean values ($p<0.001$) was observed. It is noteworthy that both at the end of the experiment and 6 days after the experiment, statistically significant differences between the average results of groups E and C were observed in favor of group E ($p<0.001$).

Conclusion. Training and improving motor skills are the major tasks in the process of technical preparation of female gymnasts. The search for ways to

Table 1. *Statistical significance level according to Fisher*

Test	Group	{1} 7,8750	{2} 8,9250	{3} 8,7250	{4} 7,9000	{5} 8,5000	{6} 8,2000
Before	E		0,000000	0,000000	0,657935	0,000000	0,000002
After	E	0,000000		0,000046	0,000000	0,000000	0,000000
6 days after	E	0,000000	0,000046		0,000000	0,000357	0,000000
Before	C	0,657935	0,000000	0,000000		0,000000	0,000000
After	C	0,000000	0,000000	0,000357	0,000000		0,000000
6 days after	C	0,000002	0,000000	0,000000	0,000000	0,000000	

effectively solve these tasks, in particular, the use of feedback, is an up-to-date direction of studies both in elite sport and physical education**.**

Therefore, the objective of the study was to gain knowledge about the impact of different verbal information and the efficiency of teaching complex gymnastic exercises - double salto backward piked to dismount from uneven bars. At the first stage of the study, the technique key elements were determined. It was established that the key elements providing the effectiveness of the exercise performance are: starting posture, motor actions aimed at assuming tuck position and motor actions during landing. Starting posture is known to exert a significant influence on the quality of each individual exercise and a connection of gymnastic exercises [4]. Based on a study by Gervais, Dunn [10], it was found that the best results during performing a double salto backward piked to dismount from uneven bars are achieved by those female gymnasts who "feel the limits" in the phase structure of movement. Identifying the phase structure of an exercise may be of crucial significance for development of effective training programs and preparation of gymnastics coaches.

These views coincide with the opinion of other authors [6], who have shown that in sports technique of gymnastic exercises one may single out specific body systems characterized by elastic-rigid and rigid interaction with bearing surface, which determines the quality of gymnastic exercise performance and their dynamic connections.

The results of the above studies indicate large reserves in preparation of female gymnasts. The technology for teaching complex motor actions should be enhanced at the expense of the optimal amount of information conveyed by the coach.

One of the directions for technical preparation optimization in gymnastics is to reduce the amount of verbal instructions about the quality of task execution passed on to the athlete. One of the effective ways is to focus the corrective actions of the coach on the errors committed in the key elements of sports technique.

Therefore, it seems advisable to carry out a kinematic analysis of the studied exercise structure and identify the technique key elements, above all. The training process design with account for the formation of the motor action correct structure, the "sense of limits" and body position, will undoubtedly contribute to decrease in the intensity of the training process of female gymnasts and the development of a progressive training model, being the most promising in the process of long-term preparation [4]. Further research should be aimed at studying a complex of entirely different theoretical approaches to the type of information presentation and control during movement motor structure formation with the subsequent development of recommendations necessary for teachers and coaches.

Conclusions. 1. Our results prove that a great deal of information is not the most effective way of teaching complex gymnastic exercises.

2. Provision of a large amount of information turned out to be less efficient for teaching gymnastic exercises than the dosed information on errors in key elements of sports technique.

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COACH IMAGE AND PSYCHOLOGICAL WELLBEING OF STUDENT ATHLETES

UDC 796.012.68

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Abstract

Objective of the study was to rate and analyze the coach image versus psychological wellbeing in academic sports.

Methods and structure of the study. We profiled the coach image under the study using the Y. Khanin and A. Stambulov Trainer-athlete Cooperation Scale making it possible to rate the coach's social perceptions, personality qualities and service efficiency and consolidate the data to produce a generalized coach's portrait with its gnostic, emotional and behavioral dimensions. In addition, the surveyed academic athletes were offered a semantic differential matrix to probe their perceptions of a real and ideal coach. The subjective well-being of the sample was rated by the K. Riff Psychological Wellbeing Scale adapted by L. Zhukovskaya and E. Troshchikhina.

Results and conclusions. The top five important qualities of a coach, both real and ideal, were as follows: professional, interested, competent, respectful, confident. These qualities characterize a certain personal "strength" of a coach as a teacher and may precondition the set-up of the students' personal development program. In the minds of student athletes with the high level of psychological wellbeing, a coach must possess professional competence, manifested in their behavior. For the student athletes with the insufficient goal-setting level, it is personal qualities of the coach that are decisive, since the structural components of their psychological wellbeing are self-acceptance and positive attitude. For the student athletes with the shaped life goals, the significance of coach image faded in comparison to their self-sufficiency and personal growth.

Keywords: *coach image, academic sports, psychological wellbeing, student, theoretical and practical training, life goals.*

Background. Coach image is known to play an important progress control role in the academic theoretical and practical training process, with a special contribution from the coach-athlete cooperation style. Every academic athlete is largely driven by the coach image when forming the own personality/ professional progress agenda [1, 6] in the academic theoretical and practical training, with the coach image contributing to self-perception and progress among the other elements of the psychological wellbeing [9]. Psychological wellbeing may be defined as the basic individual structure with the own functionality perceptions and ratings in the context of the human resource and its management qualities and skills within the framework of the individual self-perceptions and world outlook [5]; and with the self-acceptance and life goals ranked among the key psychological wellbeing elements [3].

Coach image research versus the psychological wellbeing in academic sports may be of high interest for at least the following reasons. On the one hand, a competitive success implies a certain degree of self-acceptance with an adequate self-esteem, self-confidence, self-control, as well as determination in the life agenda [2, 4]. On the other hand, academic sports may be viewed as a key stage in the individual sports careers, with the coach image playing one of the key roles.

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We sampled for the study academic athletes (n=64, including 39 males and 25 females) from Herzen State Pedagogical University (St. Petersburg), P.F. Lesgaft Novosibirsk State University, and A.S. Pushkin Leningrad State University. The sample was, aged 22 years on average, with 12% specialized in track and field sports; 15% in team sports; 17% in wrestling; 23% in individual competitive sports; and 33% in sport dances. By the sport qualifications, the sample included 41% of unqualified athletes; 32% Class I-III athletes; and 28% Candidate Masters of Sports (CMS).

Results and discussion. The semantic differential matrix made it possible to rank the priority qualities of the real and ideal coaches as follows. The top five qualities of the both classes were the following: professionalism, motivations, competence, respect and confidence: with no meaningful differences found in the perceived real and ideal coach's qualities. These data may be indicative of the physical education and sports specialized students striving to base their professional sports careers on a positive coach's image – as close as possible to their model of an ideal coach including them own in the future coaching capacity.

Furthermore, the survey data and analysis showed fairly high levels of the coach's competency, personality qualities and cooperation skills (rated by 6 points out of 8 on average) versus a relatively high psychological wellbeing in the male and female groups (7 points out of 9), without significant gender differences. A correlation analysis found the real trainer-athlete cooperation (behavioral component) being in a statistically significant correlation ($r = 0.245$, $p < 0.05$) with the athletes' positive attitudes to themselves – with the latter, in turn, being in the significant correlation ($p < 0.01$) with own competency, self-acceptance, life goals setting skills and general psychological wellbeing rates.

At the next stage, we formed the high/ low life goals groups (as life goals setting is ranked the key psychological wellbeing component, along with self-acceptance). The high and low life goals groups (n=21 both) were composed of the individual tested with 39-45 and 21-33 points on the life goals scale, respectively. Given on Figures 1 and 2 hereunder are the group test data.

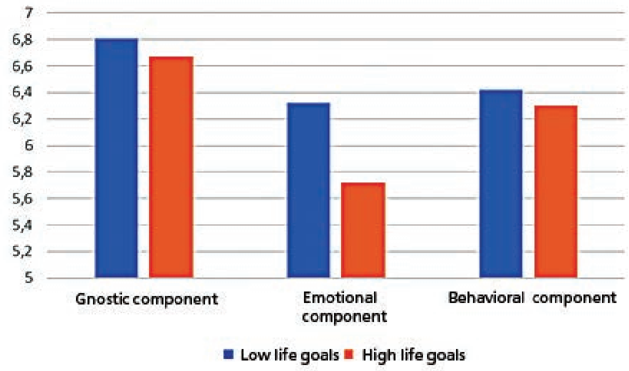

Figure 1. *High- and low-life goals groups: coach image elements*

The low life goals group was found to rate the coach's professional, personal and communicative qualities higher than the high life goals group: see Figure 1. It can be assumed, therefore, that the athletes less confident in the life goals setting domain tend to rely on the coach's personality, especially in the emotional domain. It should be noted, however, that the intergroup differences were found statistically insignificant – that may be due to the limited sample and, hence, further survey on a larger sample is recommended.

Figure 2. *High and low life goals groups: psychological wellbeing rates*

It was found that the high life goals group stands meaningfully higher (Ucr., $p < 0.01$) on the autonomy, competence, positivism and self-acceptance scales than the low life goals group.

It should be mentioned that the survey found a contradiction that needs to be clarified. At this juncture the high life goals group was apparently tested higher on the autonomy and self-sufficiency scales and less dependent on the coach in their progress. This finding is confirmed by the fact that the low life goals group was tested much lower on the autonomy scale; whilst the low life goals group data correlation analysis found significant positive correlations ($p < 0.01$) in the four-component psychological wellbeing structure on the self-acceptance, positivism, personality growth and competence scales. The high life goals group psychological wellbeing data correlation analysis found the psychological wellbeing also including the above four components, with meaningful ($p < 0.05$) correlations between the life goals setting, autonomy, personality growth and competence test rates.

Conclusion. The survey found the coach's personality qualities being of special importance for the academic athletes tested with the low life goals setting skills as one of the psychological wellbeing elements; with the top-five coach's qualities ranked as follows: professionalism, motivations, competence, respect and confidence. These qualities may be used to rate the individual images and "strengths" of the coaching specialists, particularly in the academic athletes personality progress planning initiatives. The academic athletes tested with relatively high life goals setting skills and psychological wellbeing were found to prioritize rather the professional competences among the coach's qualities and the relevant behavioral manifestations. The academic athletes with the high goal-setting skills, motivations and determinations were tested with less reliance on the self-acceptance, positivism and trainer-athlete cooperation in their psychological wellbeing structure, with a top priority given to autonomy and personality growth. The study data and findings need to be complemented and substantiated by further studies on wider sports-specific samples to obtain more specific data of potential benefits for the practical services of the sports psychologists and coaches to form an integrated progress management and support system for academic athletes and improve their psychological well-being standards.

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