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TABLE OF CONTENTS

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SportMont

EDITORIAL

Sustainability and Legacy in Sport: Ukraine Educational and Sport Scenario

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Abstract

Achieving and maintaining sustainability as well as creating legacy to be best utilized in future is a challenging and at the same time generous objective for any country and any institution. The legacy concept development by the International Olympic Committee (IOC) was further advanced through the Olympic Games Impact (OGI) project and is now efficiently governed and its execution observed by the IOC Sustainability and Legacy Commission. Most nations and institutions related to sports and physical education supported this movement to assist spreading the legacy of the Olympic Games to advance the promotion of sports for all, so that vast majority of population gets an opportunity to become more physically active, and/or to get involved in sports activities. The objectives of this editorial were on one hand to project the National University of Ukraine on Physical Education and Sport (NUUPES) activities aimed at improving sustainability and legacy in sport; and on the other hand, to highlight the outcomes and proceedings of the 4th International online conference "Sustainability and Legacy in Sport: Challenges and Perspectives" which was held on 26-27th November 2020 in Kyiv, Ukraine. This conference was as well the part of NUUPES activities aimed at further improving sustainability and legacy in Sport. Special thanks to Sport Mont for providing a platform for publishing the conference scientific papers in this Special Issue of the journal.

Keywords: *sustainability, legacy, sport*

Introduction

The development of a 'legacy' concept initiated by the International Olympic Committee (IOC) in 2002, later gained importance for the Organizing Committee of the Olympic Games (OCOG) practices. It was meant for creating positive legacies from the games and the promotion of sports for all, not just for Olympians, in the host country (Grigorov & Hills, 2008; IOC Olympic Charter, 2020). Later, the IOC developed the Olympic Games Impact (OGI) project, which required host cities to undertake longitudinal studies intended to measure the economic, social, and environmental impact of the games (Olympic Review, 2006).

As of late, the concept gained popularity in the National University of Ukraine on Physical Education and Sport (NUUPES) - premier specialized higher education institution in the country. In the mid ninetieth, University has evolved from the Institute to the National University status. Over 35 thousand sports coaches, physical education teachers, physical rehabilitationists, physical therapists, ergo therapists, sports managers, fitness, recreation, and tourism service providers, have been trained in the University from its foundation till day.

NUUPES holistically combines education, advanced specialists training, fundamental and applied research; creates advantageous environment for educating elite athletes, advances their training and top-level competing; promotes multifaceted international cooperation with countries and universities all over the world. This opens a bright opportunity to plan and implement sustainable development through educational process (Bagheri & Hjorth, 2007).

Utilizing NUUPES potential and acting in line with the

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IOC Sustainability and Legacy Commission Advises (2020), three major aspects were specified on University's ongoing contribution to further improvement of sustainability and legacy in sport.

Encouraging the development and promotion of sustainability best practices

The main priority area was identified as encouraging the development and promotion of sustainability best practices through university academic and research activities.

The University possesses modern infrastructure and facilities for the educational process, dorms, sports facilities, and the advanced "Olympic Style" fitness center. Structurally, the University comprises of four Faculties with 21 departments, Educational-Scientific Olympic Institute, Research Institute, library, "Olympic Literature" Publishing House, Center of Sports Traumatology and Regenerative Medicine, affiliated Physical Education College in the city of Ivano-Frankivsk.

Currently, the University educates and graduates Bachelors (BSc), operates post-graduate studies for Masters (MSc), Doctor of Philosophy (PhD), and Doctor of Science (DSc) candidates in six specialties.

At present, the University has over five thousand students. Their education is managed by about 430 scientific and academic staff; a quarter of them are part-time employees. Over 50 DScs, Professors, 215 PhDs, Associate Professors are involved in teaching University graduates and postgraduates.

Academic and research activities are progressively getting focused on the issues of sustainability and legacy in sport (Borisova, Frolova, & Artamonova, 2019). In academics, the respective topics are included in teaching and learning plans at the degree level of studies. In research, more attention is paid to sustainability and legacy studies by including those in the long-term research plans and by encouraging researchers to apply for national and international grants in this area of research.

Communicating sustainability achievements through athletes

Second priority area was indicated as communicating sustainability achievements through sport (IOC Sustainability Through Sport, 2012) and particularly through the University educated and trained athletes who represent the University and the country in the competitions all over the world (Imas, Dutchak, & Kateryna, 2018).

NUUPES graduates are successfully engaged in domestic and overseas clubs and other institutions. The University is the place of origin for the world-famous sports science schools of thoughts and practices. University students and graduates have won 316 Olympic medals till day, including 131 golds. NUUPES teams traditionally emerge as winners of the All-Ukrainian Universiades among the country's higher education institutions. University students are the main contributors to the World Universiades national team medal tally.

Hosting Conferences on the issues of sustained development

The third priority area of impact was highlighted as hosting the annual International Conference on the issues of sustained development.

The 4th International online conference "Sustainability and Legacy in Sport: Challenges and Perspectives" was held on 26-27th November 2020 in Kyiv, Ukraine. It was dedicated to 90th Anniversary of NUUPES and was patronaged by the International Council on Sport Science and Physical Education, European Association of Students' Sport, and International Association of Sports Kinetics. The conference was focused on the score of important matters such as contemporary issues of modern sport; environmental contributors to sustained development of physical education and sport; formation of the values' system in the upcoming generation within modern paradigm of the Olympic education and sustained development; the role of Olympic sport in implementation of the sustained development objectives; 'Motor Activity – Healthy lifestyle – Healthy nation'. All conference related sub-themes are of the primary importance to Ukraine and internationally.

Current edition of the conference gathered over 500 participants from 19 countries including rectors and lead scientists of 17 higher education institutions from Ukraine and overseas with vast representation of research and academic staff, doctoral candidates, postgraduate and graduate NUUPES students.

Conference participants were video addressed by the Chairman of the IOC Sustainability and Legacy Commission H.S.H. Prince Albert II of Monaco.

Highest level sport officials and dignitaries addressed the gathering with messages and greetings. Those were: Mr. Serhiy Bubka, DSc – the IOC member, International Association of Athletic Federations (IAAF) 1st vice-president, President of Ukraine NOC, Olympic champion, the Hero of Ukraine. Mr. Vadym Huttsait - Youth and Sport minister of Ukraine, President of the National Fencing Federation of Ukraine, Olympic champion; Mr. Adam Rochek - President of the European University Sports Association; Prof. Chinnappa Reddy - President of National Association of Physical Education and Sport Science of India; Prof. Yevheniy Imas, DSc – Ukraine NOC 'Sport and Environment' Commission head, NUUPES Rector.

The scale and magnitude of the sustainability and legacy in sport issues were fully reflected in the presentations delivered at the conference sessions and in the collection of the conference scientific papers, for which Sport Mont has generously provided the platform to publish in this Special Issue. NUUPES is grateful for such an opportunity and is open to any form of future cooperation.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Methods of Primary Selection of Young Football Players

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Abstract

There is a conflict between the objective need to improve the training of young players, the identification of promising athletes and the lack of scientifically sound methods of their selection on the indicators of physical development, physical fitness, functional status, personal psychological status. The aim of the study was to scientifically explain the methodology of sports selection of children for football. Methods included analysis and generalization of literature and content of the Internet, questionnaires, interviews, pedagogical observation, testing, pedagogical experiment, methods of mathematical statistics. The study involved 15 football coaches and 32 novice players aged 6-7 years. The study was divided into two stages. We found that the reason for dropout during the first year of training was the lack of a well-developed system of initial selection parameters. The methodology of primary selection of children for football lessons is developed and experimentally tested, consists of two parts, each of which defines the key organizational stages, tasks and relevant selection criteria. The conclusion and recommendation for football was based on a comprehensive assessment of indicators and the degree of motivation to play football. The effectiveness of the developed selection method was confirmed by the increase of physical and technical fitness after 1 year of training in the group of initial training.

Keywords: *initial training, young football players, selection criteria, expectation*

Introduction

Achieving a high level of results in modern sports today is interconnected with many factors. Among them we can enlist: the use of new advances in sports pharmacology, the use of high-tech equipment while training and competing, the introduction of effective training methods, optimization of competitive practices, but first and foremost studying individual characteristics of sport and developing effective techniques for going in for specific kind of sport (DenHartigh, Niessen, Frencken, &Meijer, 2018; Voronova et al., 2020).

In particular, in football, the athlete needs to have unique morphological data, a specific combination of a complex of physical and mental abilities that are at an extremely high level of development (Kaynar, & Bilici, 2018). It is especially important to correctly identify the ability to go in for sport among children of 6-7 years, which will determine the success of their future sport success, because particularly at this age kids usually take up football (Pot, Schenk, & Hilvoorde, 2013). Identifying these qualities determines the principle of an integrated approach (Shynkaruk, 2012). This approach allows not only to obtain significant information about the potential of a young player, but also, comparing different indicators, to identify possible ways of forming special abilities (S. Trninić, Papić, V., Trninić, & Vukičević, 2008). This explains the urgency of creating a methodology for selecting players, which will be aimed at both its organization and content.

Given the multifactorial nature of sport selection, almost all football experts consider it in their scientific publications.

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For instance, Lysenchuk (2002) developed a method of comprehensive assessment of a special technique for the selection of young players. Boychenko (2003) defined the fundamental milestones of sport selection of football players. Dulibskii (2003) suggested the ways to increase the efficiency of sport selection. Chudyn (2006) developed the technique of young football players' selection at different stages of long-term sport training. Lago-Peñas, Rey, Casáis and Gómez-López l (2014) draw attention to the relationship between performance characteristics and the selection process of young athletes. Sieghartsleitner, Zuber, Zibung and Conzelmann (2019) emphasize that the process of sport selection should take into account not only the results of multidimensional testing, but also the evaluation of the coach. The main prerequisites of sport selection are integral for other kinds of sport as well, which is confirmed by studies of local and foreign scientists, regarding basketball (Vozniuk, 2008; Shynkaruk, & Mitova, 2017; Stroganov et al., 2020); hockey (Coelho-E-Silva et al., 2012; Shynkaruk, 2020), etc. However, there are still a lot of scientific issues (both generic and practical) of selecting prospective athletes, which have not been studied well enough. This situation is especially relevant for scientific and methodological justification, practical development and implementation of methodology at the stage of primary preparation in football.

The purpose of the research is to scientifically support the methodology of selecting children for football

Methods

Participants

The study involved 15 football coaches (with at least 10 years of coaching experience) and 32 young players of 6-7 years of age. The compulsory condition for enrolling children in football training groups was a medical certificate with a doctor's permission to play sports. The study participants had no prior experience of playing football. The participants and their parents were fully informed about the testing procedures before participating in the study; the informed consent was signed by parents.

Testing

The study used empirical research methods:

- pedagogical observations were conducted to identify the means, methods and organizational forms of training young football players aged 6-7 in the groups of initial training of the first year of study, pedagogical observations were public;

-both questioning and interviewing (anonymous) were conducted to study the practical experience of coaches concerning the problems of selecting young players;

- physical testing determined the level of motor qualities developments and special abilities of young football players.

The tests choice to obtain information of physical and technical proficiency level has been conducted according to the educational standards proposed by the Children's and Youth Sports School program.

Standing long jump. The participant stood at the starting position: the legs are apart behind the starting line. Bending knees, he swung his arms back, then threw them out abruptly in front of him and, pushing off, jumped as far forward as possible, trying to land on his feet as far as possible, since the result was determined based on the distance between the starting line and the point where he touched the floor (mat) with the heels.

The 15 m running was from a high (standing) start. Out of the two attempts the best one was recorded. Measurements were made with a manual stopwatch up to 0.01 s.

Shuttle run 3x10m. By the signal, a football player sped up to the first marker (10 m distance), and then he returned to the starting line and again sped up to the marker, at which point the total time was recorded. The young football players were given two attempts. The best result was recorded.

The 50 m running was from a high (standing) start. Only one attempt was allowed.

The following tests were performed to assess the specific preparation of young sportsmen.

Juggling the ball with a foot. The kicks were performed with the right and left foot in any order at the signal of the coach. Two attempts were allowed. The best attempt was recorded – the maximum number of kicks before losing control of the ball.

Dribbling the ball 30 m in a straight line. It was made by the coach's signal. Two attempts were allowed; the average result was recorded.

Throw-in the ball at the distance. It was made with a soccer ball. The average result of two attempts was recorded.

Table 1. Football players data in the motor tests: scores

Data	R	Absolute data and scores									
		1	2	3	4	5	6	7	8	9	10
D1 –50 m running, s	1.3	9.22	9.19	9.16	9.13	9.1	9.07	9.04	9.01	8.98	8.95
D2 – standing long jump, cm		129	131	134	137	140	143	146	149	152	155
D3 – Shuttle running 3x10 m, cm		10.38	10.27	10.16	10.06	9.95	9.84	9.73	9.62	9.51	9.40
D4 –15m running, s		3.54	3.50	3.46	3.42	3.40	3.36	3.32	3.28	3.24	3.20
D5 – Dribbling the ball, times		<5	5		6		7		8		9
D6 – Throw-in the ball, m		<4	4		5		6		7		8
D7 – dribbling the ball 30 m, s	1.3	9.8	9.6	9.4	9.2	9.0	8.8	8.6	8.4	8.2	8.0

Legend: R – data premium rate

The technique to evaluate the special preparation of young football players in those exercises was used to compare the obtained results (Lysenchuk, 2002; Table 1).

The examination result of each student was compared to the control data and transformed into scores according to the scale according to table 1.

The following algorithm was used for the calculations:

R = (D1 + R1) + D2 + D3 + D4+ D5+ D6+(D7+ R2),

where: R – integral mark in scores; D1-7 – the data value in measurement; R1-2 – data premium rate.

Design

It has been held in two phases. At the first stage we stud-

ied the problem by researching scientific and methodological sources, interviewing coaches who work with youth teams. Based on the data obtained, the sports methods of selecting young football players were developed. At the second stage a basic pedagogical experiment of the comparative nature was carried out to test the effectiveness of the developed methods. The sportsmen were organized into two groups - control and experimental, each group consisted of 16 people. Players of the control group were selected by blind lot. The players of the experimental group were selected according to our proposed method.

Statistical analysis

The results analysis was inferred using the methods of mathematical statistics, and the following indicators were calculated: mean (M), square deviation (SD), error of mean (m). The probability of differences between the average results of the two groups was determined by the Student test (significance level $p<0.05$), and the hypothesis of the normal distribution of measurement by Shapiro-Wilkie test had been tested previously (Byshevets et al., 2019).

Results

During the interview with the experts who train children football teams, we found out which problems they faced selecting children for beginner groups and suggested filling in a questionnaire.

The interviewing revealed that the reasons impeding the selection are the following:

- a great number of children who have health problems and cannot go in for football due to doctors' recommendations (33.3%);
- children's low motivation for physical activities (26.7%);
- the enormous academic load and additional classes with tutors (20.0%);
- insufficient number of sport camps for regular training, located near the place of residence or study of children (13.3%)
- lack of parents' support (6.7%).

Obviously, most of these reasons are objective. We also analyzed the percentage of children leaving sport in the beginner groups during the first year of training. We compared the lists of children made on October 1st, January 1st June 1st, and September 1st of the next academic-training year.

Table 2. Quantitative analysis of the beginners' training groups: the first year of football training

The object of the research	October	January	Selecting from the last, %	June	Selecting from the last, %	September	Selecting from the last, %	General selecting, %
The beginning group preparation, participants' quantity	161	123	23.6	99	19.5	74	25.3	54.0

The summarized data of Vinnitsa sport schools can be seen in Table 2.

The obtained data show that at the beginning of the training year the number of children according to the requirements was 10 educational groups (161 persons), then by January the number of children in the groups decreased by 23.6%, and by the end of the year by another 19.5%. After the summer holidays, out of 161 children who had been chosen, only 74 remained in groups, which means 25.3% of children quit going in for football during the summer. Thereby, the total quantity of such children was 54.0%, slightly less than the official statistics. However, these changes occurred in just one year of training; so, it is alarming and requires an immediate solution.

The results of our survey with coaches working with children's teams on the problems of initial selection are shown in Table 3.

Table 3. Football coaches' questioning results: the initial selection (n=15)

Questions	Possible answers, %		
1. How long does the selecting process continue?	a month	two weeks	several days
	33.3	20.0	46.7
2. How many stages does the first stage of selecting have? (physical education lesson, meeting with parents, test training)	three stages	two stages	one stage
	26.7	40.0	33.3
3. What criteria do you use during the primary selecting?			
a) visual screening		100.0	
b) expert's opinion		20.0	
c) physical preparation tests		46.7	
d) technical proficiency tests		33.3	
e) anthropometric data		20.0	
f)physical well-being health assessment		100.0	
g) playing football motivation		93.3	
h) biological and passport age		13.3	
i) child's age		93.3	
j) parents' desire		60.0	
k) psychic and moral and volition qualities		73.3	

Summarizing the data, we found out that many coaches used different criteria to choose the most gifted children, but in most cases these criteria are subjective. Most often, selecting is conducted spontaneously, or coaches rely on the already formed level of technical and tactical skills, which can be demonstrated by children in the test games. Children's' potential opportunities are generally not taken into consideration.

The algorithm has been developed to select children for football training, thus generalized idea of the organization, structure and content of sport selection at the stage of primary preparation was created (Figure 1).

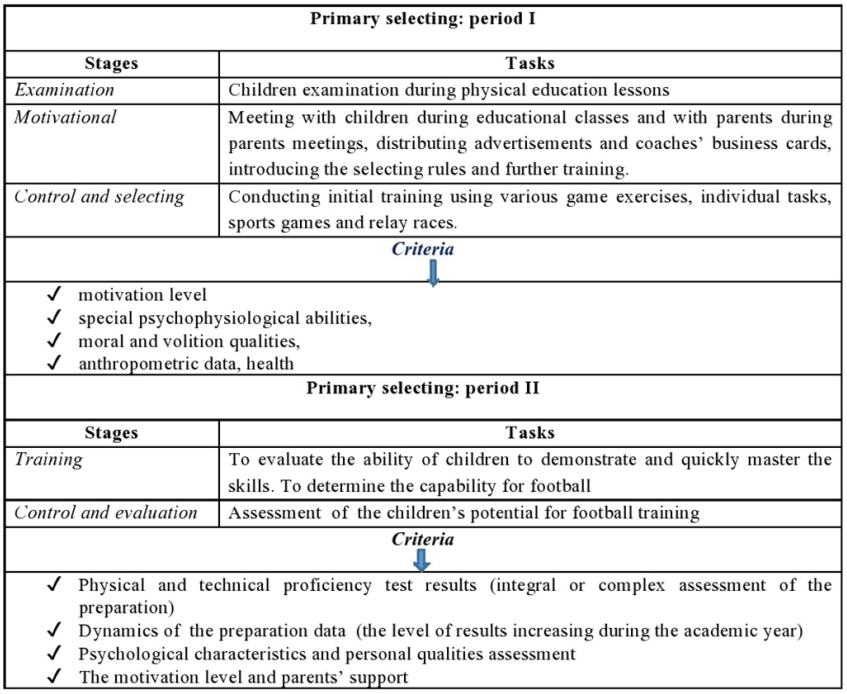

FIGURE 1. Algorithm of selecting children for football

The real evaluation of the effectiveness of the pedagogical methods of selecting children for football are the pedagogical tests results of young football players.

Two groups were formed for the pedagogical experiment. The experimental group included the children who had succeeded during all the previous stages of selecting. The control group was formed randomly. The changes in physical and technical proficiency of young football players are presented in Table 4.

Table 4. Young football players' physical preparation data: different stages of the research

Group	The research stage	Tests			
		Shuttle running 3x10 m, cm	50 m running, s	Standing long jump, cm	15m running, s
Control (n=16)	October	10.0±0.92	9.19±0.80	136±3.46	3.5±0.2
	May	9.84±0.79	9.07±0.65	143±3.17	3.4±0.12
	Data difference	0.16 (t=1.76; p=0.754)	0.12 (t=1.41; p=0.544)	7.0 (t=10.34; p=0.000)	0.1 (t=1.26; p=0.716)
Experimental (n=16)	October	10.1±1.04	9.20±0.87	137±3.75	3.5±0.09
	May	9.51±0.59	8.98±0.57	151±4.32	3.28±0.09
	Data difference	0.59 (t=2.99; p=0.000)	0.22 (t=1.91; p=0.477)	14.0 (t=14.83; p=0.000)	0.22 (t=1.87; p=0.334)
Data difference control and experimental group		0.33 (t=1.33; p=0.412)	0.09 (t=0.42; p=0.610)	8.0 (t=6.04; p=0.000)	0.12 (t=3.38; p=0.000)

Taking the results into consideration, we can infer that the experimental group results in the physical preparation tests were higher (increasing 2.4-10.2%) than in the control group (increasing 1.3-5.1%), although positive changes occurred in both groups. The young players of the experimental group met the standards of Children's and Youth Sports School in 15 m running, and exceeded the control standards in others tests. The control group results were merely close to standards. A probable difference was recorded in" Shuttle running 3x10 m" (t=2.99; p=0.000) for the experimental group and in "standing

long jump" for both groups (control - t=10.34; p=0.000; experimental - t=14.83; p=0.000). Statistical reliability between the final values of the experimental and control groups was determined in the tests of standing long jump (t=6.04; p=0.000) and 15 m running (t=3.38; p=0.000).

We also recorded the changes in technical proficiency data during the research. The data obtained indicated that the training process during the first year had a positive effect on the level of special preparedness; statistically significant changes were determined by all indicators in the experimental and control groups, but the level of increase was different: 6.4-21.1% in the control and 12, 5-37.3% in the experimental groups. Statistical reliability between the final indicators of technical proficiency of the players of the experimental and control groups is determined in the tests of throw in the ball (t=3.17; p=0.000) and juggling the ball (t=4.47; p=0.000) (Table 5). The increase in technical proficiency is explained by the stage of preparation and low initial results.

Table 5. Young football players' technical proficiency data: different stages of the research

Group	The research stage	Tests		
		Throw-in the ball, m	Juggling the ball, times	30 m running with dribbling the ball, s
Control (n=16)	October	5.8±0.79	5.7±1.19	9.40±0.83
	May	6.5±0.63	6.9±0.78	8.8±0.72
	Data difference	0.7 (t=3.34; p=0.000)	1.2 * (t=4.38; p=0.000)	0.6 * (t=3.10; p=0.000)
Experimental (n=16)	October	5.8±0.72	5.9±0.89	9.60±0.92
	May	7.2±0.62	8.1±0.74	8.40±0.96
	Data difference	1.4 (t=4.73; p=0.000)	2.2 * (t=5.93; p=0.000)	1.2 * (t=4.41; p=0.000)
Data difference control and experimental group		0.7 (t=3.17; p=0.000)	1.2 (t=4.47; p=0.000)	0.4 (t=1.83; p=0.334)

The method of comprehensive assessment of physical and technical test results and the cumulative assessment of young football players' proficiency show the results of the changes that took place during the research (Figure 2).

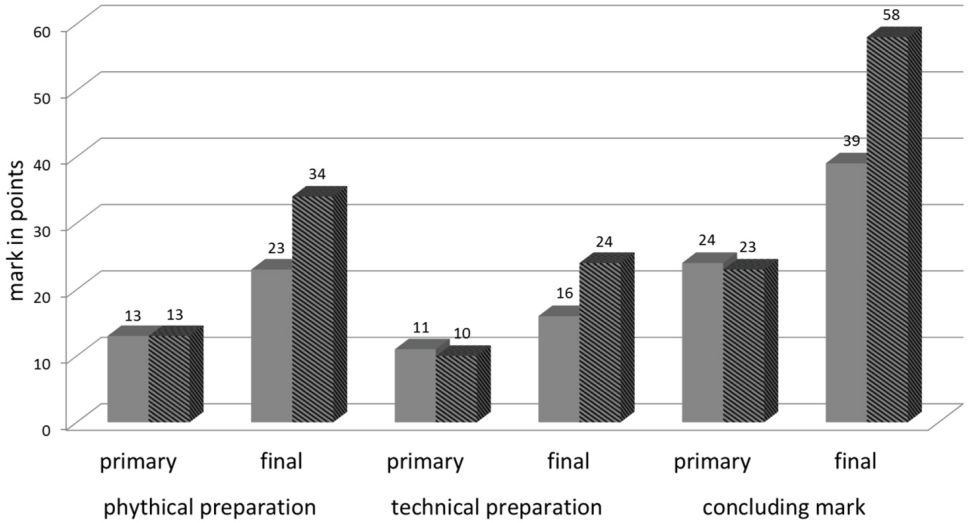

FIGURE 2. Physical and technical proficiency, cumulative assessment: dynamics of the results in points: – control group; – experimental group

Discussion

Scientific and methodological literature analysis proves the importance of sport selecting for the preparation of qualified athletes, which is emphasized in the scientific studies of sports training (Devinder, & Kansal, 2010; Adkhab, Tkhazeplov, & Khodair, 2014; Gil et al., 2014; Kilger, & Börjesson, 2015). The future implementation of sportsmen's individual abilities depends on the first correct step of preparation. The special feature of modern football should be the effective selection of children to meet the requirements of intense competitions.

However, so far, most coaches do not consider the following factor, which casts doubt on the effectiveness of the entire training process. At the same time according the Ministry of Youth and Sport of Ukraine statistics, it is a well-known fact, that in footballers' group of Children's and Youth Sports School, Specialized Children's and Youth Sports School of Olympic Reserve, Ukrainian Football Club, Ukrainian Olympic Reserve, a significantly high dropout rate has been identified; 70% of children stop football training due to the inconsistency of the program requirements and the deficiency of selecting and training system (Ovramenko, 2003). The results of our questionnaire determined the criteria that are used by coaches to select children for football. An important component of the selecting process is determining its criteria. The major criteria of the selecting process defined in the program of Children's and Youth Sports School are the following: motivation for football, the age

when the training begins, morphological features, health, the correspondence between the biological and passport age, the level of motion abilities. The questionnaire revealed that during the primary selection, the method that is used by coaches most often is visual screening (100%), which means that the future of the child in the sport is determined by ordinary observation. The least attention is paid to the biological and passport age identification (13.3%), the use of expert assessment (20%) and anthropometric data (20%).

The preparation problem cannot be solved only by natural selection because talented children get rejected together with the ones that are not inclined towards football (some children are low-skilled, but have high potential). Sometimes inappropriate methods are used working with such children, which is emphasized by most scientists (Rybin, 2001; Shynkaruk, 2002, 2011). All things considered, we can assume that the effectiveness of the selecting process for football depends greatly on solving two problems: metrological (what data are used as selecting criteria, how often and how accurately measurements are made) and methodological (the organization of instructional and training processes at the stage of primary training during the continuous selecting).

Taking the obtained data of theoretical and practical research into consideration, we have proposed a pedagogical technology of selecting children for football. Two stages of primary selecting were pointed out during the first preparation according to the presented scheme. The first period consists of three stages, and its main goal is to involve as many children as possible. The main methods of assessment are visual screening, pedagogical observation, medical and biological control. Footballers' main qualities and functions are poorly developed at this age, they are not clear and it is still difficult to identify them. Thus, selecting based on pedagogical testing at the beginning of the year is not used. Among other selecting criteria are also the level of children and parents' motivation, special psychophysiological abilities, such as sense of time, space, game-related thinking, attention, the development of moral and volitional qualities; desire to win, endurance to tensions, communication skills, ability to work in a team; anthropometric data (weight, height, length of limbs, etc.) and the health conditions for playing football.

During the second technological period of selecting, capabilities for playing are determined, inclinations for the development of special abilities is revealed, the level of motional activity is assessed, new movements and unfamiliar physical exercises are mastered. At the end of the year, contests, tests and competitions are held to check if the pre-selected group of children meet the requirements of successful specialization in football. Children special qualities, personal traits and basic preparation allow to determine their sport inclinations and their ability for improvement in this type of sport.

More significant changes obtained from the experimental group show the effectiveness of the developed technology of selecting children for football. Furthermore, it should be noted that as the result of our study the new understanding of the training organization in team sports at different stages has been developed (Kostiukevych, 2019a; Kostiukevych et al., 2019b).

Conclusions

Football is one of the efficient means of the improvement of schoolchildren' physical activity, and at the same time it remains the most favorite kind of sport in our country. Leading and young scientists devoted their principal works and research to the issue of sports selecting, acknowledging its role in the system of qualified sportsmen's preparation.

At the same time, in the theory and methodology of the national football there is a controversy between the necessity of the improvement in the young football players' training process efficiency and the lack of data-based methodology of selection based on the criteria of physical development, physical preparation, functional state of body systems, and personal psychological status. The problem of children and youth sports at the level of sport selection, according to the Ministry of Youth and Sports statistics, is a large number of children who drop out due to the imperfection of sport selecting methods.

The developed methods of selecting children for football involves two selecting periods, each of which has its stages and tasks to be solved, and each period has its own selecting criteria too. The selecting process itself lasts during the first year of preparation. The final decision to involve a child in football is based on a complex assessment of data and motivation to play football.

The efficiency of the selecting methods is confirmed by the increase in physical and technical proficiency data, obtained after the first year of training.

The complex assessment data of the experimental group preparation increased from 23 points to 58 points, while that of the control group increased from 24 to 39 points during the first year.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Training Process Structure of Highly Skilled Players in Mini-Football during the Competitive Period

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Abstract

According to the competition calendar, a one-cycle training process for highly skilled mini-football players in the annual macrocycle was selected. Participants: 15 players of the First League of Ukraine in the futsal mini-football team "Fortetsya" (Kamianets-Podilskyi City), among them 1 player – Honored Master of Sports, 1 – Master of Sports of International Class, 4 – Candidate to Master of Sports, 9 – players of 1st rank. In the competitive period, non-specific means of highly skilled players in mini-football amounted to 40.2%, specific means - 59.8%, including special-preparatory – 6.6%, leading – 30.9% and competitive – 22.3%. Aerobic loads ranged from 40.3 (4-day inter-cycle micro-cycle) to 53.6% (4-day competitive micro-cycle) during competitive and inter-gaming micro-cycles of this period. The use of mixed (aerobic-anaerobic) loads in the competitive period of futsal players training ranged from 45.0 (7-day inter-game micro-cycle) to 53.1% (4-day inter-game micro-cycle). The ratio of training means during the competitive period, the volume of training loads of different orientation in micro-cycles of competitive mezocycles of preparation, the ratio of training loads of different orientation: aerobic (49.2%); mixed (46.1%); anaerobic alactatic (2.4%); anaerobic glycolytic (2.3%) have been identified. Taking into account the structure and content of a single-cycle variant of training process structure for the players of the first league team of Ukraine, the volumes of training loads of different orientation, the ratio of the training means of the players in the competitive period were determined.

Keywords: *futsal, competitive period, micro-cycle, training loading*

Introduction

According to the provisions of the theory of periodization, one of the main criteria for choosing the options for training process constructing in an annual macrocycle is a calendar of major competitions (Reilly, Bangsbo, & Franks, 2000; Platonov, 2005; Owen, Wong, & Delal, 2012). It is established that the planning of the training process in team game sports in the annual training cycle is carried out on the basis of different variants of periodization (Manasis & Ntzoufras, 2014; Y. Adambekov, Iljasova, Achmetova, & K. Adambekov, 2015). The analysis of more than 100 references on football testified there are extremely small amount researches on mini-football (futsal). The current practice of mini-football leads to the transition to the programmed principle of training organization (Stasiuk, 2016; Kostiukevych et al., 2019). The problem of constructing a training process in the annual cycle in mini-football is still unresolved and requires the necessary development and implementation of effective methods in the training pro-

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cess, which will optimize the futsal player's training for further progress at all levels. In order to develop and experimentally justify the structure and content of the training process during the competitive period, a systematic analysis of the content of the competitive activity and the process of preparation for it is required.

One of the authors of this study, Gennadii Lisenchuk was heading the Ukrainian association of futsal and managed Ukrainian National teams and Student teams during 20 years. Ukrainian futsal team won 11 (3 gold, 3 silver and 5 bronze) medals in World and Europe Championships for this period. Another author Ivan Stasiuk coached futsal team "Fortetsya" (Kamianets-Podilsky City). Ukrainian futsal coaches use still the results of this research although the data is 12 years old.

The purpose of the study is to substantiate experimentally the structure and content of training process for highly skilled players in mini-football in an annual macrocycle during the competitive period, taking into account the basic provisions of the periodization theory of sports training.

Methods

Researchers used theoretical analysis and generalization of literary sources; pedagogical observations; pedagogical experiment; method of pedagogical control tests (testing); methods of mathematical statistics: basic descriptive statistics, such as means, standard deviations; frequency tables and histograms. Statistica 10.0 (StatSoft) was used as statistical software.

Subjects

15 players of the First League of Ukraine in the futsal mini-football team "Fortetsya" (Kamianets-Podilsky City), among them 1 player – Honored Master of Sports, 1 – Master of Sports of International Class, 4 – Candidate to Master of Sports, 9 – players of 1st rank. Everyone of futsal players gave their written consent to participate in this research, in accordance with the recommendations of the Committee on Ethics of Biomedical Research.

Design

In the process of observing, 35 training sessions have been analyzed during the competition period. Researchers studied the construction of both individual training sessions and their series. The following parameters were examined: the duration of exercise, their intensity, intervals of rest between exercises and series of exercises, heart rate during the exercise, the total duration of the exercises. These indicators determine the predominant orientation of individual exercises and training session as a whole, the value of the load, as well as the coefficients of the value and intensity of the training load that was calculated by following formulas:

$$\mathrm{LI} = \frac{\mathrm{CVL}}{\mathrm{T}}$$

Legend: CVL – coefficient of the value of load, in points; I – intensity of loading, in points; t – the time duration of the exercise, in minutes.

The scale was used to determine the intensity of loading (Tiulenkov, 2007):

$$\mathrm{CVL} = \sum_{i=1}^{n} I \cdot t$$

Legend: LI – the coefficient of the training load intensity, in points· min^{-1}; CVL–coefficient of the value of load, in points; T –the duration of training session, in minutes.

Results

On the basis of the 2008-2009 competition calendars for the teams of the first league in mini-football, a single-cycle variant of the training process was chosen, which included the planning of three periods of the annual macrocycle - preparatory (85 days), competitive (191 days) and transitional (89 days). The competition period lasted more than 6 months (191 days) from October 2008 to April 2009. It consisted of 4 mezo-cycles, each of which consisted of a series of competitive, inter-game and recovery micro-cycles. A sufficiently long competitive period required the use of various means of the training process to maintain the level of sports condition. Therefore, the structure of each competition mezo-cycle was composed not only of competitive and restorative micro-cycles, but also inter-game, which solved the problem of maintaining the player's physical and functional preparedness. According to the calendar of competitions and tasks that were solved in the competition period, 4-, 5-, 6-, 7-day competitive and inter-game micro-cycleswere developed.

Under constructing competitive micro-cycles, as a rule, three tasks were solved: bringing the players in the optimum physical, functional and game tonus to the calendar game, conducting at the high motor and emotional level of the calendar game itself, restoring the player's performance after the calendar game. Based on this, four types of training sessions were used in competitive micro-cycles namely a calendar game, an evolving, supportive, and restorative training. In addition, depending on the duration of the competitive micro-cycle, one-time and two-times training sessions were used throughout the day. Thus, in the 4-days micro-cycle, only one-time training was used, in the 5-days two-day training only two-times sessions were used in the second day, in the 6-days and 7-days micro-cycles such training was repeated twice (Figure 1). Thus, in the construction of competitive micro-cycles, depending on their duration, researches followed the appropriate sequence of alternating evolving, supportive and recovery training sessions. For example, during the 4-days competitive micro-cycle, supportive training sessions were conducted in the 1st and 2nd training days, the calendar game – on the 3rd and the recovery training – on the 4th (see Figure 1a).

In the 5-days competitive micro-cycle, one supportive training session was conducted during the first day, one supportive and one evolving training was held on the second day, a supportive training session – on the third day, a calendar game – on the fourth day, and a recovery training session – on the fifth day (see Figure 1b).

A similar trend was observed in the construction of 6-days and 7-days competitive micro-cycles (Figure 1c; Figure 1d). That is, two days prior to the calendar game, evolving training sessions were held, on the eve of the calendar game – supportive training, and the day after the calendar game – recovery training. It should also be noted that each competing micro-cycle started with a supportive load of medium value as presented in Figure 1.

Therefore, the following approaches were used in the construction of competitive micro-cycles:

- one supportive training of small volume was planned before each calendar game, and after that – a recovery training of small volume was planned;

- in order to bring players in optimal physical and psychological condition, evolving training sessions were used only in 5-, 6- and 7-days micro-cycles. Thus there was one such train-

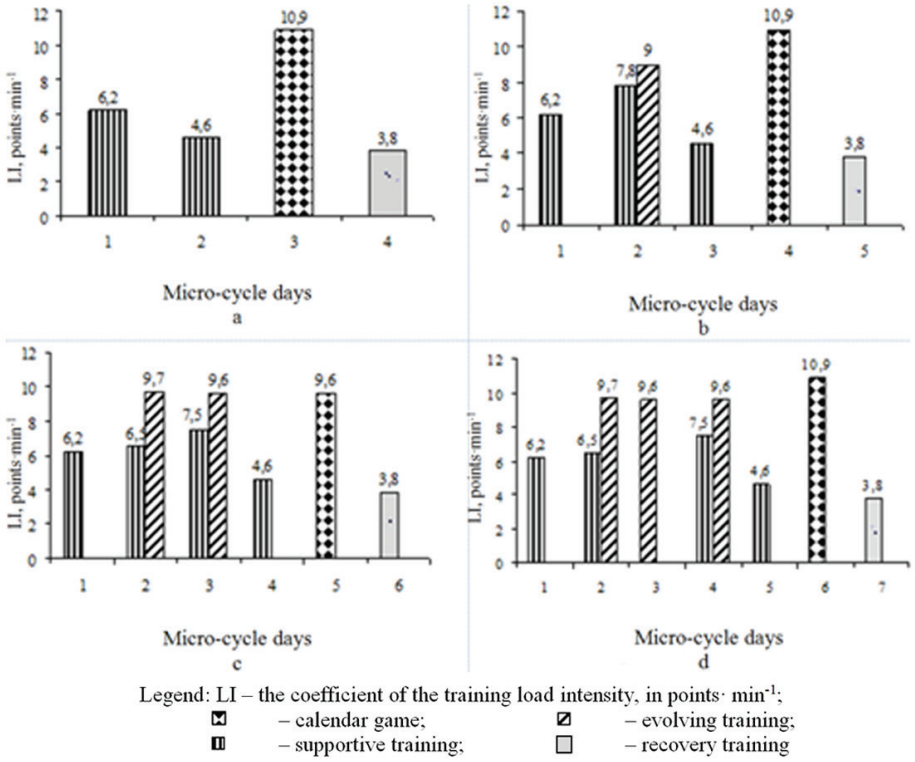

FIGURE 1. Options for constructing of competitive micro-cycles for highly skilled players in mini-football: a) 4-days, b) 5-days, c) 6-days, d) 7-days micro-cycles;

ing session in 5-days micro-cycles, two – in 6-days micro-cycles, three – in 7-days micro-cycles. That allowed to maintain the optimum level of player's sports condition during the competitive period;

- it was assumed that the intensity of training loads in separate training sessions should be less than in the calendar game. In this case, the psychological tension was in the calendar game. On the other hand, if there were not one but two or three peaks in the intensity of training and competitive loads during a competitive micro-cycle, this, in our view, would lead to incomplete recovery of players before the calendar game, which in turn would affect the efficiency of player's competitive activity.

In the competitive period, non-specific means of training work of highly skilled players in mini-football amounted to 40.2%, specific means – 59.8%, including special-preparatory means – 6.6%, leading exercises – 30.9% and competitive exercises – 22.3% (Figure 2).

The use of training means caused a certain ratio of player's

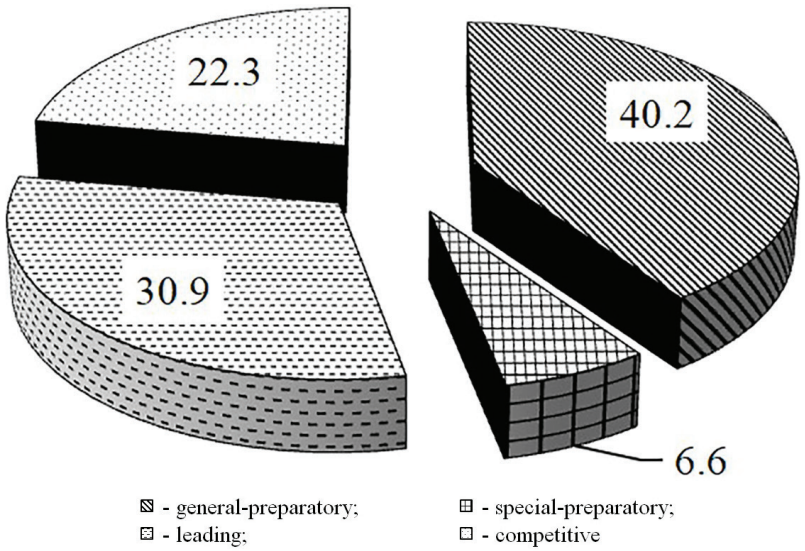

FIGURE 2. The ratio of training exercises of highly skilled players in mini-football during the competition period,%:

training loads in the competitive period (Table 1). The analysis of the Table 1 certifies that during competitive and inter-game micro-cycles in this period aerobic loads ranged from 40.3 % (4-days inter-game micro-cycle) to 53.6 % (4-days competitive micro-cycle). The use of mixed (aerobic-anaerobic) loads in the competitive period of futsal player's training ranged from 45.0 % (7-days inter-game micro-cycle) to 53.1 % (4-days inter-game micro-cycle).

Table 1. The volume of training loads of different directions in the micro-cycles of competitive mezo-cycles training for highly skilled players in mini-football

Micro-cycles	The number of micro-cycles	Load volume, in minutes (%)				Total, in minutes
		aerobic	mixed	anaerobic alactatic	anaerobic glycolytic	
The first competitive mezo-cycle						
4- day competitive	1	16.2 (53.6)	140 (46.4)	–	–	302
5- day competitive	2	448 (47.4)	456 (48.4)	20 (2.1)	20 (2.1)	944
6- day competitive	1	296 (43.7)	351 (50.5)	20 (2.9)	10 (1.4)	677
7- day competitive	1	316 (41.8)	399 (53.0)	20 (2.6)	20 (2.6)	755
7- day inter-game	2	870 (48.4)	806 (45.0)	60 (3.3)	60 (3.3)	1796
3- day recovery	2	290 (100)	–	–	–	290
Total	9	2382 (50.4)	2138 (44.8)	120 (2.5)	110 (2.5)	4764
The second competitive mezo-cycle						
4- day competitive	1	162 (53.6)	140 (46.4)	–	–	302
5- day competitive	1	224 (47.4)	228 (48.4)	10 (2.1)	10 (2.1)	472
6- day competitive	1	296 (43.7)	351 (50.5)	20 (2.9)	10 (1.4)	677
7- day competitive	1	316 (41.8)	399 (53.0)	20 (2.6)	20 (2.6)	755
7- day inter-game	1	182 (40.3)	239 (53.1)	15 (3.3)	15 (3.3)	451
7- day inter-game	2	870 (48.4)	806 (45.0)	60 (3.3)	60 (3.3)	1796
3- day recovery	3	435 (100)	–	–	–	435
Total	10	2485 (50.7)	2163 (44.3)	125 (2.6)	115 (2.4)	4888
The third competitive mezo-cycle						
4- day competitive	1	162 (53.6)	140 (46.4)	–	–	302
7- day competitive	4	1264 (41.8)	1596 (53.0)	80 (2.6)	80 (2.6)	3020
4- day inter-game	1	182 (40.3)	239 (53.1)	15 (3.3)	15 (3.3)	451
6- day inter-game	1	324 (44.9)	337 (46.7)	30 (4.2)	30 (4.2)	721
3- day recovery	2	290 (100)	–	–	–	290
7- day recovery	1	285 (66.2)	145 (33.8)	–	–	430
Total	10	2407 (46.2)	2557 (49.0)	125 (2.4)	125 (2.4)	5214
The fourth competitive mezo-cycle						
5- day competitive	2	448 (47.4)	456 (48.4)	20 (2.1)	20 (2.1)	944
7- day competitive	2	632 (41.8)	798 (53.0)	40 (2.6)	40 (2.6)	1510
3- day recovery	2	290 (100)	–	–	–	290
Total	6	1370 (49.9)	1254 (45.7)	60 (2.2)	60 (2.2)	2744
Total for competitive period	35	8644 (49.2)	8126 (46.1)	430 (2.4)	410 (2.3)	17610

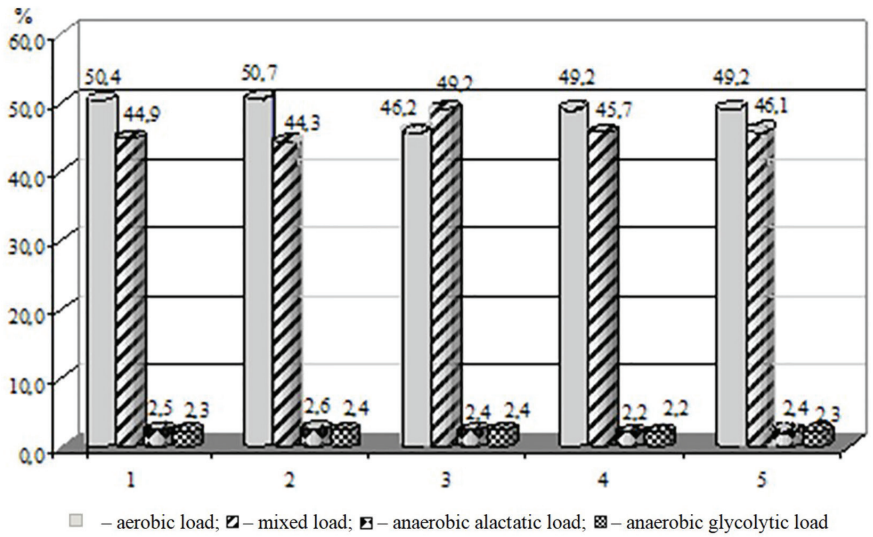

FIGURE 3. The ratio of training loads of different directions in the competitive period of highly skilled players in mini-football: 1 – the first competitive mezo-cycle, 2 – the second competitive mezo-cycle, 3 – the third competitive mezo-cycle, 4 – the fourth competitive micro-cycle; 5 – in total for the competitive period

Anaerobic loads in the micro-cyclesof the competitive period were used in the range of 4-5%, including anaerobic alactate from 2.1 (5-days competitive micro-cycle) to 4.2% (4-days inter-game micro-cycle).

In general, 49.2% of aerobic load, 46.1% of mixed load, 2.4% of anaerobic alactate and 2.3% of anaerobic glycolytic loads accounted during the competitive training period of mini-football players (Figure3).

Discussion

The competition period usually consists of several tournament stages, separated by 1-2 training micro-cycles. A similar model of the annual training cycle was developed by Aleshin (2004) for skilled handball players, who proposed to lay the one-cycle construction of the training process with a 4-week transition period, short (8-9 weeks) preparatory period and long (about 9 months) competitive period as the basis of the annual training structure.

Among the classic types of micro-cycles, researches presented the planning of inter-game micro-cycles mainly in the competitive period in the construction of the training process in mini-football, that were wide spread in the practice of training teams in sports games (Clemente, Martins, & Mendes, 2014; Lisenchuk et al., 2019). Their expediency is determined by the calendar of competitions. The rational use of the inter-gaming micro-cycle allows to maintain a high level of special readiness throughout the competitive period of the annual training cycle, as well as to avoid the long-term loss of sports condition in the transition period.

B. Krsmanovic, Krulanovic, T. Krsmanovic and Kovacevic (2010) studied the aerobic and anaerobic loading of football players of "Spartak-Zlatibor voda" as a 1st-league club of Serbia and the methodology of programming training work. It is necessary to note that researches on futsal adhered to the theoretical and methodological approaches for alternating the phases of loading and rest during the respective cycles of the training process in constructing of competitive micro-cycles with different duration (Stasiuk, 2013), and also researches based on scientific data on the recovery of athlete's performance after loads of different volume and orientation (Lisenchuk, 2003).

According to the developed training programs, it is estimated that the total amount of motor activity of highly skilled players of the I-League mini-football team in the annual training cycle is 598 hours, of which 150 hours of training time is allocated for preparatory period, 294 hours – for competitive period and 149 hours – for transitional periods. Those data complement the research of Polurenko (2009) in mini-football and are comparable to the studies of this problem in other team sports games, in particular in football by Tiulenkov (2007) and Kostyukevich (2019), according to which the volume of direct motor work of the 1st League team players during the annual training cycle is 829 hours.

Our materials confirmed the data of Babkin (2004) on the use of organizational forms of technical and tactical training of qualified players in mini-football; Manasis and Ntzoufras (2014); Voronova et al. (2020) on comprehensive control over the level of player's and team's preparedness in football; Hudec (2002) on the means of player's testing in mini-football.

Our study supplement and expand the data of Vyprikov (2008) on the peculiarities of a training process constructing on the basis of external and internal characteristics of loads in mini-football; Skorovich (2012) on the rational planning of special means in the training process of players in mini-football; Lisenchuk (2003) on the training specifics of players with different qualification in mini-football.

The results of our research complement the data both about the peculiarities of the three-cycle training process planning (Lisenchuk, 1989; Tiulenkov, 2007; Platonov, 2013), and also concerning to the ratio of training loads of highly skilled football players during the competitive period of the macrocycles (Stasiuk, 2016; Kostiukevych et al., 2019).

Based on the periodization theory of sports training, researches have chosen a one-cycle construction of the training process in the annual macrocycle for highly skilled players in mini-football. The structure and content of the competitive period in training process of highly skilled players in mini-football have been developed and experimentally substantiated: the ratio of training means during the competitive period, the volume of training loads of different directions in the micro-cycles of competitive mezo-cycles, the ratio of training loads of different directions: aerobic, mixed; anaerobic alactate; anaerobic glycolytic.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Football Players' "Cardiorespiratory System and Intermittent Endurance" Test

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Abstract

Twenty six football players of the Shandong Luneng youth team (U17), the 2019 season Chinese National Youth Super League champions. Based on a comprehensive assessment of the working capacity and functional support of intermittent endurance, the levels and changes in the reaction of the cardiorespiratory system and energy supply of football players' activities were analyzed under the condition of fatigue cumulating in the process of performing a series of high-speed segments. The prerequisite for testing was the preservation of the parameters of running 70 m in 10 s during the entire testing period. Content of Cardiorespiratory System and Intermittent Endurance test: duration of work in a series – 4 minutes; duration of work with the maximum available intensity – 10 s (running distance 70 m), rest interval – 20 s. The number of combinations of work segments 10 s and rest intervals 20 s in a series is 8. The efficiency of work is assessed by the number of completed series and the reaction of the cardiorespiratory system. The typological differences in the functional support of the special working capacity of football players who had a high level of working capacity were determined. They are associated with a balanced type of aerobic and anaerobic energy supply, with an insignificant tension of the mechanisms for fatigue compensating and a predominantly anaerobic type of energy supply provided a high level of respiratory compensation for metabolic acidosis.

Keywords: *football, U17, intermittent endurance, cardiorespiratory system, aerobic energy supply, anaerobic energy supply*

Introduction

At present, the means and methods of control, assessment and interpretation of its results, which provide information on the functional support of the special working capacity of athletes, acquire a special relevance (McDougal, & Green, 1998; Bompa & Haff, 2009; Iaia & Bangsbo, 2010). Based on the assessment of indicators of the special working capacity of the reaction of the cardiorespiratory system and the energy supply of work, group and individual parameters of special functional training can be developed (Ekblom, 1994; Hoff, Wisløff, Engen, Kemi, & Helgerud, 2002). The implementation of this approach in football is one of the most effective ways to form the organism's functional reserves and their realization in the process of competitive activity (Helgerud, Engen, Wisloff, & Hoff 2001; Iaia et al., 2015). An important condition for the implementation of control as a function of managing the special functional training of football players is the search for means and methods of registration, assessment and interpretation of the control results in accordance with the structure of the functional support of special working capacity(Przybylsky & Mischenko, 2005; Impellizzeri et al., 2008). In accordance with this, quantitative and qualitative characteristics, reflecting the integral manifestations of functional readiness, acquire importance. Football related special literature covers the characteristics of the functional support of special working capacity under conditions of a

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pronounced repeated and variable nature of competitive load with the development of fatigue, under the general concept of intermittent endurance (Przybylsky, 2003; Gutierrez Diaz Del Campo, Pastor Vicedo, Gonzalez Villora, & Contreras Jordan, 2010).

The data presented in the modern literature characterizes the functional support of football players' special working capacity in the conditions of intense motor activity of variable character (Hoff & Helgerud, 2004; Reilly, 2000).

At the same time, the suggested means and methods for assessing the working capacity and functional capabilities of football players do not allow to fully assess one of the most important aspects of the functional readiness of football players – the ability to perform work in conditions of maximum intensity at short runs during the development of fatigue. We are talking about the choice of a test task that allows standardizing the measurement conditions and simulating the load at which a football player reaches the highest effort of the functional support of special working capacity, typical for periods of intense game activity. An important aspect of the assessment is the analysis of the reaction of the cardiorespiratory system and energy supply of work to the development of hypoxia. hypercapnia, products of anaerobic metabolism(Warren, 1987; Miyamoto, Nakazono, & Yamakoshi, 2007; Puype, 2013). This will make it possible to determine the individual characteristics of the reactivity of the cardiorespiratory system and the energy supply of the work of football players, including the possibility of compensating for fatigue in the process of modelling the intense motor activity of football players (Mischenko, Lysenko, & Vinogradov, 2007; Przybylsky & Mischenko, 2005).

The aim of the study is the development and experimental verification of a test aimed at intermittent endurance, the reaction of the cardiorespiratory system and energy supply of work as an assessment of the functional support of the special working capacity of football players.

Methods

Subjects

Twenty six (26) football players of the Shandong Luneng youth team (U17), of 16-17 years old, champions of the 2019 Chinese National Youth Super League (U17).

All participants were informed of the requirements prior to the study, and their parents and coaches gave their informed written consent for them to participate. The local research ethics committee in the spirit of the Declaration of Helsinki approved all procedures (The protocol of National University of Ukraine on Physical Education and Sport No 2 of December, 16, 2020).

Design

Research protocol

Oxygen consumption (VO_2), CO_2 production (VCO_2), minute ventilation (V_E), was assessed on a breath-by-breath basis using an Oxycon mobile (Jaeger) metabolimeter. The blood lactate concentration was assessed using a portable lactate analyzer (Biosen S. line lab +) on a blood sample obtained from the ear lobe at the end of the last test series at third and fifth minute of recovery.

CRS & IE test Protocol

The nominal name of the Cardiorespiratory system and intermittent endurance test is CRS & IE test. The work parameters modelled the conditions for the realization of the power and capacity of anaerobic energy supply (La), a high degree of mobilization of the reaction of respiratory compensation of metabolic acidosis (V_E/VCO_2) and aerobic energy supply of work (VO_2). Duration of work in a series – 4 minutes; run length – 70 m, run timing – 10 s, rest interval – 20 s. The number of combinations of 10 s work segments and 20 s rest intervals in a series was 8. The number of series was regulated by "failure" or the inability to maintain the specified running parameters (work intensity). Series that have been completed in full were registered. The duration of the recovery period between series was two minutes. After series 3 and 4, the duration of the rest intervals could be increased to 3–5 minutes, depending on the recovery of the heart rate up to 120 beats / min. The testing scheme is shown in Figure 1.

The working capacity was assessed by the number of work performed (the number of series). If one or two series were completed – 1 point, three or four series – 3 points, five

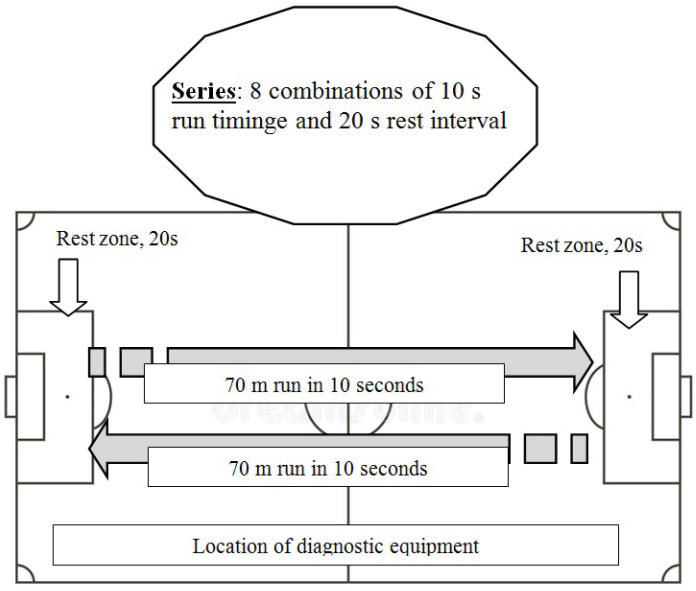

FIGURE 1. CRS & IE testing scheme

or more series – 5 points.

The indicators of the reaction of the cardiorespiratory system and the energy supply of work are considered as criteria for the effectiveness of the functional support of football players' special working capacity. The indicators of consumption of O2 (VO2), blood lactate, specific indicators of pulmonary ventilation and CO_2 emission were analyzed. All indicators were recorded during the first and third series. The highest average values of indicators for 10 s of work on a segment in a series were taken as a basis. Blood sampling for measuring the concentration of blood lactate was carried out at 3 and 5 minutes of the recovery period after the last series. The highest rate was registered.

Statistical Analysis

The statistical analysis is using the Statistical Package for the Social Sciences (SPSS 25.0). The methods of the mathematical statistics used were descriptive statistics, selective method. The Shapiro Wilk test was used in testing for normality. As data was not normally distributed, Mann-Whitney test (U) was used to determine the statistical significance of the differences between two independent samples and Wilcoxon test (T) for comparing two dependent samples. A significance level (that is, the probability of error) was assumed to be p=0.05. The informativeness of the tests and indicators was recorded, evaluated under the standard conditions of measurement.

Results

The indicators of a homogeneous group of football players (n=26), recorded in the process of performing the first and third series of segments (indicators of the reaction of cardiorespiratory system and aerobic energy supply) and indicators of the concentration of blood lactate are presented in Table 1.

The analysis of the average indicators (Table 1) indicates a clear tendency to an increase in the indicators of the power

Table 1. The indicators of changes in the functional capabilities of football players during the CRS & IE test (n=26)

Parameter*	The interval of data recording					
	First series		Third series		After the test	
	$\overline{x}$	SD	$\overline{x}$	SD	$\overline{x}$	SD
VO_2, ml·min^{-1}·kg^{-1}	37.3	2.3	48.8**	3.7	–	–
			T=23, p=0.000469			
V_E/VCO_2 ,conventional units	37.1	2.1	39.4	2.7	–	–
			T=146, p=0.657069			
La, mmol·l^{-1}	–	–	–	–	13.1	1.9

Legend: * – average values of the indicator during overcoming run in 10 second: ** – the differences in football player's indicators between the first and third series are significant at p<0.05

of the cardiorespiratory system and the energy supply of football player's work. The individual differences in the indicators (CV) of the reaction of cardiorespiratory system and the energy supply of work, which increase in the process of performing the third series, draw attention. Wilcoxon signed-rank test (T) was used to compare two repeated measurements on a sample of 26 football players' indicators between the first and third series. Differences in the indicators of the first and third series, respectively: consumption of O_2 – 6.2% and 7.6%, V_E/VCO_2 – 5.7% and 6.9%; differences in blood lactate concentration – 14.5%. These differences characterize high and lowered indicators of cardiorespiratory system reaction and energy supply in a homogeneous group of athletes.

The analysis of football player's working capacity showed a high level of differences in intermittent endurance. The average working capacity indicators were 3.5±1.2 points; 34.2% ($\overline{x}$ ±SD; CV). Two groups of athletes are clearly distinguished, conventionally named Group "A" and Group "B". The first Group "A" – nine footballers completed 5 or more series; the second Group "B" – fifteen players completed 3–4 series. Two football players showed negative test results – less than three episodes.

Those results provided the basis for assessing the typological differences in the reaction of cardiorespiratory system and the energy supply of work in football players with high and low levels of intermittent endurance. For this, an analysis of the typological differences in the reaction of cardiorespiratory system and the energy supply of football player's work of the Groups "A" and "B" was carried out. Table 2 presents the analysis results of indicators of the cardiorespiratory system reaction and energy supply of football player's work of the Groups "A" and "B". The Mann-Whitney test (U) was used to determine the differences between indicators of the Groups "A" and "B".

As shown in Table 2, football players with a high level of intermittent endurance in the first segment had a higher level of aerobic energy supply response. This tendency remained in the process of performing the third series. Differences between the reaction of the cardiorespiratory system and the energy supply of work were noted during the third segment of the testing program. This kind of tendency was noted when analysing changes in cardiorespiratory system response (V_E/VCO_2).

Particular attention was drawn to the results of a comparative analysis of the respiratory response to CO_2 emission recorded in the first and third series. According to the special literature, changes in the reaction of cardiorespiratory system show the possibilities of respiratory compensation for metabolic acidosis (Mischenko et al., 2007). This is one of the components of the reaction to compensate for fatigue in the process of intensive physical activity (Mischenko & Monogarov, 1995). In football players with a high level of intermittent endurance (Group "A"), the reaction of respiratory compensation of metabolic acidosis increased by 5.4%, in football players in Group "B" – by 2.4%.

Analysis of the reaction of anaerobic energy supply (according to La) showed a higher level of indicators of blood lactate concentration after the test task in the football players

Table 2. Individual indicators of the reaction of the cardiorespiratory system and energy supply of football player's work during the CRS & IE test

Parameter	The interval of data recording								
	First series			Third series			After the test		
Indicators of Group "A" football players who scored 5 points (n=9)									
Statistics	$\overline{x}$	25%	75%	$\overline{x}$	25%	75%	$\overline{x}$	25%	75%
VO_2, ml·min^{-1}·kg^{-1}	38.3	37.1	39.5	49.8**	47.9	51.9	–	–	–
V_E/VCO_2,conventional units	37.1	36.0	39.1	39.2**	37.5	41.7	–	–	–
La, mmol·l^{-1}	–	–		–	–		14.1	12.4	15.8
Indicators of Group "B" football players who scored 3 points (n=15)									
Statistics	$\overline{x}$	25%	75%	$\overline{x}$	25%	75%	$\overline{x}$	25%	75%
VO_2, ml·min^{-1}·kg^{-1}	35.5	33.5	37.1	45.8**	43.9	48.1	–	–	–
V_E/VCO_2,conventional units	36.1	35.0	38.1	37.0**	36.4	38.5	–	–	–
La, mmol·l^{-1}	–	–		–	–		12.1	11.0	13.2
Mann-Whitney test	U=61, p=0.698			U=21, p=0.0056			U=39.5, p=0.095		

Legend: * – average values of the indicator in the process of overcoming run in 10 second; ** – differences in indicators between Group "A" and "B" are significant at p<0.05

of Group "A". At the same time, in this group of football players, blood lactate concentration indices have a higher level of individual differences. This gives reason to think about the differences in the structure of the football players' energy supply. The characteristics of individual differences are provided by the analysis of individual indicators of the players of Group "A".

With a general tendency towards the balance of aerobic and anaerobic reactions, two athletes showed the type of individual reaction of cardiorespiratory system and energy supply of work. This type is characterized by high anaerobic capacity and metabolic acidosis compensation response. Two sportsmen of Group "A" are marked with typological characteristics of endurance, which is based mainly on anaerobic sources of energy supply, provided that the reaction of respiratory compensation of metabolic acidosis is activated. In these athletes, the level of O_2 consumption in the third series was at the level of 47.9 and 47.3 VO_2, ml·min^{-1}·kg^{-1}, the concentration of blood lactate was 15.8 and 16.1 mmol·l^{-1}, the increase in V_E/VCO_2 was 6.2 and 6.9 conventional units.

The test results showed high rates of cardiorespiratory system reaction and energy supply of work. High individual differences in indicators are noted. The typological features of the reaction of cardiorespiratory system and energy supply in athletes with high and decreased levels of working capacity are given. This testifies to the informativeness of the given quantitative and qualitative indicators of the reaction of cardiorespiratory system and energy supply of work, as well as the characteristics of the working capacity of football players, which show the level of intermittent endurance.

Discussion

In the specialized literature on football, the conditions for monitoring, evaluating and interpreting indicators of special working capacity and functional capabilities of football players of different ages and qualifications are presented (Pereira, 2002; Beswick, 2010, Longo, Aquilino, Cardey, & Lentini, 2016). Special tests "Yo-Yo", "Bangsbo", "Hoff-Helgerud" and others have become widespread in practice due to their informative value and the possibility of using them in natural conditions of sports training (Bangsbo, 1999: Hoff & Helgerud, 2004; Bangsbo, Iaia, & Krustrup, 2008). The possibilities of registering the reaction of cardiorespiratory system and anaerobic energy supply, as well as indicators of working capacity of football players in natural working conditions are shown (Krustrup et al., 2006; Iaia & Bangsbo, 2010; Bujnovky, 2019).

The test results provided a lot of important information about the structure of functional support for the special working capacity of football players, their typological and individual characteristics. This made it possible to increase the special orientation of functional training, to develop and use modes of training work in accordance with the body's response to the load. The accumulated scientific and empirical knowledge made it possible to expand the understanding of the possibility of obtaining information about the functional readiness of football players, taking into account highly specific manifestations of functional capabilities. At the same time, there was an understanding that the reserves of the special working capacity of football players are based on the search for new opportunities for the development of functional capabilities in extreme conditions of playing activity. This is largely due to the development and implementation of functional support of high-speed modes of training and competitive work in the process of mobilizing the reaction to compensate for fatigue.

When developing the test task, we took into account the fact that during the load of maximum and submaximal intensity, the athlete reacts to the development of hypoxia. hypercapnia, accumulation of products of anaerobic metabolism. In the opinion in athletes with a high level of preparedness, these states are physiological stimuli (drives) of the reaction, which have additional effects on the mobilization and implementation of functions in the process of intense physical load. According to the authors Miyamoto, Nakazono and Yamakoshi (1987); Mischenko and Monogarov (1995); Mischenko et al. (2007); Ward, Lamarra and Whipp (1996), the ability of an athlete's organism to quickly, adequately and fully respond to physical activity, which is accompanied by neurohumoral stimuli of the reaction stimulates the kinetics of cardiorespiratory system and energy supply of work. This stimulates the achievement of peak characteristics of the reaction of cardiorespiratory system and energy supply of work, affects the increase in the

reaction of respiratory compensation for metabolic acidosis.

The reactivity of the cardiorespiratory system and the power supply of work to repeated loads of maximum intensity is the main target setting for the implementation of the testing program. This kind of information will help to clarify the athlete's ability to respond to training and competition loads.

For this, testing regimes were developed, which simulated the conditions for mobilizing the reaction of cardiorespiratory system and energy reserves of the body during repeated performance of the high-speed work modes. The accumulation of fatigue occurred as a result of the cumulation effects of running 70 m segments in 10 s. The combination of work and rest modes, load for 10 s and rest for 20 s stimulated the consumption of O2 and the reaction of respiratory compensation of metabolic acidosis in response to the development of hypoxia, hypercapnia, and the accumulation of products of anaerobic metabolism. This made it possible to realize the reserves of the functional support of special working capacity under the conditions of high-speed modes of operation, to form a reaction structure that characterized the specific manifestations of the special endurance of football players, or intermittent endurance, as indicated in the special literature on football. To assess the specific manifestations of intermittent endurance when performing a series of segments of high-speed work, the test conditions were formulated. which received the code name Cardiorespiratory System and Intermittent Endurance test – CRS & IE test.

As a result of the CRS & IE test, the typological characteristics of the reaction were determined for football players, who had a high and reduced level of special working capacity. A high level of football player's working capacity provides two types of reaction of cardiorespiratory system and energy supply of work. The first type is characterized by a balanced manifestation of aerobic and anaerobic energy supply, a moderate stress reaction of cardiorespiratory system at the end of work. The second type is characterized by an increased level of anaerobic metabolism and a high level of the reaction of respiratory compensation for metabolic acidosis.

As a result of the study, a program for testing football players was developed and experimentally tested. The program is based on a series of short accelerations that, when repeated, stimulate fatigue. As a result, new possibilities for monitoring and evaluating the functional support of the football player's special working capacity are shown. The presented program makes it possible to determine the level of functional readiness, typological features of the functional support of the player's working capacity, the focus of special functional training and individual parameters of training work during the period of fatigue compensation in the process of developing the speed capabilities of football players.

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ORIGINAL SCIENTIFIC PAPER

Neurohumoral Components of Rapid Reaction Kinetics of the Cardio-Respiratory System of Kayakers

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Abstract

The article shows the influence of the neurogenic and humoral components of the reaction on the development of rapid kinetics of the cardiorespiratory system and the functionality of the kayakers during the loads of maximal and submaximal intensity. Research was performed on kayakers team of Jianshi and Shandong provinces (China), n=32. We did gas analysis (Oxycon mobile (Jaeger) metabolimeter) and ergometry (Dansprint). Test tasks included loads with maximum intensity of work for 10 s, 45 s and 120 s. The analysis of indicators of quantitative characteristics and relationships of response indicators maximum level of pulmonary ventilation (V_E), partial pressure of CO2 ($PaCO_2$), oxygen consumption (VO_2), equivalent of oxygen consumption (EqO_2) , equivalent of CO2 emissions ($EqCO_2$), equivalent of partial pressure of CO2 ($EqPaCO_2$) , which characterize the rapid kinetics of the cardiorespiratory system in the process of analyzing the functional support of the special working capacity of kayakers. This allowed us to determine the initial components of the reaction and the degree of their influence on the effectiveness of the functional support of the special working capacity of kayakers. Analysis of the reaction components indicates that specific indicators of the ratio of the concentration of carbon dioxide in arterial blood, as well as CO_2 emission and breathing reactions ($EqPaCO_2$ and $EqVCO_2$), can be used to assess the rapid kinetics of the cardiorespiratory system. Depending on the duration and intensity of the load, these reaction components also form the structure of the functional support of special performance, influence the development of power, economy and stability of the reaction. The informative characteristics of rapid kinetics are associated with the highest rates of the reaction of the cardiorespiratory system (breathing reactions) to an increase in the partial pressure of carbon dioxide and the release of CO_2 in the external respiration system. Normative model characteristics of $EqPaCO_2$ and $EqVCO_2$can be registered during the 45 s test, when indicators of $EqPaCO_2$ and $EqVCO_2$reach the highest values in a series of tests: $EqPaCO_2$ – 3.6±1.0. $EqVCO_2$ – 30.1±3.4. These indicators can be used as a characteristic of the components of the rapid reaction kinetics of the cardiorespiratory system.

Keywords: *functional capabilities, rapid kinetics, neurogenic stimulus, humoral stimulus, cardiorespiratory system of kayakers*

Introduction

At the core of the implementation of competitive activity in cyclic sports consists from integral manifestations of the functional support of special working capacity: speed of development of reactions, steady state of functions, compensation of fatigue (Mishchenko & Suchanowski, 2010).The reaction components form the structure of functional readiness and are combined into a system, where an increase in the effectiveness of each component leads to an increase in the effectiveness of the entire system (Lysenko, Shinkaruk, & Samuilenko, 2004).

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The special literature shows the influence of the rapid kinetics of the reaction of the cardiorespiratory system (CRS) on the structural components of the functional support of special working capacity (Ward, Lamarra, & Whipp, 1996). The quantitative and qualitative characteristics of fast kinetics have been substantiated in special literature as well (T_{50}HR, VO_2, VCO_2, V_E). The normative basis for the rapid kinetics of CRS has been brought in line with the gender, age, qualifications and specialization of athletes (Wang, Rusanova, & Diachenko, 2019).The individual reactive properties of the body play a special role, which is manifested in the magnitude of the body's response to specific physiological drives ("drives") (Mishchenko, Lysenko, & Vinogradov, 2007).

The issues of the implementation of stimuli of rapid kinetics of CRS were considered in the process of analyzing the conditions for the realization of neurogenic and humoral stimuli of reaction (Miyamoto, Nakazono, & Yamakoshi, 1987; Warren, 1987; Withers, Ploeg, & Finn, 1993). When considering the development of the initial part of the reaction of CRS, the issues of the influence of various degrees of concentration in arterial blood of carbon dioxide and oxygen and CO_2 emissions in exhaled air are considered (Burton, Stokes, & Hall, 2004). There is evidence in scientific literature that indicates that the achievement of peak synchronization of $EqCO_2$ and $PaCO_2$ indicates the respiratory compensation threshold (RCT) of metabolic acidosis during standard exercise with increasing intensity (Liu, Steinacker, & Stauch, 1995). Increased partial pressure on the vascular wall enhances chemoreceptor "neurogenic" stimulation of respiration. The next phase of development of function is humoral phase, which manifests itself when a high degree of "acute" load hypoxia is reached and hypercapnia is actively developed. This component of the response stimulates the peaks of the pulmonary ventilation response. Both neurogenic and humoral components of the reaction affect the formation of the structure of the initial part of the reaction of CRS (Mishchenko et al, 2007). The degree of influence depends on the individual reactivity of CRS of athletes, as well as the structure of training and the level of functional fitness of athletes.

In the scientific community, there is an understanding that the analysis of the structure of the initial part of the reaction of CRS makes it possible to accurately assess its effect on the rapid kinetics of the reaction and other components of the functional support of special performance. This will make it possible to clarify the means and methods for managing training and competitive loads. It also requires a special analysis, taking into account the intensity and duration of the load. Particular attention should be paid to assessing the informativeness of indicators of function development (changes in $PaCO_2$ and VCO_2) or the reaction of CRS on changes in function under the influence of intense stress ($EqPaCO_2$ and $EqVCO_2$).

Purpose. To determine the effect of neurohumoral stimuli of the rapid kinetics of the cardiorespiratory system on the functional support of the special working capacity of kayakers.

Methods

Subject. 32 qualified male paddlers, leading athletes of Jiangxi & Shandong provinces, age=23.8±2.3 years, training age=7.0±0.9 years.

All participants were informed of the requirements prior to the study and gave their written consent. The local research ethics committee in the spirit of the Declaration of Helsinki approved all procedures.

Research protocol

For standardizing the measurements of special performance, the "Dansprint" ergometer with Gas exchange Characteristics were recorded. The specialists of the Scientific Sports Management Research Centers in Shandong Province (Jinan) and Jiangxi (Nanchang) carried out the measurements of the reaction of the cardiorespiratory system.

Oxygen consumption ($V^{\cdot}O_2$), CO_2 production ($V^{\cdot}CO_2$), minute ventilation ($V^{\cdot}_E$) were determined on a breath-by-breath basis using an Oxycon mobile (Jaeger) metabolimeter. The metabolic unit was calibrated a gas of known composition (16.00% O2, 4.00% CO2), respectively.

We used the following tests: "test 10 s", "test 45 s", "test 120 s":

In "test 10 s", the conditions for the realization of fast reaction kinetics were simulated. Measurements of indicators of the cardiorespiratory system were carried out within 10 seconds of the recovery period after exercise.

In the "test 45 s" conditions of a high degree of load hypoxia and respiratory compensation of metabolic acidosis were modeled. The indicators were recorded in the process of performing the exercise.

The "test 120 s" modeled the conditions for the development of fatigue and its compensation. The indicators were recorded in the process of performing the exercise.

Statistical Analysis

In order to assess and analyse the data received the Statistical Package (SPSS 10.0) was used. Descriptive statistics suggested defining arithmetical average - , standard deviation - SD, as well as medaine - Me, maximal (Max) and minimal (Min) indexes, 25 % and 75 % indices. Correlation analysis used. The data was verified in accordance with the normal distribution (applying the Shapiro WIlk criteria). If the data were normally distributed, then in order to define the statistical validity of differences Student Criteria was applied. In case when the data has not complied with the normal probability law non-parametric criteria of Wilkinson was applied to define the statistical validity of discrepancies. The error probability during the statistical analysis was set at the level of p=0.05 (significance level).

Results

Table 1 shows the quantitative and qualitative characteristics of CRS, which stimulate the kinetics of the initial part of the reaction and form the structure of the functional support of special working capacity. The table shows that all indicators had values that corresponded to the indicators of the functional readiness model of qualified kayakers. Individual differences (CV) are noteworthy in $PaCO_2$, VCO_2, $EqCO_2$, $EqPaCO_2$. CV parameters of $PaCO_2$ in "test 10 s", "test 45 s", "test 120 s" were in range of 10.0-11.0%; CV of $EqPaCO_2$ were significantly higher, 34.9%, 29.0%, 17.8% respectively. In the "test 45 s" the highest quantitative characteristics of the reaction of CRS were registered: upper quartile scores (75%) $EqPaCO_2$, $EqCO_2$ and VCO_2. At the same time, individual differences of specific indicators of CRS reaction and energy supply of work remained high.

Table 1. Indicators of the reaction of the cardiorespiratory system during the performance of tests of various duration and intensity among rowers on kayaks (n=32)

Data	V_E	$PaCO_2$	VCO_2	VO_2	EqO_2	$EqCO_2$	$EqPaCO_2$	V_E	$PaCO_2$	VCO_2	VO_2	EqO_2	$EqCO_2$	$EqPaCO_2$	V_E	$PaCO_2$	VCO_2	VO_2	EqO_2	$EqCO_2$	$EqPaCO_2$
	Test 10 s *							Test 45 s *							Test 120 s*						
	79.9	41.0	2.9	40.8	29.2	28.2	2.2	126.9	38.7	4.4	49.7	37.2	30.1	3.6	123.2	35.9	4.0	54.2	39.3	30.6	3.5
Me	75.2	41.5	3.0	40.6	27.0	28.7	2.0	132.4	39.2	4.4	51.0	36.1	29.2	3.6	124.8	36.0	4.0	53.8	37.9	30.4	3.5
SD	21.9	4.5	0.7	8.6	7.4	3.3	0.8	25.7	4.3	0.8	6.0	7.4	4.0	1.0	20.1	3.6	0.5	7.4	9.1	3.3	0.6
min	43.4	32.3	1.6	26.1	20.8	21.8	1.2	77.7	31.2	2.7	34.9	24.3	24.1	1.9	82.4	30.1	2.9	41.4	24.8	25.2	2.2
max	124.3	48.7	4.3	56.0	50.2	34.2	4.2	172.9	46.4	5.8	60.0	53.0	40.3	5.3	159.7	42.5	5.1	68.0	58.9	37.6	5.1
25%	65.6	38.3	2.4	33.6	24.2	25.6	1.7	110.5	35.3	4.0	45.7	32.4	27.4	2.7	113.3	32.4	3.7	48.7	32.1	27.8	3.1
75%	95.0	43.5	3.1	47.0	33.3	30.4	2.4	144.3	42.0	4.8	53.8	40.5	32.3	4.4	136.5	38.8	4.4	60.3	45.2	33.2	3.8
CV	27.4	**11.0**	**24.3**	21.2	25.4	**11.9**	**34.9**	20.2	**11.1**	**17.5**	12.1	19.9	13.4	**29.0**	16.3	**10.0**	**13.5**	13.7	23.1	**10.8**	**17.8**

Legend: * – in "test 10 s measurements of indicators of the cardiorespiratory system were carried out within 10 seconds of the recovery period after exercise; in the "test 45 s" the indicators were recorded in the process of performing the exercise; in the "test 120 s" the indicators were recorded in the process of performing the exercise. The analysis was contacted of indicators maximum level of pulmonary ventilation (V_E), partial pressure of CO_2 ($PaCO_2$), oxygen consumption (VO_2), equivalent of oxygen consumption (EqO_2), equivalent of CO_2 emissions ($EqCO_2$), equivalent of partial pressure of CO_2 ($EqPaCO_2$)

Table 2 shows reliable correlations of indicators of CRS reaction to an increase in the concentration of carbon dioxide in arterial blood and CO_2 release in the external respiration system, registered by rowers in tests of various duration and intensity. The result of the analysis is the substantiation of a high degree of interconnection of indicators of the development of function, reaction to an increase in workload and the efficiency of energy supply of work (Table 2).

Table 2. Correlation relationships ($p<0.05$) of the indicators of the reaction of the cardiorespiratory system during the performance of tests of various duration and intensity in rowers on kayaks (n=32)

Data		V_E	$PaCO_2$	VCO_2	VO_2	EqO_2	$EqCO_2$	$EqPaCO_2$	V_E	$PaCO_2$	VCO_2	VO_2	EqO_2	$EqCO_2$	$EqPaCO_2$	V_E	$PaCO_2$	VCO_2	VO_2	EqO_2	$EqCO_2$	$EqPaCO_2$
		Test 10 s							Test 45 s							Test 120 s						
V_E	Test 10 s	-		0.9	0.7	0.5	0.6	0.9														
$PaCO_2$			-		0.5	0.5																
VCO_2				-	0.8	0.5	0.5	0.8														
VO_2					-		0.6	0.6														
EqO_2						-	0.5	0.5														
$EqCO_2$							-	0.6														
$EqPaCO_2$								-														
V_E	Test 45 s								-		0.9	0.6	0.6	0.6	0.96							
$PaCO_2$										-		0.7										
VCO_2											-	0.8	0.6		0.8							
VO_2												-										
EqO_2													-	0.9	0.7							
$EqCO_2$														-	0.6							
$EqPaCO_2$															-							
V_E	Test 120 s															-		0.9	0.5	0.7	0.8	0.8
$PaCO_2$																	-	0.5	0.7			
VCO_2																		-	0.7	0.7	0.6	0.5
VO_2																			-	0.6		
EqO_2																				-	0.7	0.5
$EqCO_2$																					-	0.8
$EqPaCO_2$																						-

Legend: The analysis was contacted of indicators maximum level of pulmonary ventilation (V_E), partial pressure of CO_2 ($PaCO_2$), oxygen consumption (VO_2), equivalent of oxygen consumption (EqO_2), equivalent of CO_2 emissions ($EqCO_2$), equivalent of partial pressure of CO_2 ($EqPaCO_2$)

Noteworthy is the high degree of correlation between $EqPaCO_2$ and specific indicators of pulmonary ventilation and energy supply of work ($EqVCO_2$ and $EqVO_2$) observed in all tests. During "test 120 s" $PaCO_2$ and $EqPaCO_2$ had a stable tendency to be related to the indicators of the efficiency of aerobic energy supply $EqVO_2$. The analysis also took into account the correlation dependence of $EqVO_2$ and VO_2.

It is important to note the fact that the indicators of function development ($PaCO_2$ and VCO_2) had the number of reliable connections of one and four in the "test 10 s", in "test 45 s" it was one and three, in "test 120 s" it was two and four; reactions of pulmonary ventilation to changes in function ($EqPaCO_2$ and $EqVCO_2$) had four and five, two and four, three and four, respectively.

The general trend is that the characteristics of the development of the function and reaction of pulmonary ventilation had high correlations between themselves and with $EqVO_2$ and VO_2. The most distinctly integral manifestations of the relationship between indicators of the initial part of the reaction of CRS and aerobic energy supply of work is shown in the "test 120 s".

Discussion

Currently, there is a clear understanding that the indicators of the reaction power of CRS and the energy supply of work do not provide complete information about the potential of the athlete, his readiness for maximum implementation of functional capabilities in the process of competitive activity. Special literature shows thatVO_2max, blood lactate concentration, maximum pulmonary ventilation and other characteristics of functional fitness, registered under standard protocol (Mac Dougall, Wenger, & Green, 1991),often differ from the reaction indicators noted in the process of overcoming the competitive distance (Diachenko et al., 2020).

In this regard, more and more attention is paid to the study of the components of the body's reaction, which provide stimulation of functions in the process of overcoming a specific competitive distance. These reaction components are part of physiological processes that stimulate functional capabilities under conditions of hypoxia, hypercapnia and accumulation of products of anaerobic metabolism (Garnacho-Castaño et al., 2019). They have an impact on the formation of the structure of the reaction of the functional support of the special working capacity of athletes (Mishchenko et al., 2007). In cyclic sports, the reaction components are clearly manifested in the process of training, steady state and compensation of fatigue (Vogler, Rice, & Gore, 2013; Nikonorov, 2015).

In the special literature, the possibilities of functions regulation during physical activity are shown based on the implementation of neurogenic (Vilaça-Alves et al., 2016) and humoral drives of the reaction (Bourgois & Vrijens, 1998). The latter is associated with the body's response to the development of hypoxia, hypercapnia and accumulation of products of anaerobic metabolism (Mishchenko et al., 2007). Optimization of neurohumoral regulation of functions affects the formation of the structure of the functional support of special performance, increases the reaction speed of power supply at the beginning of work (Ward et al, 1996), power of functional support during steady state period (Maté-Muñoz et al., 2015) and activates mechanisms to compensate for fatigue (Hill, 1993).

The problem is that the conditions of competitive activity in cyclic sports are accompanied by high energy power and work capacity, where transient processes and the associated conditions for the implementation of neurohumoral stimulation of the body rapidly change. At the same time, the quantitative and qualitative characteristics of neurohumoral regulation have been studied under conditions of standard loads (de Klerk et al., 2020). Analysis results provide informative characteristics of CRS reactivity, which allow to determine the predisposition of an athlete to work of a certain duration and intensity (Michael, Rooney, & Smith, 2008; Paquette, Bieuzen, & Billaut, 2018). The issues of the influence of CRS stimulation on the development of functions and the implementation of competitive activity have not been sufficiently studied. This is due to insufficient knowledge about the structure of the reaction and the choice of specific operating modes, aimed at the implementation of stimuli of reactions in specific conditions of training and competitive activity. This problem occurs especially often when it comes to differentiating between neurogenic and humoral stimulation. These criteria are not sufficiently developed and are little used in the training load management system. As a rule, we are talking about complex stimulation, when neurogenic and humoral influences are closely interrelated. External integral manifestations of the reaction are used as assessment criteria, namely: function increase amount ($T_{50}HR$, VO_2, CO_2, V_E) (), fatigue compensation response and related differences in function during steady state and fatigue development ($V_E \cdot VCO_2^{-1}(V_E \cdot VO_2^{-1})_{\text{ofsteady state}}$ / $V_E \cdot VCO_2^{-1}(V_E \cdot VO_2^{-1})_{\text{period of fatigue development}}$ x 100%) ()etc.

The article presents the possibilities of optimization of the functional support of the special working capacity of kayakers based on the analysis of neurogenic and humoral stimuli during the initial part of CRS reaction. During the analysis, we took into account that the rapid kinetics of CRS is considered as a trigger mechanism for the regulation of functions in the process of intense physical activity. The degree of realization of fast kinetics affects the formation of the structure of the functional support of the competitive distance.

Quantitative characteristics and relationship of V_E, $PaCO_2$, VCO_2, VO_2, EqO_2, $EqCO_2$ and $EqPaCO_2$showed the effect of neurohumoral stimulation on the rapid kinetics and the formation of the structure of the functional support of work during loads with maximal and submaximal intensity. The development of this process goes through two stages: neurogenic, when the process of neurohumoral regulation of functions is associated with an increase in the concentration of carbon dioxide in arterial blood and humoral, when the development of function is influenced by the rate of CO_2 excretion. It has been shown in the special literature that the achievement of synchronization of these processes is indicative of respiratory compensation (RCP) of metabolic acidosis. This is one of the aspects of the manifestation of the reactive properties of the organism, as well as a component of the rapid kinetics of CRS. The results of the analysis confirm the data of special literature and at the same time indicate that informative criteria for rapid kinetics are indicators of the reaction of CRS to changes in $PaCO_2$ andVCO_2. Their quantitative characteristics are shown during evaluation of $EqPaCO_2$ and $EqVCO_2$. Most informative characteristics of $EqPaCO_2$ and $EqVCO_2$are the indicators registered in the "test 45 s". This test shows the highest scores of V_E, $EqPaCO_2$ and $EqVCO_2$, when the highest level of pulmonary ventilation response is reached.

The given components of the initial part of the reaction stimulate the rapid kinetics of CRS, form the prerequisites for

a quick and adequate reaction of energy supply to work in conditions of hypoxia, hypercapnia and accumulation of products of anaerobic metabolism. This creates conditions for optimizing the structure of the functional support of special working capacity and more efficient use of the functional reserves of the body.

Conclusion

The influence of the neurogenic and humoral components of the reaction on the increase in the rapid kinetics of the cardiorespiratory system and the development of the functional capabilities of kayakers under conditions of maximal and submaximal intensity loads was shown. Analysis of the reaction components indicates that specific indicators of the ratio of the concentration of carbon dioxide in arterial blood, CO_2 excretion and breathing reactions ($EqPaCO_2$ and $EqVCO_2$) can be used to assess the rapid kinetics of CRS. Depending on the duration and intensity of the load, these reaction components form the structure of the functional support of special performance and influence the development of power, economy and stability of the reaction. Normative model characteristics of $EqPaCO_2$ and $EqVCO_2$ can be recorded during the "test 45 s" when the indicators of $EqPaCO_2$ and $EqVCO_2$ reach their maximum values.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Biogeometric Profile of the Posture as a Factor of Men's Functional Assessment of Movements in the Early Middle Age

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Abstract

The research of the physical development of men in the early middle agewith different types and levels of biogeometric profile in the course of health fitness classes are presented. Subjects: 50 men of 35-45 years old engaged in physical activities. Visual screening of the biogeometric profile state of men's posture has been used to assess the indicators in the sagittal and frontal planes. It was specified the indicators of the state level of the biogeometric profile of the different types of posture with men in the early middle age. Comparative analysis of indicators of functional assessment of men's movements (using Functional Movement Screen) showed statistically significant decrease ($p<0.01$) in motor skills in all test exercises depending on age. Analysis of variance showed that the level of the state of the biogeometric profile of posture of men of the early middle ageis statistically significant ($p<0.05$) affects the functional assessment of the movement. Analysis of the dependence of functional assessment of movements on the level of biogeometric profile of the posture of men 36–45 years found that the maximum differences are observed between men 36–40 years and 41–45 years with a high level of biogeometric profile of their posture, and the minimum in men with average level, however, there are no statistically significant differences between the functional assessment of the movement of men 36–40 and 41–45 years with different levels of biogeometric posture profile.

Keywords: *biogeometric profile, posture, men, early middle age, movement functional assessment*

Introduction

For the wide range of researchers, the state of health of the modern population is of serious concern (Kashuba, Rudenko, Khabynets, & Nosova, 2020; Hakman et al., 2020). Scientists note that the highest morbidity rate in the class of circulatory system diseases the second place is occupied by diseases of the organs, the third rank is occupied by diseases of the musculoskeletal system (Ettinger, Wright, & Blair, 2006; Andrieieva et al., 2019; Goncharova et al., 2020). The urgency of the problem of the awareness of the phenomenon of spatial organization of the human body can be traced:

- in the late twentieth and early twenty-first centuries the growing trend of disorders of the spatial organization of the human body, in particular, a decrease in the biogeometric profile state of posture, is of thorny issue. It is the most relevant for the living conditions of humans in megapolises (Kashuba

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et al., 2017);

- the increasing value of human individuality in the modern world and increased perception of everything related to personal self-expression, and biogeometric profile of posture is one of the characteristics of this individuality (Tkachova et al., 2020);
- the formation of the spatial organization of the body in the conditions of modern civilization as one of the characteristics of physical health (Kashuba et al., 2019);
- the increased importance of issues of image in the modern society as the ability to present themselves to the society in the proper state of spatial organization of the men's body. The questions on the factors that affect the state of the spatial organization of the body of men were taken into consideration.

As the result of summarizing over 100 research articles it was concluded the study of the biogeometric profile of the men's posture in the early middle age is relevant and has the theoretical, practical and social significance for improving the health of adulthood people.

Methods

Visual screening of the state of the biogeometric profile posture of men aged 35-45 years used the express-control cards. The researchers assessed a number of indicators: in the sagittal plane – the position of the head and torso relative to the vertical axis, the state of thoracic kyphosis and lumbar lordosis, the shape of the abdomen, the angle in the biopairs of the thigh and lower leg; in the frontal plane - the location of the shoulders, lower corners of the shoulders and pelvis, waist triangles, the position of the feet. The researchers received an integrated assessment – the maximum number of points – 33 (subject was evaluated of all 11 indicators in 3 points), and the minimum – 11 (subject was evaluated of all 11 indicators in 1 point) points (Kashuba, Bibik, & Nosova, 2012).

The researchers used the Functional Movement Screen (FMS) Testing by American Physiotherapists Cook, Burton, Hoogenboom and Voight (2014) to identify the functional assessment of movements of men in early middle age. Those are the following: 1 –Deep Squat; 2 – Hurdle Step; 4 – In Line Lunge; 4 – Shoulder Mobility; 5 – Active Straight Leg Raise; 6 – Trunk Stability Push Up; 7 – Rotary Stability.

During testing, the subject performs three attempts in each test, the best result of which is recorded. Evaluation system has the following levels: score 3 – absolutely correct performance of the test, without compensatory movements, loss of body balance, etc.; score 2 – performance of the test with compensatory movements or in a light version; score 1 – failure to perform the test or its implementation is not in full; score 0 - performing a test with pain. Three coaches of "GYMMAXX" fitness-club with at least 5 years of experience were the assessors.

Subjects

50 men of 36–45 years old were selected randomly from clients of "GYMMAXX" fitness-club. They have been divided into two subgroups: 36–40 and 41–45 years old. Everyone gave written consent to participate in this research according to the recommendations of the Ethics Committee, in accordance with the ethical standards of the Helsinki Declaration.

Statistical analysis

The following methods of mathematical statistics were used: descriptive statistics, analysis of variance (ANOVA). The following parameters were determined: mean ($\overline{x}$), standard deviation (SD), standard error (m). One-factor ANOVA was used to analyze the impact of the biogeometric profile of men's posture on their physical fitness. Two-factor ANOVA determined the influence of the biogeometric profile of men's posture and the posture type on the physical qualities of men in early middle age. The Duncan's ranking criterion for multivariate comparisons was used to analyse the movement functional assessment and level of biogeometrical profile posture of men by pairwise comparisons of averages between the groups. The analysis was performed using the Statistica 10.0 (StatSoft, Inc).

Results

The research of the somatoscopic indicators of men of 36 – 45 years old determined that among the persons under study the disturbance in the sagittal plane with the increase of physiological curves of the spine – flat back dominates: among men of 36 – 40 years old there were recorded 36.4%, and among men of 41 – 45 years old – 42.9%. The distributionof 36-40-year-old men by levels of biogeometric posture profile showed that among men with normal posture, men with medium and high levels of biogeometric profile were equally distributed and their shares were 13.6%. Moreover, among men with a round back there was 9.1% larger proportion of low level than that of the medium level, as well as the patients with scoliotic posture in which the difference between the shares was 4.5%, and among the men with flat back, on the contrary, the proportion of the medium level of biogeometrical profile posture dominated the share with a low level over 4.5%.

Those data allowed establishing that the level of the biogeometric profile posture of 36-40 year-old men is ($\overline{x}$ ±SD) 18.59±6.12 points and of 41–45 year-old men– 16.57±4.82 points (Table 1).

Table 1. Characteristics of the biogeometric profile of the posture of men 36–45 years old (n=50)

Parameters of of the biogeometric profile of the posture, point				
Age, years	**Statistical characteristic**	**Frontal plane**	**Sagittal plane**	**The state of biogeometric profile posture**
36–40 (n=22)	$\overline{x}$	8.86	9.73	18.59
	SD	3.06	3.30	6.12
	m	0.65	0.70	1.31
41–45 (n=28)	$\overline{x}$	7.71	8.86	16.57
	SD	1.80	3.08	4.82
	m	0.34	0.58	0.91

It was identified that the level of the biogeometric profile posture in the frontal plane is 14.0% higher inmen 36-40 years old, in the sagittal – 8.23% higher, and the overall level of the biogeometric profile of posture is 10.9% higher than of men 41-45 years old (Figure 1).

It has been found that the decrease in the biogeometric

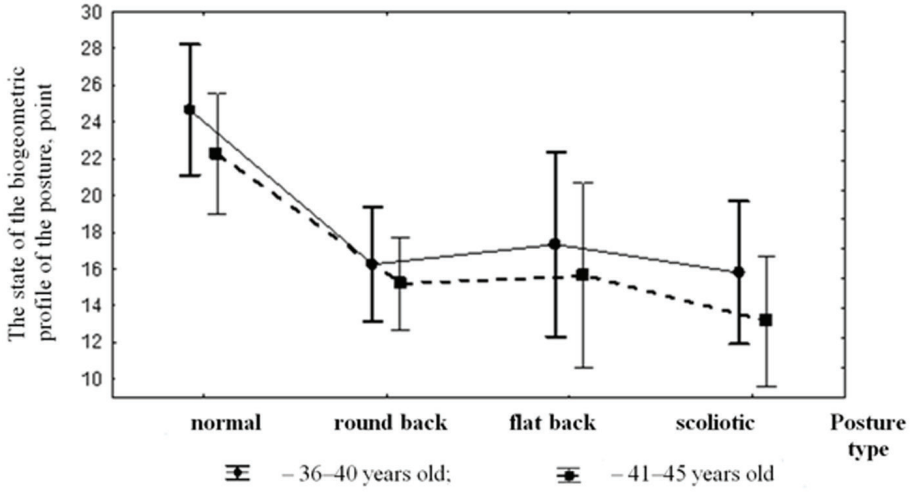

FIGURE 1. The level of the biogeometric profile of the posture, depending on the posture type of men (n=50)

posture profile of men of both subgroups does not cause statistically significant (p>0.05) changes in body length and weight.

Men in the early middle age have a tendency to a gradual decrease in the state of the biogeometric profile of posture, regardless of the type of disorders, but the difference between the indicators is statistically nonsignificant (p> 0.05) (see Figure 1).

The next question: how do posture disorders affect the functional assessment of the movements of men in the early middle age? According to the peculiarities of the development of men's physical qualities in the early middle age, it was found that 9.1% (n=2) men of 36–40 years performed the "Deep Squat" test absolutely correctly, without compensatory movements and loss of body balance and no man of 41–45 years old performed this test;18.2% (n=4) men of 36–40 years old and 7.1% (n=2) men of 41–45 years old performed "Hurdle Step" test; 9.1% (n=2) and 10.7% (n=3)–"In-Line Lung" test; 13.6% (n=3) and 7.1% (n=2) – "Active Straight Leg Raise" test; 9.1% (n=2) and 3.6% (n=1) respectively – "Trunk Stability Push Up-"and "Rotary Stability"each test. On the other hand, absolutely no one man in each of the 2 subgroups was able to perform the correct movement when performing the "Shoulder Mobility" test.

Comparative analysis of indicators of functional assessment of men's movements showed a decrease in motor skills in all test exercises, which was observed with age (Table 2). Thus, the results in men of 40–45 years old were lower compared to men of 35–40 years old and statistically significant differences were recorded as follows: "Deep Squat" – by 16.3% (p<0.05); "Hurdle Step" – by 14.0% (p>0.05); "In-Line Lung" – by 20.5% (p<0.01); Shoulder Mobility – 28.6% (p<0.01); Active Straight Leg Raise – 14.6% (p>0.05); "Trunk Stability Push Up" – 21.6% (p<0.05); Rotary Stability – 16.7% (p>0.05).

Table 2. Comparative analysis of indicators of movement's functional assessment of men 36–45 years old (n=50)

		Evaluation, point						
Age, years	**Statistical characteristic**	**Deep Squat**	**Hurdle Step**	**In Line Lunge**	**Shoulder Mobility**	**Active Straight Leg Raise**	**Trunk Stability Push Up**	**Rotary Stability**
36–40 (n=22)	$\overline{x}$	1.95	1.95	2.0	1.59	1.86	1.68	1.64
	SD	0.49	0.65	0.44	0.50	0.64	0.65	0.66
	m	0.10	0.14	0.09	0.11	0.14	0.14	0.14
41–45 (n=28)	$\overline{x}$	1.64	1.68	1.59	1.14	1.59	1.32	1.36
	SD	0.49	0.48	0.59	0.35	0.50	0.48	0.49
	m	0.09	0.09	0.11	0.07	0.09	0.09	0.09
t		2.22	1.63	2.81	3.59	1.63	2.17	1.66
p		0.031	0.110	0.007	0.001	0.110	0.035	0.103

It was found that the overall score of men 36–40 years was 12.67±2.71 points against 10.32±1.81 points for men 41–45 years, i.e.for men 36–40 years the score was 18.6% more. Statistically significant differences (p<0.01) were proved between the indicators of functional assessment of men's movements depending on age.

ANOVA showed that the level of the state of the biogeometric profile of posture of men of the early middle age is statistically significant (p<0.05) affects the functional assessment of the movement. Men with a high level of biogeometric posture profile have a higher functional assessment of movement compared to low, which is characteristic of both age subgroups (Kashuba et al., 2020). Analysis of the dependence of functional assessment of movements on the level of biogeometric

profile of the posture of men 36–45 years found that the maximum differences are observed between men 36–40 years and 41–45 years with a high level of biogeometric profile of their posture, and the minimum in men with average level, however, there are no statistically significant differences between the functional assessment of the movement of men 36–40 and 41–45 years with different levels of biogeometric posture profile (Figure 2).

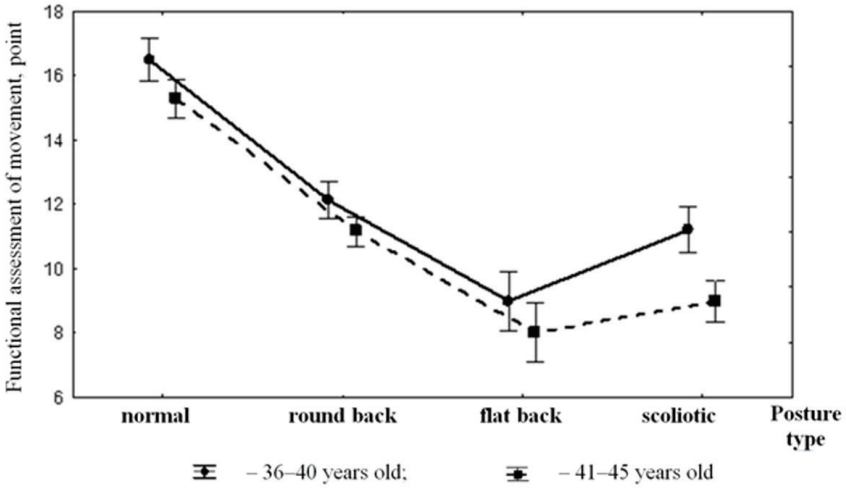

FIGURE 2. The influence of posture type on the functional assessment of the movement of men (n=50)

Some tests that assess the right and left sides, namely the "Hurdle Step", "In-Line Lung", "Shoulder Mobility", "Active Straight Leg Raise" and "Rotary Stability" tests were repeated by men for the right and left upper (or lower) limb, but statistically significant differences were not found between the functional assessment of movements ($p>0.05$). However, some posture disorders cause asymmetry. In particular, asymmetry was registered in 9.1% (n=2) of men aged 36-40 when performing the "Hurdle Step" test, namely in 4.5% with a round back and in 4.5% with a scoliotic posture. Moreover, each of them was characterized by a low level of biogeometric posture profile. In this test exercise, asymmetry was observed in 10.7% (n=3) of men 41–45 years with a low level of biogeometric posture profile, of which 3.6% had a round back, and 7.1% – scoliotic posture. Asymmetry was not detected in men 36–40 years when performing the "In-Line Lung" test, but asymmetry was detected in 3.6% (n=1) of men 41–45 years with a flat back with a low level of biogeometric profile of posture. Asymmetry was not recorded in men aged 36– 40 years during the "Shoulder Mobility" test, while 7.1% (n=2) of men aged 41–45, 3.6% of whom had a round back, and 3.6% – scoliotic posture was characterized by asymmetry at low level of biogeometric posture profile. Asymmetry was stated in 4.6% (n=1) men 36–40 years and 10.7% (n=3) men 41–45 years with scoliotic posture and low level of biogeometric profile of posture during the "Active Straight Leg Raise" test. At the same time, asymmetry was established in 4.6% (n=1) of men 36–40 years old and 17.9% (n=5) men 41–45 years old with scoliotic posture and low level of biogeometric posture profile during the determination of rotational stability (Kashuba, Lopatskiy, & Rudenko, 2017).

Discussion

The problem of men's health in adulthood has been the subject of a number of theoretical and experimental studies, in particular, the authors focused on: methods of health and recreational beach volleyball with mature men in sanatorium conditions (Yarish, 2009); complex methods of physical culture and health classes with middle-aged men on the basis of the integration of football and general physical training (Ghosn, 2013); training program for middle-aged men based on the use of strength exercises in a dynamic mode (Karpov, 2010); the influence of fitness aerobics, cycle aerobics, Cross Fit, on TRX simulators on the physical condition of men in first and second mature age (Yurchuk, 2011); approaches to the organization of fitness programs for men of mature age with the use of exercise equipment in a fitness club (Chernyshova, 2012); program of preventive and health-oriented classes with the use of table tennis for mature men engaged in mental work (Penzai, 2014); program for the health correction of men aged 25–40 years, suffering from obesity 1-2 degree and hypertension 1A, using the "Multidoctor" simulator and the use of dietary supplements Trekrezan (Golovanov, 2015); the program of health fitness classes with the use of "Outdoor activity", aimed at correcting the physical condition of men of the second mature age (Apaychev, 2016); game fitness technology (on the example of basketball), the disclosure of its organizational and methodological, technical and tactical, physical culture and health characteristics and determining the place in the system of modern fitness (Perevoznikova, 2017).

Our research by the analysis of movement functional assessment (using the system of tests Functional Movement Screen) and level of biogeometrical profile posture of men by pairwise comparisons of averages between the groups using the Duncan's ranking criterion for multivariate comparisons allowed to reveal the following: the functional assessment of the movement in the group of men of 36-40 years old with a high level of biogeometrical profile posture is statistically significantly higher ($p<0.05$) thanin the group of men with medium and low levels of both age subgroups. At the same time, it was confirmed that in group of men of 36-40 years old with the average level of biogeometric profile posture, the functional assessment of movement is statistically significantly higher ($p<0.05$) than in the group of men with a low level of both age subgroups. It should be noted that in group of men of 36-40 years old with a low level of biogeometric profile posture, the functional assessment of movement is statistically significant higher ($p<0.05$) than in the group of men with a low level of

both age subgroups. However, there are no statistically significant differences ($p>0.05$) between the functional assessment of movement of men with the same level of biogeometric posture profile depending on the age subgroup. The use of analysis of variance (ANOVA) allowed to establish a statistically significant ($p<0.05$) effect of the biogeometric profile posture of men of 36-45 years old on the endurance of the abdominal muscles and mobility of the hip joint and lumbar spine (Kashuba et al., 2019).

The above data have indicated that at the process of developing the corrective and preventive measures for the men of the early middle age, it is necessary to take into account not only the level of the biogeometric profile of their posture, but also to take into account the indicators of functional assessment of movements.

Taking this into account, special attention should be paid to the features of the spatial organization of their body, and corrective and preventive complexes should be developed in accordance with the level of the biogeometric profile of their posture. We get the further development of knowledge on the regulation of human body's pose (Laputin, Gruzin, & Khmelnitska, 1995) in the diagnosis of the state level of the biogeometric profile of men's posture in the course of health fitness classes (Kashuba et al., 2020).

Therefore, it can be argued that men in early middle age have a gradual increase in asymmetry, and its threat increases along with a decrease in the state of biogeometric profile of posture. In addition, despite lower scores on the functional movements of men with flat backs in both groups, due to the risk of asymmetry in the development of physical qualities, scoliotic posture was the most unfavorable type of disorder. However, there are lower functional estimates of movement in men 41–45 years compared to men 36–40 years, regardless of posture type (Kashuba et al., 2018).

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Factor Analysis of Special Qualities of Elite Field Hockey Players

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Abstract

One of the methods to make an objective analysis of the use of adequate means and methods of the training process depending on the special qualities of athletes is factor analysis. The article describes a methodological approach to factor analysis of special qualities of elite field hockey players. The aim of the research is to determine the factor structure of special qualities of elite field hockey players based on experimental data. The study involved 40 elite male field players in field hockey. The average age of sportsmen was 24.7±4.27 years. Sports qualification – masters of sports of Ukraine. Research methodology: analysis and generalization of special literature and Internet data, lesson observation, pedagogical testing, methods of functional diagnostics, video recording of competitive activities, pedagogical expertise, methods of mathematical statistics. 28 specific qualities of elite male field players in field hockey were defined. The structure of special qualities of hockey players was determined by five orthogonal factors, and the sum of the contribution to the total sampling variance was 69.55%. Factor analysis of special qualities of elite field hockey players allowed to manage the training process more purposefully and adjust the managerial impact on the state of the players ' sports form in the training macrocycle.

Keywords: *field hockey, elite field players, special qualities, factor analysis*

Introduction

The construction of the training process of elite athletes is based on the development of criteria for monitoring various indicators, characterizing the level of readiness of sportsmen, and on defining the relationship between these indicators and their impact on the sports result. One of the methods to make an objective analysis is factor analysis (Yermolayev, 2002; Kozina et al., 2017; Doroshenko et al., 2019).

The factor analysis is used to systematize indicators into factors that reflecting the level of special training of athletes (Alekseeva, 2010). The problem is relevant for team game sports (Bukova, 2008; Kostiukevych, 2019, 2020). In particular, the factor structure of sportsmen's readiness was studied: in basketball by Koryagin (1997); Bezmylov and Shynkaruk (2010); in volleyball – Maslov and Nosko (2002); in football - Lisenchuk (2004), Bukova (2008), etc.

The basis of research is a methodological approach, which is based on taking into account the integrated level of skill of athletes as a structure. Factor analysis was carried out with the use of the system for comprehensive statistical analysis and data processing in the "Windows" - "Statistic" environment (Yermolayev, 2002). The methods of main components and axis rotation using the "non-normalized varimax" method were used (Zatsiorsky, 1969; Denisova et al., 2008). The objective of factor analysis in the processing of experimental data is to evaluate the importance of factor of weight, as well as the part of the influence of each factor on the general dispersion (sampling variance) of the sample (Babushkin, 1991;

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Vincent, 2005). The scheme of the results of factor analysis is characterized by such indicators as: the number of factors, the dispersion of factors, factor of weight, factor dispersions (Yermolayev, 2002; Nachinskaya, 2005). The number of K factors shows how many linearly dependent feature groups are characteristic of the complete set of initial features. The dispersion of factors indicates how important individual factors are for the entire feature system. Factor loads (weight) allow to judge the strength of the relationship between indicators and factors. Factor dispersions show which variables play a crucial role in shaping the set of factors that is defined (Zatsiorsky, 1969; Korenberg, 2004).

The aim of the research was to determine the factor structure of special qualities of elite male field hockey players based on experimental data.

Methods

The research involved 40 elite male athletes (field players) in field hockey. The average age of athletes was 24.7±4.27 years. Sports qualification - master of sports of Ukraine. The research was conducted in the competitive period of the macrocycle. All players agreed to participate in the research.

Video recording of competitive activity - definition of integral assessment of technical and tactical activities (IA TTA). The key points that were taken into account when developing of the integral assessment:

1. Registration of technical and tactical actions was carried out taking into account the complexity of coordination and the intensity of the game of their implementation.

2. The methodology of analysis of technical and tactical activities took into account the direction and importance of technical and tactical moves (transfers, dribbling, mannequin, etc.).

3. Quantitative indicators of technical and tactical activities were analyzed together with their qualitative characteristics.

4. A differentiated approach was needed to determine a comprehensive assessment of the technical and tactical activities of hockey players of different roles.

5. Comprehensive assessment objectively reflected the athlete's skills shown in the game, and was the basis for developing models of competitive activities.

The following methodological approaches were used to control and analyze the technical and tactical activities of hockey players:

1. Execution of technical and tactical actions was recorded in 3 modes of coordination complexity and game intensity. The first mode of coordination complexity (1st MCC) - technical and tactical actions (TTA) were performed on site or at a convenient speed (stops, transmissions, implementation of standard provisions, etc.). The second MCC - TTA was performed in the process of movement with restrictions in space and time (stops, dribbling, passing, holding, hitting the goal). The third MCC - TTA was performed in conditions of active intervention by the opponent (stops, mannequins, transfers, retention, shots on goal).

2. Execution of the ball was recorded in accordance with the goal. As a technical and tactical move, it could be: holding the ball, developing the attack, aggravating the game situation. On this basis, passes were classified into maintenance, development and sharpening.

3. Integral assessment reflected the quantitative and qualitative indicators of technical and tactical activities of hockey players. Six coefficients were developed: intensity, mobility, aggression; efficiency, effectiveness of martial arts, creativity (Kostiukevych et al., 2018).

1. The intensity coefficient (IC) determined the overall activity of the player in the game:

$$IC = \frac{\sum_{i=1}^{n} TTA}{t}, (1)$$

where: $\sum_{i=1}^{n} TTA$ - total amount of technical and tactical actions;

t - time played by a player in a match

2. The mobility coefficient (MC) characterized the general mobility of the player during the match, his desire to perform technical and tactical actions in motion in different parts of the field:

$$MC = \frac{\sum_{i=1}^{n} TTA(2nd\ MCC + 3rd\ MCC)}{t} \times 2, (2)$$

where: $\sum_{i=1}^{n} TTA(2ndMCC + 3rdMCC)$ - total amount of technical and tactical actions performed by the player in the second and third modes of coordination complexity;

t - time played by a player in a match;

2 – indicator of coordination complexity

3. The aggressiveness coefficient (AC) characterized the player's activity in single combats, in conditions of active intervention by the opponent:

$$MC = \frac{\sum_{i=1}^{n} TTA(2nd\ MCC + 3rd\ MCC)}{t} \times 2, (3)$$

where: $\sum_{i=1}^{n} TTA(3rdMCC)$ - total amount of technical and tactical actions performed by the player in the third mode of coordination complexity;

t - time played by a player in a match;

3 – indicator of coordination complexity

4. The efficiency coefficient (EC) reflected the value of the player for the team, the quality of performed by him technical and tactical actions:

$$EC = \frac{\sum_{i=1}^{n} preciseTTA}{\sum_{i=1}^{n} allTTA}, (4)$$

where: $\sum_{i=1}^{n} preciseTTA$ - total amount of precise technical and tactical actions performed by the player;

$\sum_{i=1}^{n} allTTA$ - total amount of all technical and tactical actions performed by the player in a match

5. The efficiency coefficient of martial arts (ECMA) characterized the quality of technical and tactical actions performed by the player in conditions of active intervention by the opponent:

$$ECMA = \frac{\sum_{i=1}^{n} preciseTTA(stops, holds, tackings, dummies, performed\ in\ 3rd\ MCC)}{\sum_{i=1}^{n} allTTA(stops, holds, tacklings, dummies, performed\ in\ 3rdMCC)}, (5)$$

where: $\sum_{i=1}^{n} preciseTTA(stops, holds, tackings, dummies, performedin3rdMCC)$ - total amount of precise technical and tactical actions performed by the player in the third mode of coordination complexity;

$\sum_{i=1}^{n} allTTA(stops, holds, tackings, dummies, performedin3rdMCC)$ - total amount of all technical and tactical actions performed by the player in the third mode of coordination complexity during the match

6. The creativity coefficient (CC) allowed us to integrally evaluate the player's game creativity in the confrontation with the opponent. Usually a player with a high creativity coefficient must be confident in his actions, have a wide arsenal of technical and tactical actions and be able to apply them in accordance with the situation:

$$CC = \frac{\sum_{i=1}^{n} preciseTTA(DP \times 1 + SP \times 2 + GP \times 5 + GK \times 5 + G \times 10)}{t}, \quad (6)$$

where: DP – developing passes; SP – sharpening passes; GP – goal passes; GK – goal kicks; G – goals.

7. The integral assessment (IA) of a field player was determined by the sum of six specific indicators and was one of the criteria for creating an athlete rating:

IA = IC + MC + AC + EC + ECMA + CC (7)

Educational testing. A 30 m run from a high start was used to estimate the starting speed. Photo sensors were installed on the start and finish lines. At the command "to start», the hockey players stood in front of the starting line in the high start position. At the signal of the coach, they had overcome the distance of 30 m with maximum intensity. The time to overcome the distance was fixed with accuracy to 0.01 s. The best result of two attempts was taken into account. Rest between attempts lasted from 3 to 5 minutes.

Speed and strength qualities were determined by a long standing jump. The hockey player got toes on the line, prepared to jump. First he waved his hands back, and then abruptly took them forward and pushing off with two legs jumped as far as possible. Two attempts were given. The length of the jump was measured from the line to the point where the athlete's back foot touched the ground of the field or floor. It was not allowed to take the feet off the field or floor before jumping.

To assess the speed endurance of hockey players, the test – Shuttle run of 180 m (Kostiukevych, 2011) is informative. In a straight line, three cones were placed at a distance of 15 m, one after the other. At the signal of the coach, the hockey player started running from the first cone, covering a distance of 15 m, ran around the second cone, went back to the first, then ran to the third cone, ran around it and returned to the start line, after which the exercise was repeated again without stopping (Figure 1). Immediately after the test, the heart rate was recorded for 10 seconds, and again at the end of the first, second and third minutes of recovery.

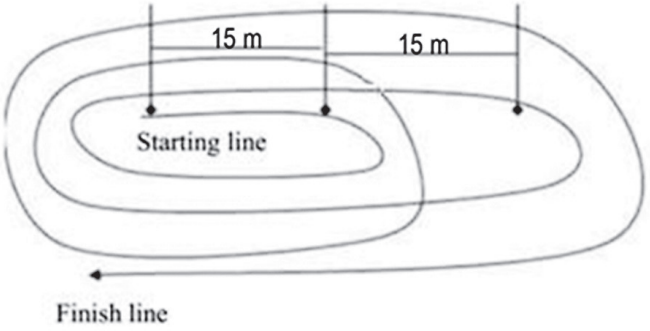

FIGURE 1. The scheme of performing the 180m Shuttle run test.

The Cooper test (continuous running for 12 minutes) was used to determine the overall endurance of the players. Before the test, a 15-minute warm – up was performed, followed by a 5-minute rest, and after the rest, a testing exercise was performed. The test result was evaluated by the number of meters that the hockey player overcame during 12 minutes of running.

The level of technical preparedness of elite hockey players was determined using the following tests:

1. Running 14.63 m from the stand with the knocking the ball out – assessment of the starting speed in connection with special agility. The duration of the entire exercise was evaluated from the start of running to hitting the ball with a stick. The best result was chosen from two attempts. The pause between attempts was 2-3 minutes.

2. Dribbling - running the cones around - a shot on goal – assessment of high-speed technique (Figure 2). The result was assessed by the duration of the entire exercise - from the beginning of the dribbling to the ball touching the back wall of the goal.

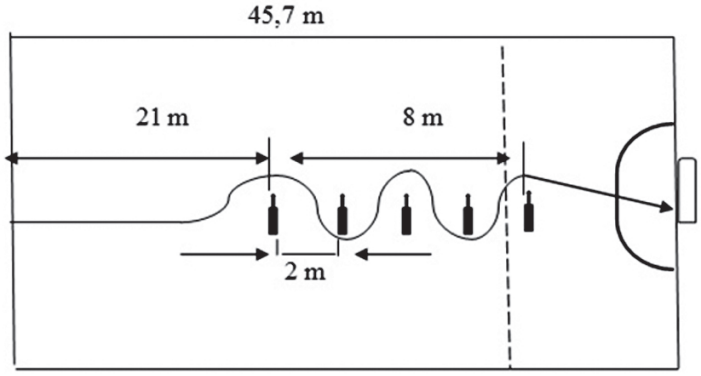

FIGURE 2. Scheme of the test "dribbling, running the cones around, shot in the goal"

3. Dribbling - the target passing (performed in the form of a shuttle run - 5 times) – assessment of high-speed technique in combination with special endurance (Figure 3). Were evaluated the duration of the entire exercise - from the start of the dribble of the first ball to the crossing by the hockey player the start line after the fifth pass of the ball and the total accuracy of five passes (when hitting the goal – 1 point, for a miss – 0 points).

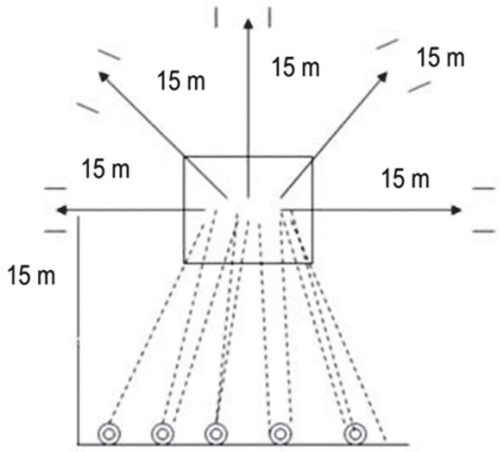

FIGURE 3. Scheme of the test: "dribble - shooting the goal"

4. Throwing the ball with a stick on the range – an assessment of technical preparedness and special strength. Conditions: The hockey player threw the ball with a stick in the corridor 10 m wide.

5. A series of shots on goal – an assessment of special speed-strength endurance (Figure 4). Were evaluated the duration of the entire exercise - from the start of the strike on the first ball and the touch of the goalkeeper or crossing the goal line of 31 goals and the total number of goals scored in the goal.

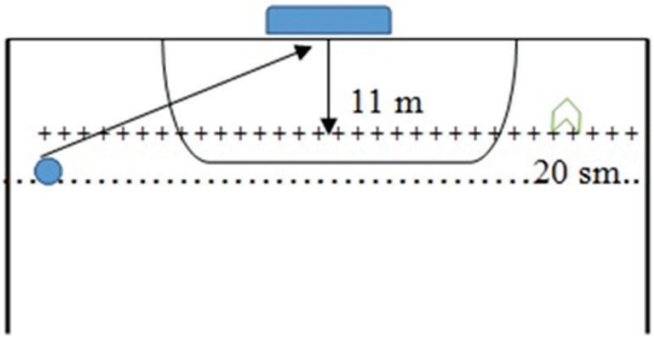

FIGURE 4. Scheme of the test "series of shots on goal"

Methods of functional diagnostics. The determination of the level of physical performance (PP) and maximum oxygen consumption (VO2max) using the running version of the PWC170 (V) test (Carpman et al., 1998).

Step 1. The player without warming-up performed the first running load. Distance 700-900 m. Running speed should be constant. The player's heart rate immediately after running was approximately – 110-130 bpm. The time taken to cover the distance was about 5 minutes. At the end of the first running load, the heart rate was recorded.

Step 2. The player rested for 5 minutes.

Step 3. The second running load was performed. Distance - 1100-1300 m.

Step 4. The running speed was calculated when overcoming the first (V_1) and second (V_2) distances.

$$V = \frac{S}{t}, (8)$$

where: V – speed of running while overcoming the distance ($m \cdot s^{-1}$);

S – length of the distance (m);

t – time to overcome the distance (s).

Step 5. The physical performance of PWC170 (V) was determined:

$$PWC_{170(V)} = V_1 + (V_2 - V_1)\frac{170 - f_1}{f_2 - f_1}, (9)$$

where: $PWC_{170(V)}$ – load power in $m \cdot s\text{-}1$, at which the heart rate reaches 170 bpm;

f1, f2 – heart rate during the first and second physical activity.

Step 6. For this purpose, the formula of Belotserkovsky (2005) was used:

$$PWC_{170} = 417 \cdot PWC_{170(V)} - 83 \quad (10)$$

Step 7. The absolute value of maximum oxygen consumption was calculated:

$$VO_{2max(abs)} = 1{,}7 \cdot PWC_{170} + 1240 \quad (11)$$

where: $VO_{2max(abs)}$ – the absolute value of maximum oxygen consumption

Step 8. The relative indicator was determined:

$$VO_2\,\max(rel) = \frac{VO_2\,\max(abs)}{MT} \quad (12)$$

where: $VO_{2max(rel)}$ – the relative value of the maximum oxygen consumption ($ml \cdot min^{-1} \cdot kg^{-1}$);

$VO_{2max(abs)}$ – the absolute value of the maximum oxygen consumption ($ml \cdot min^{-1}$);

MT – body weight of a hockey player (kg).

For an expert assessment of the level of technical and tactical skill (LTTS) of hockey players, a 10-point scale was used in which volume, mastery, and effectiveness of the technique were estimated from 1 to 10 points. The total amount of points scored by the player allowed determining the rating of his

technical and tactical skill.

Methods of mathematical statistics. The research determined the main characteristics of the variation series: mean ($\bar{x}$), dispersion (S^2), standard deviation (SD), coefficient of variation (CV). The samples for the normal distribution of the results were checked using the Shapiro-Wilky test. Factor analysis was performed using the method of main components. The consistency of experts in determining the level of technical and tactical skill of hockey players was determined by the Kendall's coefficient of concordance. Statistical processing of experimental material was carried out using computer programs of mathematical statistics such as "Microsoft Excel" and "Statistica -6".

Results

In this study, factor analysis revealed the most significant indicators of the special qualities of elite field hockey players (Table 1, Figure 5). The structure of special qualities of hockey players was determined by five orthogonal factors, and the contribution to the total dispersion of the sample was 69.55%.

Table 1. Factorial structure of special qualities of elite male field hockey players (field players, n=40)

Indicator	Factor				
	1	2	3	4	5
Age, years old	0,360	**0,494**	0,012	-0,335	0,290
Height, sm	-0,074	**0,591**	0,374	-0,176	**-0,452**
Body mass, kg	0,045	**0,933**	0,251	-0,112	-0,109
Quetelet index, g·см$^{-1}$	0,076	**0,914**	0,177	-0,069	0,026
VO_2max(abs), l·min^{-1}	0,163	0,148	**0,792**	0,150	0,104
VO_2max(rel), ml·min^{-1}·kg^{-1}	0,028	**-0,786**	0,309	0,170	0,189
PWC_{170}, кgm·min^{-1}·kg^{-1}	0,051	**-0,775**	0,407	0,168	0,195
$PWC_{170(V)}$, m·s^{-1}	0,145	0,016	**0,848**	0,070	0,176
Running 30 m from the high start, s	-0,097	0,017	-0,210	**-0,743**	-0,187
Standing long jump, m	0,152	0,167	0,391	**0,639**	-0,176
Shuttle run 180 m, s	-0,079	0,364	-0,366	**-0,523**	0,006
Cooper Test, m	0,150	-0,432	**0,561**	0,274	0,174
LTTS – 1 MCC, points	**0,866**	0,128	-0,046	0,163	0,206
LTTS – 2 MCC, points	**0,893**	0,021	-0,030	0,244	0,216
LTTS – 3 MCC, points	**0,849**	-0,105	0,001	0,284	0,207
LTTS – average value, points	**0,884**	0,041	-0,060	0,244	0,247
Running 14,63 m with knocking the ball out, s	-0,101	0,148	-0,068	**-0,858**	-0,046
Dribbling – running the cones around– shot on goal, s	-0,467	0,080	0,084	**-0,690**	-0,260
Dribbling– targeting, s	-0,117	0,280	-0,045	**-0,476**	-0,004
Throwing the ball with a hockey stick at a distance, m	**0,659**	0,347	0,152	0,025	0,003
Series of shots on goal, s	-0,293	0,207	0,075	-0,549	0,083
Intensity coefficient, points	**0,752**	-0,062	0,268	-0,004	-0,241
Mobility coefficient, points	**0,716**	-0,209	0,262	0,186	-0,287
Aggressiveness coefficient, points	0,192	-0,348	-0,060	**0,431**	-0,350
Efficiency coefficient, points	0,139	-0,103	0,242	-0,076	**0,758**
Efficiency coefficient of martial arts, points	0,125	-0,303	0,171	0,208	**0,686**
Creativity coefficient, points	**0,461**	0,028	0,284	0,001	0,030
Integral assessment, points	**0,734**	-0,346	0,273	0,328	-0,131
Total of operating variables	5,97	4,58	2,93	3,90	2,11
Input of the factor on total dispersion, %	21,31	16,35	10,45	13,93	7,53

The first factor - a factor of technical and tactical skill and competitive activity (21.31%). The high weight factors were noted here according to the level of expert assessment of technical and tactical skills in all three modes of coordination complexity (LTTS - 1 MCC, r=0.866; LTTS - 2 MCC, r=0.893; LTTS - 3 MCC, r=0.849), and also by the average value of LTTS, r=0.884.

High weight factors were also noted for such indicators of competitive activity of field hockey players as the throw of the ball with a stick at a distance (r=0.659), the intensity coefficient (r=0.752), the mobility coefficient (r=0.716), the creation coefficient (r=0.461), as well as the integral assessment (r=0.734).

In the second factor (16.35%), the system-forming indicators were those that primarily reflected the functional preparedness of hockey players. High weight factors were observed in Body mass index (r=0.933), Quetelet index

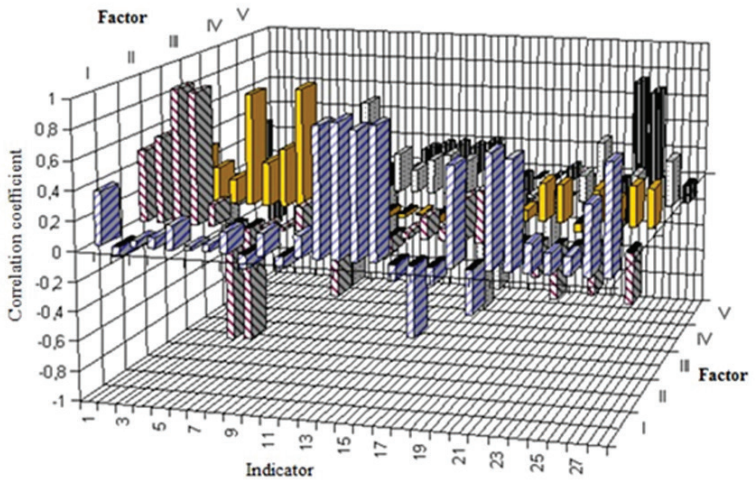

FIGURE 5. Factorial structure of special qualities of elite male field hockey players

(r=0.914), $VO_{2max(rel)}$ (r=-0.786), PWC_{170} (r=-0.775).

The third factor was interpreted as a factor of Physical Working Capacity (10.45%). High weight factors in the indicators of the $VO_{2max(abs)}$ (r=0.792), $PWC_{170(V)}$ (r=0.848) were highlighted here.

The interpretation of the importance of speed and speed-power indicators for competitive activity in field hockey was determined by the fourth factor (F4).

The most significant indicators in it were: running 30 m from the high start (r=–0.743), standing long jump (r=0.639), running 14.63 m with a ball knocked out (r=–0.858), dribbling – running the cones around - shot on goal (r=–0.690), series of shots on goal (r=–0.549), coefficient of aggressiveness (r=0.431).

The fifth factor, (7.53%) was designated as a factor in the effectiveness of competitive activity. The high weight factors in it fell on the indicators of the coefficient of effectiveness (r=0.758) and the coefficient of effectiveness of martial arts (r=0.686).

Discussion

Factor analysis is used when there are problems in determining the most important indicators of athletes' preparedness, which affect the sports result (Akhmetov, 2005; Kutek, 2019). The working hypothesis of our study involved a number of consistent logically conditioned actions.

Firstly, it was necessary to determine the special qualities (SQ) of elite field players in field hockey. Based on previous research of the features of managing the training of athletes in team sports and building the training process in field hockey (Kostiukevych et al., 2018, 2019), 6 components of special qualities of elite hockey players were determined:

1. The morphofunctional component (4 SQ): age, body length, Quetelet index (body mass ratio (g) to body length (sm)).

2. The component of physical fitness (4 SQ): the 30 m run from a high start.

3. The functional preparedness component (4 SQ): $VO_{2max-(abs)}$; $VO_{2max(rel)}$, PWC_{170}; $PWC_{170(V)}$.

4. The component of technical and tactical skill (4 SQ): LTTS in the 1st MCC, LTTS in the 2nd MCC; LTTS in the 3rd MCC; the average value of LTTS.

5. The technique related component of physical fitness (5 SQ): running 14.63 m with a ball knocked out; dribbling – running the cones around - shot on goal; dribbling – passing – targeting; throwing the ball with a hockey stick at a distance; series of shots on goal.

6. The component of the integral assessment of technical and tactical activities (7 SQ): intensity coefficient (IC); mobility coefficient (MC); aggressiveness coefficient (AC); efficiency coefficient (EC); efficiency coefficient of martial arts (ECMA); creativity coefficient (CC); integral assessment (IA).

Secondly, the results of measuring and testing the special qualities of elite male field hockey players in the competitive period of the macrocycle were determined.

Thirdly, a factor analysis scheme was chosen - the method of principal components.

Conclusions

Factor analysis (FA) in field hockey, is carried out in the following sequence: formation of FA goals; determination of the main indicators of training and competitive activity of athletes; mathematical data processing; choice of factor analysis method.

The structure of the special qualities of elite field hockey players was determined by five orthogonal factors: 1) factor of technical and tactical skill (21.31% of the total variance of the sample); 2) system indicators are indicators of functional readiness (16.35%). 3) factor of physical performance (10.45%); 4) the speed and speed-power abilities of hockey players (13.53%) 5) factor of competitive activity (7.53%).

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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SportMont

REVIEW PAPER

Aspects of Increasing Efficiency of Young Football Players Physical Training Process

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Abstract

The results of the research indicate the intensification of training and competitive loads in children's football and their negative impact on the body of young athletes. The increase in the complexity of young football players training occurs due to the system of children's competitions and their requirements for the training process arrangement, the choice of criteria for monitoring loads and assessing athletes condition. The ways of minimizing pedagogical errors and preventing the use of inadequate loads in the training process are shown based on the strategy of preparing a sports reserve for professional football and maintaining health of young football players.

Keywords: *young football players, children's competitions, physical fitness, fitness control*

Introduction

Organizational and methodological aspects of sports training for young talented players largely determine the further success of a country in the international sports arena (Platonov, 2013; Nikolaienko, 2014). In recent years, the attention of football experts is increasingly focused not only on the development of training technology for highly qualified athletes, but also on the further improvement of the sports reserve training system (Haddad et al., 2015; Khizhevsky et al., 2018; Shaposhnikova et al., 2018; Gornikova et al., 2020).

At the same time, it should be noted that early sports specialization as well as its accompanying intense training and competitive activities are extremely dangerous, violating the objective laws of long-term improvement, leading to injuries and premature wear of the young athlete's body (Brenner, 2016; Green, 2019).

The way out of this situation is seen in the fact that regarding young football players engaged in intensive sports training, it is necessary to reconsider the traditional views on the process of long-term sports training and active participation of a child in this process. Planning of training and competitive loads should be conducted taking into account biological mechanisms of adaptation by organs and systems of the child's body, optimization of the use of training effects that meet the specifics of the sport, development of a control system over the state of health and the reaction of young athletes to training loads.

It is the target orientation for long-term training of young talented athletes that should determine the strategy of building the training process in football.

Objective of the study is to substantiate the theoretical and methodological foundations of physical training of young football players based on the analysis of scientific and methodological literature, training and competitive activity.

Methods

Include theoretical analysis and generalization of data from scientific and methodical literature, materials of the Internet; pedagogical observation of physical training process of young football players.

Results

Health-preserving focus

It should be noted that the correct schemes in general and

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the ones corresponding to the current level of our theoretical and methodological ideas, knowledge, skills, abilities and methods of managing individual aspects of sports training process have not yet developed into a complete organizational and methodological system of long-term training process management.

As Mikhailova (2009) rightly noted, this is largely due to the fact that the coach must successfully manage not the process of sports training, but mainly the process of the athlete's training.

Based on this provision, we will focus on certain approaches that determine the quality and effectiveness of the long-term training program for talented youth. Regular involvement in football training classes presupposes the successful participation of the child in the mode of both intensive training and competitive activities. The latter means that young footballers must meet certain criteria for sports fitness. These include health, fitness, coordination skills, body constitution (physique), mental composition, motivation (Balsevich, 2009; Nikolaienko, 2014; Kostyukevich, 2018).

It is known that a significant factor in achieving sports success of a child is, above all, the state of their health. Hence, one of the components of a child's sportsmanship development is the regularity of educational and training activities. Children, who miss training due to increased morbidity, master the technical elements, improve functional and physical fitness, gain the theoretical basis of sports activities arrangement to a lesser extent.

Based on the fact that children join the football club section at the age of 6-7, the issue of a modern first-grade pupil's state of health is topical.

It is established that children of primary school age are characterized by the following problematic components: 15-20% of children have chronic diseases, 50% suffer from musculoskeletal disorders, 20-25% have nasopharyngeal diseases, 30-40% have neurotic disorders, 10-23% have developed allergic reactions, 10-25% have got disorders of the cardiovascular system (Kaminska, 2016).

Thus, initially low health level of primary-school-aged children seriously complicates their adaptation to educational, training and competitive activities.

It is obvious that increased motor activity for children and adolescents not only does not prevent the occurrence of functional blockage in various body organs and systems, but in some cases can even provoke them (Kashuba et al., 2012).

It has been found out that more than 70% of young athletes who are under 16-17 years old have various health disorders, some of which are the main cause of premature withdrawal from sports (Orlovskaya, 2000).

Therefore, while organizing the pedagogical process the coach must constantly make changes to the educational and training plan as well as take into account the dynamics of practical material mastering, and most importantly based on the fact that young players are engaged in intensive sports training, constantly monitor the body's response to training loads.

Educational and training process

Traditional system of an athlete's training is based on the fact that the human body will build itself, shall the athlete just complete the right motor drills. And still a large number of contemporary scientific papers on football, and sports in general come from the outdated in its half-hearted view of man as a soulless biological entity.

However, the training of the athlete should be seen as the one especially focused on their psyche aimed at developing the ability to control body and metabolic processes in it, therefore, improving conditioned motor skills or training motor skills and abilities is the formation of mental programs to manage body movements and processes.

Hence, any arrangement of training process should be based on the fundamental position of the psyche and its priority as the original conscious or unconscious guiding principle for any practical human activity.

Given this, in order to teach a young football player, it is necessary to interact with their psyche, not with the physical body. Hence, it is important to focus on muscular performance being aware that the muscles carry out commands sent by the brain. Muscles are not able to study, unlike the brain. It is wrong to think that players will play better if their lung volume increases or that it is better to play with their head, if their leg muscle strength enhances. In order to learn to play football at a good level, it is not good to simplify football to the level of motor activity, but it is necessary to focus on solving motor issues in the process of football play (Engel et al., 2016; Wein, 2018).

In this regard, considering the structural features of children's functional fitness, the sequence of changes under the influence of targeted exercise, it should be noted that a living organism is a complex system that counteracts the environment and changes under its influence by activating adaptation mechanisms. The body can reach the same ultimate motor goal in different ways, using a set of the same reactions (Bernstein, 1991).

The coach is interested in the motor abilities of the child, i.e. mainly in the structure of their musculoskeletal system and movement regulation system. Assessment of these systems state should be performed using test exercises that do not require special motor experience and skills. Otherwise, it is not the conditioned motor qualities of the child that will be assessed, but the conditioned motor qualities plus the acquired skill in performing this motor action as well as individual skills, which in most cases is unacceptable (Guba, 2012; Žvan et al., 2018; Sarsania et al., 2019).

We should keep in mind that the human body, in terms of biomechanics of the musculoskeletal system, is a complex motor system with 244 degrees of freedom. The upper and lower extremities have 30 degrees of freedom. It is clear that a system with so many degrees of freedom can perform the same task with a different trajectory. Therefore, when performing the movement constant control over the working muscles is required, as no motor impulses to the muscles can ensure the accuracy of movement, no matter how accurate they are. Performing a given movement with high accuracy requires constant correction throughout the amplitude of the movement. This correction is done by the muscles that are involved in the movement as information about the progress of a given movement enters the brain from the periphery. Nervous devices (receptors) monitor for movement, "carried" to the periphery - in the joints, muscles, tendons. The so-called "proprioceptive impulses" go from these receptors to the brain, and it corrects the movement by involving auxiliary muscles or enhancing the work of antagonists.

Thus, motor skill in simple and complex movements cannot be a simple motor pattern, just as a conditioned reflex can-

not be a simple reflection in the motor centres of the brain. This is a complex, ever-changing process. Motor skill is not a formula for movement; it is not just a formula for muscle response reflected in the motor centre. Motor skill is the mastered ability to solve one or another type of motor task (Bernstein, 1991). Now it is clear that in order to perform a movement correctly, it is necessary to go through the path of the motor act hundreds of times, so that the sensitive centres can "feel" all possible deviations when performing this movement.

Hence, if the player knows how to act in game situations, their brain will adequately control the muscles. The more experience a player has in solving situational tasks, the faster they make the right decision. Therefore, the task of physical training is to improve the quality of playing football.

Well-known German specialist in children's football Wein (2018) has once remarked: "A beautiful game is football that starts in the head and ends in the legs."

That is why, the goal of the training process should be a playing boy (Ponomarenko, 2005). As the author notes, based on his practical experience, the training program should not be of small, medium or large load, because classes are not held for qualified athletes, but for children who need to be taught to play. Therefore, the important principle of working with young players is that everyone does everything in the optimal mode of their individual capabilities, on the verge of high but still possible to overcome difficulties. No motor tasks on the spot should be there, it is better to do everything in motion, at speed. No additional loads with a barbell, kettlebells, on treadmills are needed; vice versa all classes should be held on the football field (playground) and as much as possible, i.e. in the playing conditions. This will be enough for young talented players to develop harmoniously, without risk of developing scoliosis, lordosis and kyphosis, without pathologies of all body systems, but rather taking into account the daily routine, age, initial physical and game data. Every motor task or action must be justified and thought out. The player must know why it is necessary to perform this or that action, why this particular task and not another, and what is the benefit of this.

The Dutch specialist Verheijen (2017) has drawn attention to one of the main principles of physical training method for young football players, which is as follows: “When playing football, you should improve your physical condition. The higher the football player’s level is, the higher the level of his ability to work is as well as the faster the recovery process takes place between actions." He has gone on to emphasize the importance of football sprints and reciprocal training games in small squads and small play areas so that the training process is at the centre of the game itself, rather than a 400-meter run or a long run around the field.

Competitive activity

The current practice of organizing children's and youth competitions provides for holding regular championships starting from the age of nine. Thus, children from an early age are forced to play in the same way as adults, with an emphasis on the result.

It is noted that when the result comes first, it violates the basic principles and patterns of training process design at the stages of long-term training, and as a consequence an imbalance between the level of young players’ training and the requirements for professional football appear (Nikolaienko, 2017).

The focus on "winning at any cost" involves, above all, forcing the training process, with an emphasis on physical training, and as a result, it leads to premature depletion of the child's body, exacerbation of disease and injury, as well as limiting the technical and tactical potential of young football players (Stratton et al., 2004; Nikolaienko, 2014).

Hence, most coaches are narrowing the scope of their professional qualities usage. In fact, the management of sports activities for young football players today is reduced to the management of sports training. In other words, the main attention is paid directly to the training process, first of all, planning, dosing and control of training loads, the content of which is determined by the desire to achieve sports results quickly.

As a result, for a long time the domestic system of children's and youth football has been based on the principles of the "inverted pyramid": when from stage to stage the number of students in sports schools and clubs is steadily declining by "culling" less promising children who cannot show a good level of training and sportsmanship according to their leaders and coaches. Therefore, the whole system of children's and youth football, starting from the stage of initial training, is considered not as a system of a long-term training designed to meet the needs and progressive development of each child in sport, but rather as a means to meet the needs of professional football.

At the same time, it is established that from beginning of systematic sports training and before getting involved in sports of higher achievements, the system of competitions should be subordinated to the system of training (Platonov, 2013).

In this regard, for quality training and progressive development of talented football youth it is necessary to make changes in the existing practice of organizing and conducting children's competitions (Nikolaienko, 2017).

Regarding the successful formation of the initial level of physical fitness among young football players during their long-term training, it is necessary to take into consideration the age characteristics of the child's body and sensitive periods of conditioned motor qualities development (Nikolaienko, 2015).

It should be noted that when organizing and determining the content of sports training, coaches do not pay enough attention to changes in the functional state of young players, namely how they adapt to physical and psychological stress of different nature, volume and intensity.

It is difficult to imagine the coincidence of training programs and plans that determine the content, scope and intensity of this influence, even the most ingenious in predicting the dynamics of the young athlete’s state, with the rhythm of sensitive periods of this influence perception (Balsevich, 2009).

Thus, the need to overcome this contradiction causes the coach to conduct continuous monitoring of the development of conditioned motor qualities and abilities as well as the state of functional systems of young football players’ body (Nikolaienko, 2014).

In the pedagogical sense, such control will ensure a positive evolution of motor skills, adequate correspondence of motor actions to the needs of effective competitive practice and maintenance of homeostasis parameters in maintaining reserves necessary for normal life, as well as continuous correction of volume, intensity, forms of training aimed at achieving long-term training goals for young football players.

With this approach in mind the volume, intensity, content

and direction of training activities tend to be determined due to real processes occurring in the body of young athletes and the ones which are flexibly regulated by both coach and athlete, rather than fictional kilometres, kilograms and tons of expected weightlifting loads, number of approaches and repetitions or interval pace of overcoming competitive distances and unclear figures for construction of micro-, macro- and meso-cycles of sports training (Balsevich, 2009).

Regarding the chronology of motor abilities formation, it is necessary to pay attention to the sequence of their development: speed, speed-strength abilities, speed-strength endurance, power, general endurance (flexibility accompanies the development of all abilities).

Currently, in the practice of children's football training there is often another picture of the educational and training process – you can observe the development of speed and speed-strength endurance, and then speed increase, which creates barriers to the full development and realization of the child's potential.

In the process of developing conditioned motor qualities the coach must take into account that the child's adaptation should go, first of all, not with relation to the competitive size of the football field, but regarding competitive modes; thus, it is desirable to limit these competitive modes in space and time (Guba et al., 2015).

For example, if a young football player trains on a standard football field, instead of speed, which is manifested in the pace of movement, he develops speed endurance and another way of energy supply respectively.

Individualization

Coaches often have a question: what is better to develop - the strengths or weaknesses of the athlete? In this regard, there is a clear idea that the main strategy in training should not be "smoothing" the personality, but, vice versa, the development of athlete's strengths and personality as a leading condition for achieving high sports results (Platonov, 2013).

In particular, it has been found out that improving fitness motor skill, which is "lagging behind", leads to harmonious physical development of children, but does not improve the results in the chosen sport over time. Increasing the initial level of the leading conditioned motor quality contributes to the growth of sportsmanship in sports associated with the manifestation of one, leading ability, i.e. quality (speed, strength, endurance, etc.); simultaneous development of leading and lagging fitness motor quality leads to increased sports results in game sports, where priority is given to the simultaneous performance of several motor actions or the development of abilities that differ in the structure of their performance (Guba et al., 2015).

In the formation and enhancing of motor skills it is necessary to either develop a leading conditioned motor quality (focus on sport), or improve "lagging" qualities (focus on health) in order to achieve the best sports results.

In the training process with young players involved you need:

to use motor tasks aimed at development of certain conditioned abilities that are relevant to real game;

to improve the leading conditioned abilities for the player;

to create such a structure of physical fitness in which all components are in harmonious relation to each other.

As the optimal structure of player's physical fitness we should regard the level of development of individual fitness motor qualities, and such a ratio that allows the athlete to most successfully realize the potential accumulated in their training and achieve stable sports results (Stepanov, 2010).

Control and planning of training loads

It is known that physical training should be given close attention at all stages of football players' long-term improvement. However, the approaches to its implementation in relation to other aspects of football skills are significantly different.

When it comes to the development of football players' conditioned motor skills, it is usually associated with tired muscles, running, fever, profuse sweating, jerks, gym exercise, in other words activities aimed at improving athletic performance.

In this case, the training process is usually built in such a way that the load in the motor tasks is higher than those which players are usually used to.

However, the choice of training tools should be based on the fact that playing football is not just a combination of endurance, strength, speed, technical skills, and mental qualities and so on. These factors alone do not say anything about football skills of the players. It is important how the player reacts to different game situations and how he solves them. This is the main criterion for assessing skill in football (Szczepanski, 2015).

It is clear that implementation of this training aspect takes much longer than increasing muscle mass, jumping or lung volume. Therefore, the results in the Cooper run and the 30-meter run tests will not say anything about it.

Assessment of player's physical fitness level must be carried out taking into account the effectiveness of his actions in the game. For example:

- the ability to solve problems quickly, over a long period of time, in conditions of active confrontation with the opponent and the audience;
- ability to press, play creatively, quickly move from defence to attack and vice versa, etc.

The children's coach must know the basics of physical training; choose the right training tools, taking into account individual capabilities of the child's body, which are focused on, above all, creating such game situations that will encourage players to perform better, more often or faster, as shown in Table 1. The quality of the game is based on the ever-increasing complexity of performing motor tasks. It is necessary to "challenge" the players the way they are willing to accept. Evaluation of such tasks effectiveness will not consist of heart rate, distance that can be overcome, kilograms or minutes, but of the player's ability to perform the task (Ponomarenko, 2005).

The same conclusion has been reached Seluyanov, Sarsania and Zaborova (1991), who have found out that the average heart rate is not a criterion for the effectiveness of game. If the increase in heart rate is associated with the performance of game actions, i.e. accelerations, which are performed with maximum intensity and useful for the team as a whole, then such an increase of heart rate can be considered effective. In the case of heart rate increase as a result of running on a field of low intensity with the complete absence of useful actions for the game, such increase in heart rate cannot be considered effective, while the intensity of the load is high.

With regard to heart rate, the practice of football players' physical training is often based on the response of cardiovas-

cular system to motor tasks or competitive activity (Stolen et al., 2005; Godik et al., 2010; Bujnovky et al., 2019).

In this case, it is assumed that in the cyclic task, performed in the form of running it is necessary to determine the power of the aerobic and anaerobic thresholds. Heart rate is also determined for these thresholds. Next, it is presupposed that the pulse can determine the mode of power supply. If the task is performed up to the aerobic threshold, the load is aerobic. If the task is performed with a heart rate above the aerobic threshold, but below the heart rate of the anaerobic threshold (ANT), the load is of mixed nature. When the heart rate is higher than the ANT, the load has a glycolytic direction. This classification of loads is widely used in cyclic sports, but the legitimacy of its use in acyclic sports, and even more in sports games has not received a convincing justification (Seluyanov et al., 2012; Sarsania et al., 2019).

In football, the same average heart rate can be registered in different forms of competitive activity. For example, a player can run at a maximum speed of 10-20 m and repeat a fast run at intervals of 30-45 s. In this case, the average heart rate is 130-160 beats/min. If you increase the segment length to 50-80 m, slightly reduce the intensity and increase the rest interval to 60-90 s, you will get the same heart rate. When performing a steady run with heart rate at the level of aerobic or anaerobic thresholds, you can record the same heart rate. Note, however, that the physiological effect will be different. In the first case, when running is performed at maximum speed, all muscle fibres are involved in the physical work, in general, the muscles are slightly acidified, so there is a significant increase in aerobic and speed-strength abilities. In case of running at the level of the aerobic threshold, the training effect is zero, because only oxidative muscle fibres (MB) are recruited, about 1/3 of their total number, and these MB are already developed to the limit (marginal ratio between myofibrils and mitochondria).

Thus, to classify the load according to the pulse is incorrect. It is reasonable to register the pulse for one purpose only - to record the degree of the load influence on the myocardium (Sarsania et al., 2019).

It has been found out that performing loads with a heart rate of more than 180 beats / min and those lasting more than 30 s, as well as participation in several games a week, cause "diastole defect" in the myocardium among young athletes (Helsen et al., 2010; Efimov, 2011).

Moreover, common practice of using "squares" in football as a means of special physical training can be added. When used even once a week, it will lead to dystrophic phenomena in the myocardium in 1-2 months of regular exercise, reduced aerobic capacity and increased likelihood of muscle injury due to deterioration of their ability to relax (Meerson et al., 1988; Godik, 2009).

Particular attention should be paid to this issue when planning loads during pubertal or post-pubertal physical development of adolescents, when children develop the cardiovascular system and, above all, the myocardium lags behind the development of their musculoskeletal system relax (Meerson et al., 1988; Capranica et al., 2001).

Despite the position of Sarsania, Sarsania and Seluyanov (2019), it is worth noting that there is still no consensus among football experts on the basis of which indicators control and planning of training loads should be carried out. This is explained by the fact that most motor tasks in games are complex, i.e. they simultaneously improve the conditioned motor skills as well as technical and tactical skills of athletes (Godik et al., 2010).

For these purposes, as Godik (2009) has noted, indicators of time for certain types of training are used, but most of the tools applied in training do not have a pronounced effect (Morcillo et al., 2006). Therefore, it is very difficult to assess the direction of training sessions and tasks correctly.

Therefore, in the current situation it is advisable to plan and control training loads in their predominant direction, taking into account the mechanisms of energy supply, which in their turn are divided into anaerobic (lactate and glycolytic), aerobic-anaerobic and aerobic (Nistratov, 2011; Iordanskaya, 2013; Sonkin et al., 2018).

This way, firstly, allows you to determine the degree of load impact on the athlete's body accurately, and thus reduce the factors of fatigue and overexertion, and even more overtraining, which in its turn allows you to manage the development of training skills effectively. Secondly, on the basis of motor tasks systematization it is possible to unify the work supervision according to indicators of time and influence of certain motor tasks (Lalakov, 2000; Suchilin et al., 2005; Varyushin, 2007).

Conclusions

1. Early specialization, intensification of training and competitive activity at the background of a low initial level of children's health, impose high demands on the functional capabilities of their growing body, which in its turn results in an increase in morbidity and, as a consequence, premature cessation of sports (Orlovskaya, 2000; Kaminska, 2016).

2. It is necessary to reconsider the traditional views on the process of training a sports reserve, as the coach must successfully manage the process of an athlete's training rather than the process of sports training (Mikhailova, 2009). Such training should be based on the wide use of game-playing tasks that correspond to the specifics of the chosen sport, which are performed in the optimal mode of individual capabilities with an emphasis on the development of the game intelligence of young football players (Ponomarenko, 2005; Verheijen et al., 2017; Wein 2018).

3. The existing system of conducting children's competitions leads to a contradiction between training and competitive activities (Nikolaienko, 2017). The focus on "results" leads to forcing of training process with an emphasis on physical fitness; as a result, it leads to premature depletion of the child's body, exacerbation of diseases and injuries, as well as to the limitation of the technical and tactical potential of young football players (Stratton et al., 2004; Nikolaienko, 2014). At the same time, it has been established that starting from taking up systematic sports activities and until reaching the highest achievements in sports, the competition system should be subordinated to the training system in the way of gradual development of the young football players' versatile qualities (Platonov, 2013; Nikolaienko, 2015).

4. Optimization of the training process, especially at the initial stages of training, should be based on an understanding of the need to individualize the training process, as far as it should not be based on smoothing out individuality, but rather on the development of the body's strengths (Platonov, 2013; Guba et al., 2015). In the training process that involves young football players, it is necessary to apply motor tasks aimed at developing certain conditioning abilities related to real play; as well as to improve the conditioning abilities prevailing among

other player's skills; to create such a structure of physical fitness activities, in which all components have a harmonious balance. The optimal structure of a football player's physical fitness should be referred to as such a level of development of individual conditioned motor qualities, and such a ratio between them, that allows an athlete to realize the potential accumulated in training sessions and achieve stable sports results most successfully (Stepanov, 2010).

5. The of young football players' physical training is due to the high-quality organization, planning and control over training loads, where the choice of training influences should be based on the fact that playing football is not only about endurance, strength, speed, technical skills, mental qualities or indicators of heart rate, distance overcome, kilograms or minutes (Stolen et al., 2005; Godik et al., 2010; Seluyanov et al., 2012; Bujnovky et al., 2019; Sarsania et al., 2019). These factors alone do not say anything about the football skills of the players. It is important how a football player reacts to various game situations and how he/she solves them. This is the main criterion for assessing the skill in football (Ponomarenko, 2005; Szczepanski, 2015). Hence, the children's coach must choose the right training means, taking into account the individual capabilities of the child's body, which first of all, presuppose creating such game situations that will stimulate the players to perform actions better, more often, or faster (Michels, 2013; Table 1). A coach should especially carefully approach the planning of loads during the period of puberty or post-pubertal physical development of adolescents, when the development of the cardiovascular system and, first of all, the children's myocardium lags behind the development of the musculoskeletal system (Meerson et al., 1988; Capranica et al., 2001).

Table 1. Means of regulating focus of training load (Michels, 2013)

Means	Effect
Reducing the size of the game space	Less time to make a decision in a certain game situation
Increasing the size of the game space	More time, longer distance to run and pass the ball
More rivals	Less time, harder to "read" the game
Fewer rivals	More time, harder to "read" the game
Pressure on the opponent	Less time, harder to "read" the game
Using the out-of-play position	Less space, less time
Enough balls outside the playing field	Continuous game
Score balls only with the head	Playing through the flanks and much game with the help of head
Time limit (play only 5 minutes or last minute)	Players are forced to attack more effectively, fight for the ball, control the ball and so on

The listed aspects of young football players' physical training will optimize the process of managing the level of their fitness development, which in its turn will reduce the factors of physical and mental overwork and overstrain occurrence, especially overtraining (Lalakov, 2000; Suchilin et al., 2005; Varyushin, 2007).

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Conflict of Interest
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SportMont

ORIGINAL SCIENTIFIC PAPER

Research of Emotional Intelligence as a Psychological Resource of an Athlete

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Abstract

Emotional intelligence (EI) is an important part of the psychology of an athlete and must be considered when a training programme is being devised. The aim of this research is to determine the impact of physical activity on the EI level among youth; examine the extent to which EI and sports achievements is correlated; consider the discrepancies between EI indicators within athletes in different sport disciplines. The EI of 245 young people aged 17-19 was studied. 125 of them were athletes who were systematically engaged in sports and competitions for 3½ years. The remaining 120 were not engaged in any sport. The research is based on the methodology that Nelson-Hall devised to assess EI. It also uses various methods of mathematical statistical analysis, such as Student's t-test. The extent of the EI in young athletes was significantly higher than that in their peers who had not done any sports. In a group of athletes differences were found in EI components between athletes of different sport disciplines. This was shown in the indices of emotional management, self-motivation and in the extent to which they were aware of other people's emotions. The research showed that athletes with higher levels of emotional management tend to achieve better results than those with lower emotional management abilities. It is likely that this observation will hold true for athletes from across the broad spectrum of sporting ability.

Keywords: *emotional intelligence, psychological resource, athletes, non-athletes*

Introduction

Modern research into psychological training in sports raises the issue of how an athlete's psychology can be used as a resource (Arnautova & Petrovska 2019; Fletcher & Sarkar, 2012). Another issue is the need to consider the personal qualities of the person who coaches the athlete (Balogh & Trzaskoma-Bicsérdy, 2020; Petrovska, 2020).

The need to counteract the wide range of stress factors that often arise during training and competition presents a range of challenges that an athlete's character must overcome (Grin, 2009). For example, athletes can only obtain good results in sport by adapting to high training loads and to constant competition. This demands a complex set of personal resources and qualities in an athlete (Kovryga, 2003).

Theoretical analysis offers many insights into how best to form and shape the personal resources of an athlete. The literature on the subject is extensive and much of it is overlapping. Nevertheless, it seems from the writings that there are four main resources. They are motivational (Nicholls, Morley, & Perry, 2015); cognitive (Kolosov, 2006 Cowden, Fuller, & Anshel, 2014); behavioural (Nicholls et al., 2015); and emotional (Fletcher & Sarkar, 2012; Galli & Gonzalez, 2015). Emotional stability, confidence and motivation, dedication, optimism, and the ability to control aggression (Petrovska, 2020); anxiety (Cejudo, Rodrigo-Ruiz, López-Delgado, & Losada, 2018); the ability to concentrate and high self-esteem (Sakal & Petrovskaya, 1999); and the importance of having a stable psychological profile (Arnautova & Petrovska, 2019) are closely linked to or

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are subsets of the four main resources.

In essence the literature on the subject stresses the need for careful research into the psychological resources of an athlete. It also argues that those resources will differ from one athlete to another. The versatile use of the emotional resource capabilities of an athlete's psyche effectively increases their ability to embody their sports potential in competitions (Galli & Gonzalez, 2015). Harnessing EI has the potential for improving an athlete's emotional resources (Petrovskaya, 2014; Castro-Sánchez, Zurita-Ortega, Chacón-Cuberos, López-Gutiérrez, & Zafra-Santos, 2018).

The aim was to determine the impact of physical activity on the level of EI among youth; establish the correlation between the level of EI and sports achievements; and examine the discrepancy between EI indicators within athletes in different sports disciplines.

Methods

Its scope covered 245 young people (120 males and 125 females) aged 17-19. 125 of them (64 males and 61 females) were systematically engaged in sports for 3½ years (athletes). The remaining 120 (56 males and 64 females) were not engaged in any sport (non-athletes). Athletes group comprised of the players from Table tennis (12); Sprints (23); Football (33); Wrestling (19) and Volleyball (38).

The study was conducted by Bukovinian State Medical University, Yu. Fedkovych Chernivtsi National University, Chernivtsi regional sports school and Youth Sports School No. 1 in Chernivtsi.

It uses the methodology Nelson-Hall devised to diagnose EI. It also uses various methods of mathematical statistical analysis, such as Student's t-test. The Shapiro-Wilk W test was used in testing for normality. As the Integrative EI Index was normally distributed the Student's t-test was used in comparing Athletes and Non-Athletes.

Using the method of statistical grouping based typical indicators students were divided into two main groupings: 'athletes' and 'non-athletes'. The 'athletes' group consisted of the following subgroups: team contact sports (football), team non-contact sports (volleyball), individual contact sports (wrestling), individual non-contact sports (table tennis), cyclic sports (track and field athletic, and sprint). Based on the results of the athletes' performance in competitions, the 'athletes' group was further divided into two sub-groups: 'prize winners' (21 athletes) and 'non-prize winners' (104 athletes).

All athletes aged 18 or over gave their consent to the data being used for scientific research according to the recommendations of the biomedical research ethics committee. For those students who were aged under 18, consent was given by their parents or guardians.

Results

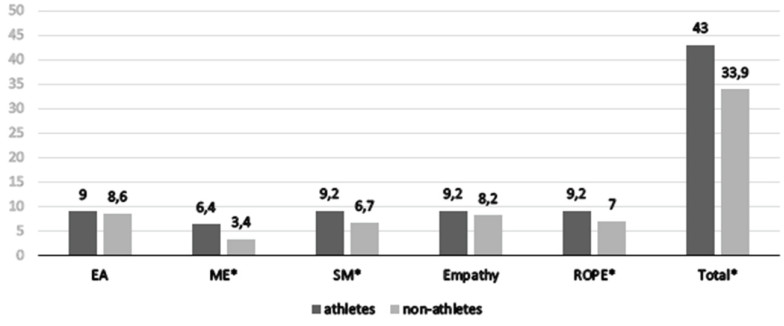
Statistics proves that there was a correlation between the EI level and physical activity. Table 1 shows the significant discrepancy between the level of the EI of athletes and non-athletes ($p<0.001$).

Table 1. The Integrative EI Index of Athletes and Non-Athletes

Indices	Athletes	Not athletes
Number of subjects (n)	125	120
Mean (ẍ)	43.024	33.875
Standard error (SE)	1.6296	1.5356
Standard deviation (SD)	19.074	16.822
T score for the mean difference		
t-test (Student's test) for the mean difference	t=3.99, p=0.000089	
Critical value of t for p=0.05 and n=245	3.34	
Error probability	p<0.001	

Our research shows that participation in sport plays a key role in helping to shape an athlete's psychological profile. To examine and describe the differences between 'athletes' and 'non-athletes' we analysed the indices of EI components (Figure 1). The level of EI components on each scale correlates with the results they achieved: 14 or more - High; 8-13 - Medium; 7 or less - Low. The integrative index of EI with the dominant sign determined the following quantitative indicators: 70 or more - High; 40-69 - Medium; 39 or less – Low.

A significant difference was found in the following components: managing emotions (ME), self-motivation (SM), and recognition other people's emotions (ROPE). No significant



*Legend: EA - emotional awareness; ME - managing emotions; SM - self-motivation; ROPE - recognition the of other people's emotions; *=significance ≤ 0.001*

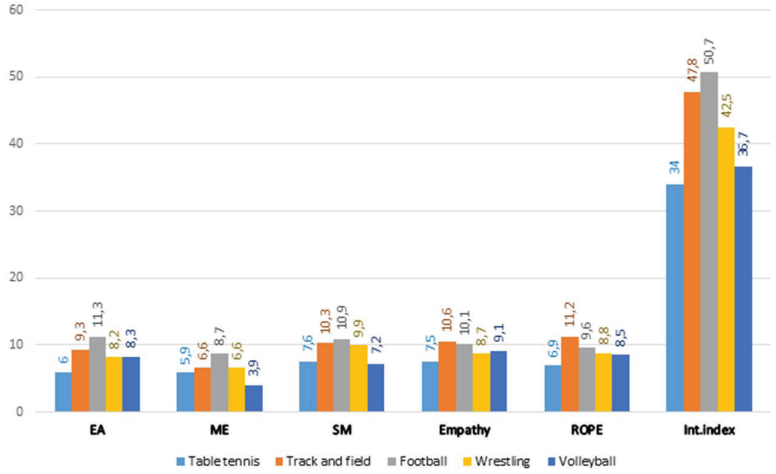
FIGURE 1. EI components of "athletes" and "non-athletes"

difference was observed in the emotional awareness (EA) and empathy scales.

Sports activities promote the development of the following EI components: managing your own emotions, self-motivation, and recognition of other people's emotions. These components form the psychological resource of an athlete.

Our study involved representatives of five sports. Consequently, the 'athletes' group was divided into the following sub-groups: team contact sports (football), team non-contact sports (volleyball), individual contact sports (wrestling), individual non-contact sports (table tennis), cyclic sports (track and field athletic, and sprint). We investigated whether the EI indices of athletes representing different sports very and how the specifics of the different sports affect the development of the EI integrative index as well as its components.

As the sub-groups representing different sports contained only a small number of athletes, it was not possible to determine statistically whether there is significant difference in the EI indicators of athletes within different sports. The means for each group, however, allowed us to comment on some trends noticed. The research showed that football players, short distance runners e.g., sprinters, and wrestlers have an integrative index of emotional intelligence that is at the 'medium' level and that table tennis and volleyball players have a lower integrative index. This can be explained by the differences in the physical distance between competitors. In essence, it seems that physical contact in sport stimulates the development of EI in general. As Figure 2 shows, football players have the highest position on the EI integrative index, sprinters and wrestlers occupy the middle position, and volleyball and table tennis occupy the lowest position.



Legend: Int.index - Integrative index

FIGURE 2. EI components indices of athletes in different sports

Footballers have the highest indices of most EI components. Their scores in emotional awareness and emotion management are much higher than those obtained by athletes in other sports.

In our study, we tried to determine whether success in sports activities depends on the level of development of EI, and if so, what component of EI is crucial for success in sport. Since it is difficult to assess the level of success in different sports for different competitions, we took the results of the athletes' performance in competitions (namely, victory in the competition) as a criterion that would standardise our assessment of the athlete's success. To conduct our analysis, all athletes who participated in the study were divided into two subgroups: 'prize winners' (21 athletes) and 'non-prize winners' (104 athletes).

The integrative index of EI in the sub-group of 'prize winners' is higher than the same index in the 'non-prize winners', but the difference that was found is not statistically significant. The difference in the indices of EI components in the studied samples is also statistically unreliable. Therefore, we cannot say that success in sports depends on the level of development of EI. However, we did identify certain trends (shown in Figure 3).

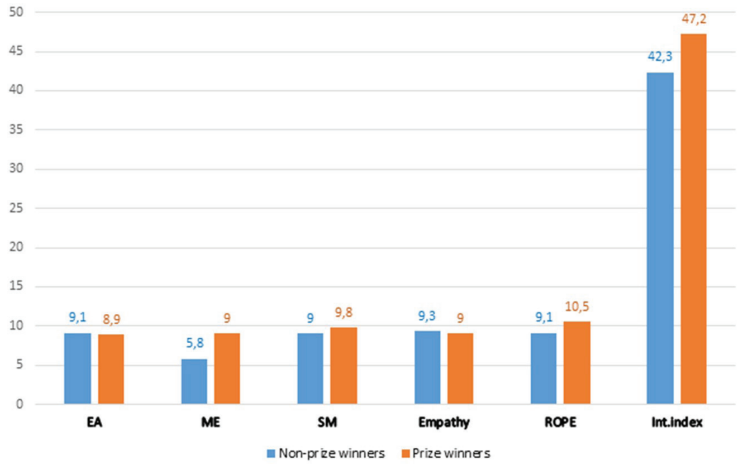


FIGURE 3. Indices of components of EI in athletes with different qualifications

The rate of development of emotional awareness and empathy in the sub-group of 'non-prize winners' was higher than in the sub-group of 'prize winners', but the opposite trend is observed for other components of EI. Most of all, the above sub-groups differ according to the index of managing their own emotions. Here the difference in indices reached almost 30%, while the difference between the indices of other components did not exceed 10%.

Discussion

The subject of EI arises at the intersection between the psychology of thinking and the psychology of emotions. More research is needed to understand the interaction between these mental processes and the impact this interaction has on the functioning of the individual. The most recognized model of EI in behavioural science has four components. They are awareness of emotions; the ability to manage emotions; recognition of other people's emotions; and an individual's ability to establish and maintain relationships with people (Goleman, 2005). Leading researchers in this field agree that the general essence of EI is the ability to understand and manage your own emotions and those of other people (Lysin, 2004). These components belong to two main components: personal and interpersonal.

The overwhelming majority of researchers think that success in an activity is dependent on the level of development of EI (Gorskaya & Grin, 2008). Individuals with highly developed EI are likely to achieve success in their careers than people with have a low level of EI development (Bradberry, 2009). Scientists consider EI to be a type of information system that helps a person to adapt to the environment by helping a person to connect their intelligence with three key processes of human life. They are: internal information processes, experience, and interaction with the outside world (Mayer, Salovey, Caruso, & Cherkasskiy, 2011). It is only by considering EI as an additional information resource that an athlete can understand how the mechanisms of influence of EI can help them achieve success in competitive activities. Various studies (Petrovskaya, 2014; Fernández at al., 2019) have confirmed that an athlete's EI affects an athlete's ability to control the level of situational anxiety before he or her takes part in high level competitions. Similar results were obtained in a study of aggression. In that study aggression was significantly lower in elite athletes compared to non-elite ones (Petrovska, 2020). Important components of EI that affect the ability to regulate anxiety or aggression before competitions are: managing your own emotions, self-motivation, and the ability to read the emotions of other people and competitors in competitions.

Our research showed that sports activities contribute to the development of components of EI in young athletes. The components they helped develop were managing their own emotions, self-motivation, and recognition of other people's emotions. Such results are logical because both the training process and taking part in competitions in sports require high self-control over your own emotions. An athlete who is not able to control his own emotions cannot achieve high results. Equally important for an athlete, especially in sports games and martial arts, is the ability to recognise another person's emotions and the ability to resist. (Manko & Petrovska 2009). Very often, the success of a game or match, especially those that involve athletes of equal training and experience, depends on the ability to see and understand the emotional reaction of the opponent ahead of time and use the information received to win (Petrovska & Kulish, 2010).

Conclusions

The level of development of young athletes' emotional intelligence was significantly higher than that of their peers who were not engaged in any sport. According to the results of the analysis of the components of EI in a group of athletes, statistically significant differences were found in the indices of managing their own emotions, self-motivation and in recognition of other people's emotions. Thus, sports activities have a positive effect on the development of young people's EI.

The specifics of activities in various sports to a certain extent determine the peculiarities of the development of athletes' EI. The highest rates of emotional intelligence development were found in football players, followed by representatives of track and field and wrestling. Representatives of volleyball and table tennis have the lowest rates of EI development.

The study of the possible interaction between the level of athletes' EI and the result of their performance in competitions proved that the integrative index of EI in the sub-group of 'prize winners' is higher than the same index in the group of 'non-prize winners'. The difference revealed though is not statistically significant. The biggest difference between subgroups of athletes is in terms of managing their own emotions. It enables us to assume that control over your own emotions is one of the factors that determine success in sports and can be considered as a component of the psychological resource of an athlete.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Organizational Principles of Development of Golf in Ukraine. An Overview of Strategic Planning

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Abstract

The article analyses the modern trends of world golf. The experience of national golf federations of the world's leading countries, interviews with golf experts assisted (29 participants in the survey: including 8 representatives of the National Olympic Committee (NOC), 10 members of the Board of the Ukrainian Golf Federation, 6 golf judges, 5 coaches and golf instructors) to identify the specific features of golf development and popularization trends. The modern causes affecting further development of golf in Ukraine are investigated: the deficiencies of the legislative provision of sports development and the promotion of the activities of subjects of the national golf system; low level of motivation of different groups of population for golf to practice in the country; lack of golf courses at children's and youth sports schools; the backlog of the material and technical base of golf development from the level of most countries of the world; mismatch with the modern requirements of scientific and methodological support for the development of golf and staffing, and others. The strategic directions, goals and objectives for the development of golf in Ukraine for the period up 2030 are resulting from this study. The strategy of golf development in Ukraine will allow dignified representation of the state in the world sports community, popularize golf as a leisure activity in the system of a healthy lifestyle of citizens and promote the consolidation of the nation.

Keywords: *golf, development trends, problems, strategy, prospects*

Introduction

One of the main trends in the development of modern society is the process of globalization, in which sport becomes an important political, social and economic factor. As a result, the main features of the functioning of modern sports are: integration into the market economy system, the migration of athletes and trainers, the formation of a powerful transnational market of sports equipment and equipment, information and ideological measurements (Tereshchuk, 2012, 2014; Tereshchuk, & Drobyshevsky, 2014).

The professionalization and commercialization of the Olympic sport contributed not only to the modification of modern sports in general, the management and training of athletes, but also led to a change in the proportion of the professional component in the overall system of sport with a focus on maximum efficiency, technicality, aesthetics and entertainment (Lawrenson, 1997). The inclusion of golf in Olympic sports determines the prospects for the development of this sport in the framework of both national and international scale (Kostenko et al., 2003; Shynkaruk, 2012).

Golf in Ukraine is an integral part of the nation-wide system of physical culture and sport and aims at strengthening the health, development of physical, moral-volitional and intellectual abilities of a person through its involvement in golf competitions (Dutchak, 2009). Despite the interest of the population in golfing in Ukraine, the positive development of golf in recent years, there are a number of problems regarding the development of golf in the country (Shynkaruk, Dutchak, & Pavlenko, 2013).

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The purpose of the research was to study the golf system in the world and Ukraine and based on the expert survey to determine the main issues and prospects of its modern development.

Methods

Methods used included the analysis of scientific and methodical literature, Internet data and statistics methods.

Participants

A sociological and expert survey of golf specialists was conducted to determine the current situation regarding the development and popularization of golf in Ukraine. There were 29 participants in the survey: 8 representatives of the NOC, 10 members of the Board of the Ukrainian Golf Federation, 6 golf judges, 5 coaches and golf instructors.

Study Organization

Studies were conducted during the preparatory period of the seasons 2019-2020 using the methods described below. The special literature and Internet data analysis and synthesis was used for the theoretical study problems in Ukrainian golf.

The methodology of the group expertise included: formulating the tasks, selecting and composing the group of experts, creating the expertise plan, interviewing the experts, analyzing and processing the obtained information.

Concordance of experts' opinions was checked by means of Kendall's concordance coefficient calculation under the condition of non-strict sequence of ranking according to the formula:

$$W = \frac{12\,S}{m^2\left(n^3 - n\right) - m\sum_{j}^{m}\sum_{t_j}\left(t^3_j - t_j\right)}, (1)$$

where, m – number of experts; n – sample size; tj – number of identical ranks assigned to different alternatives by the j-th expert, S – sum of squares deviation from the mean, which was calculated according to the formula:

$$S = \sum_{i=1}^{n}\left(\sum_{j=1}^{m} x_{ij} - \bar{s}\right)^2, \text{ where } \bar{s} = \sum^{n}\frac{s_i}{n}, \; s_i = \sum^{m} x_j \quad (2)$$

To verify the concordance coefficient, which describes the average level of the consistency of the experts' opinions, the relevance was checked using Pearson's consistency criteria — $\chi 2$- criteria. The necessity of such evaluation arises because we use the sampling data (not all experts are involved, but only a group of experts, that is why the obtained result can be accidental).

Statistical analysis

The obtained data were processed by mathematical statistics using Statistica, MS Excel software. Expert assessment was carried out by the method of preference (Byshevets et al., 2019; Byshevets et al., 2019).

Results

Experts estimate that the main limiting factors in the development of golf in Ukraine are social and economic situation in the country (rank 1), lack of material and technical basis (clubs, fields) (rank 2), low popularity of the sport (rank 3), inadequate regulatory and organizational support (rank 4), lack of optimal level of state and local support (rank 5), lack of goal-oriented programs for the development and popularization of golf in the country (rank 6), lack of staffing (rank 7), inadequate competition system (rank 8), etc. (table 1). The coefficient of concordance of the experts' opinions was W=0.71. The analysis and generalization of the research results of scientific and methodological materials, regulatory documents, the experience of national golf federations of the world's leading countries, interviews with golf experts allowed to identify the specific features of golf development and popularization trends. Considering these peculiarities, we can create a program of golf development and popularization in Ukraine by improving organizational and methodological conditions and substantiate its implementation mechanism in the country.

Strategic directions, goals and objectives for the further development of golf in Ukraine were developed on the basis of the group's expertise (Table 1).

Factors	Sum scores Σ	Rank
The social and economic situation in the country	38	1
Popularity of the sport	62	2
Material and techinal basis (availability of clubs and fields)	66	3
Regulatory and organizational support	123	4
State and local support for golf development	148	5
Availability of goal-oriented programs for the development and popularization of golf in the country	158	6
Staffing support	180	7
The competitions system	271	8

Note: Σ - the sum score, the less the sum score, the higher the expert`s score

In the course of the research, strategic directions, goals and objectives of golf development in Ukraine for the period until 2030 were determined: Golf is accessible to all; Children's and Youth Golf; Golf as elite sport; Golf in the system of physical and sports rehabilitation; Promotion and information provision of golf; Development of golf infrastructure; Scientific and methodological provision of golf; Staffing of golf; International Cooperation on Golf Development.

Direction "Golf is accessible to all" (Figure 1). Strategic Goal 1. Implementation of golf courses at educational institutions. Objective: to introduce golf in the educational process and extra-curricular work on physical education in educational institutions of all levels (development of methodological recommendations, improve material and technical support, improve the system of training and advanced training of physical education teachers for conducting lessons with golf

elements, use effective means of motivation schoolchildren and students to go to golf; hold all-Ukrainian competitions for the best organization of the relevant work, etc.); to organize cooperation between educational institutions in which there are sections of golf and mini golf; to ensure the creation and operation of the Student League of Ukrainian Golf.

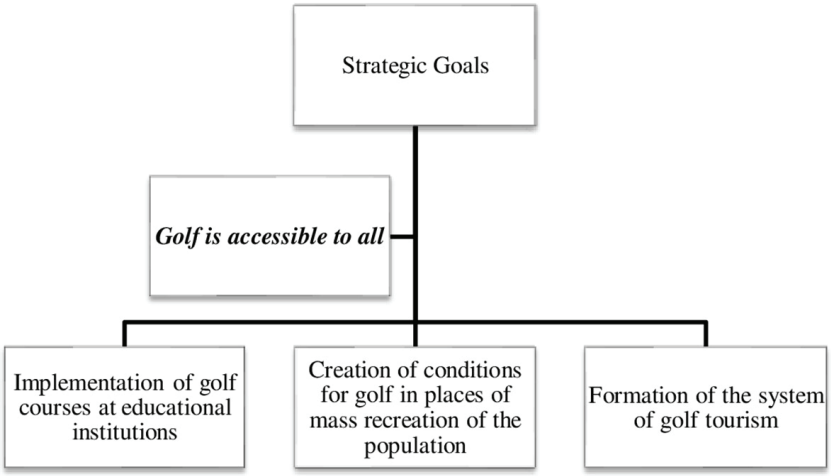

FIGURE 1. Strategic Goals for Destination "Golf is accessible to all"

Strategic Goal 2. Creation of conditions for golf in places of mass recreation of the population.

Objective: to conduct public sporting events with elements of golf as effective types of family activities in places of mass recreation of citizens; create family golf courses; develop and o implement target programs for the creation of children's playgrounds and flat sports facilities from golf in t recreational parks and recreation areas; to create a system of mass sports events, holidays with elements of golf among children, adolescents and youth; Provide conditions for bringing children to short-term training on technical elements of golf on the basis of the special project "Massive entertaining golf schools".

Strategic Goal 3. Formation of the system of golf tourism. Task: to organize excursions of schoolchildren for golf and mini golf competitions; to create favorable conditions on the golf courses for the stay of tourists as spectators and / or participants in mass competitions; to promote the formation of tourist groups for viewing prestigious international sports competitions on golf; organize a tourist route to the golf courses of Ukraine.

The direction "Children's and Youth Golf" (Figure 2). Strategic Goal 1. Introduction of golf to subjects of children's and youth sports. Objective: to implement a training program for children's and youth sports schools, specialized children's and youth sports schools of the Olympic reserve, schools of higher sporting skills and specialized schools of sports golf profile; to open golf departments in children's and youth sports schools and other subjects of children's and youth sports; Create a Golf Academy for young players based on leading golf clubs; to conduct summer sports camps for the best young golfers; to develop programs for the preparation of the Olympic reserve for golf "From the first ball hit to the sport of higher achievements".

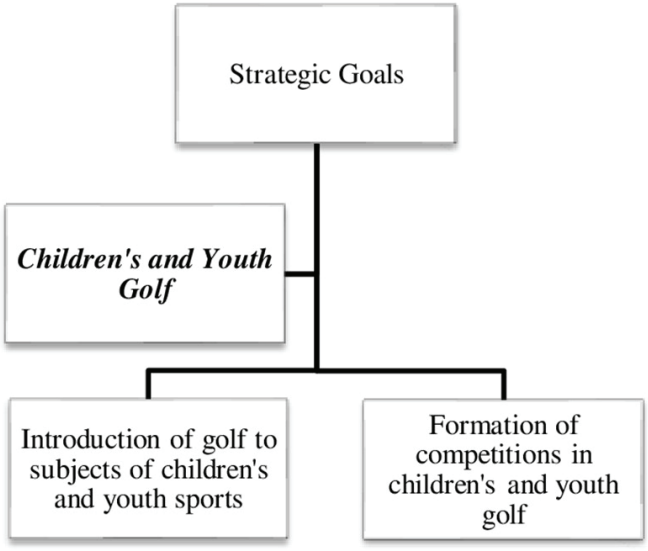

FIGURE 2. Strategic Goals for Destination "Children and Youth Golf"

Strategic Goal 2. Formation of competitions in children's and youth golf. Task: to organize All-Ukrainian multi-league golf competitions among young players; Ensure participation in various international sports competitions of the best young golfers; To launch and conduct an international tournament for young golfers in Ukraine.

Direction "Golf as elite sport " (Figure 3.). Strategic Goal 1. Ensuring the development of golf infrastructure as a sport of higher achievement. Objective: To promote the formation of a system of golf clubs of various forms of ownership; to create a center for the preparation of national teams of Ukraine on golf; to ensure the functioning of the national team of Ukraine on golf.

FIGURE 3. Strategic Goals of the "Golf as elite sport"

Strategic Goal 2. Promotion of amateur and professional golf. Objective: To stimulate clubs of tournaments among golf lovers and launching a relevant national tournament; to create in Ukraine a competitive system of competitions for professional golf players in accordance with international standards and rules; To register the Ukrainian golf professionals, their certification and assignment of the corresponding categories; conducting the official sports rating of Ukrainian golf professionals; to Figure 3 Strategic Goals of the "Golf as elite sport" support the participation of Ukrainian players in prestigious international golf competitions of amateurs and professionals; to assist leading Ukrainian golfers in attracting sponsors and investors from commercial amateur and professional golf projects; to carry out a complex of activities for the participation of athletes of Ukraine in the Olympics and the Paralympic Games of Golf.

Direction "Golf in the system of physical and sports rehabilitation" (Figure 4). Strategic Goal 1. Introduction of golf elements into the system of physical and sports rehabilitation of persons with disabilities. Objective: to implement social programs using the elements of golf in physical culture and sports rehabilitation of persons with disabilities, children with disabilities in order to improve their physical and psychological condition; to ensure the availability of golf lessons (mini golf) for physical education and sports rehabilitation of military and veterans of combat operations; to provide barrier-free golf courses for unhindered access by persons with disabilities, children with disabilities.

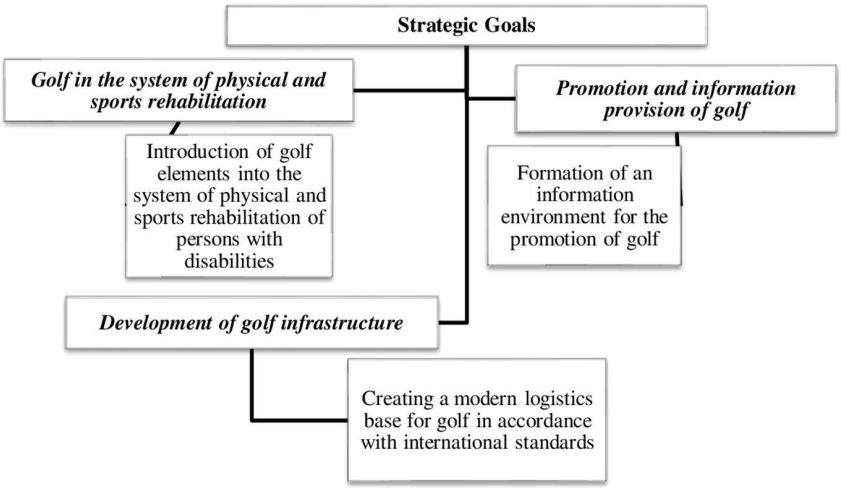

FIGURE 4. Strategic goals of "Golf in the system of physical education and sports rehabilitation", "Propaganda and information provision of golf", "Golf infrastructure development"

Direction "Promotion and information provision of golf" (Figure 4). Strategic Goal 1. Formation of an information environment for the promotion of golf. Objective: To introduce in the mass media, primarily on television, social advertising on the benefits of golf for the formation of a healthy lifestyle of citizens, as well as cognitive programs for people of all ages in relation to golf during the life process and overcoming the state of social indifference; Provide coverage of sporting events from golf in the media and social networks; Integrate existing and create new information resources to ensure the exchange and dissemination of golf information; To launch the publication of the periodical printed edition - the magazine "Golf of

Ukraine"; create a golf league of journalists in Ukraine.

The direction "Development of golf infrastructure" (Figure 4). Strategic Goal 1. Creating a modern logistics base for golf in accordance with international standards. Task: to prepare and make changes and additions to the legislation in the established order in order to create a favorable legal field for development of the infrastructure of domestic golf; Further development of golf infrastructure through the construction of modern golf courses and the introduction of their certification for sporting events of various levels; Improvement of city planning in terms of creating golf courses and mini golf; making necessary changes to the corresponding state building standards; accept and financially provide a long-term plan for building golf courses for 9 and 18 holes of different types and classes, shortened golf courses, mini golf courses; to create a network of golf simulators on sports facilities of Ukraine.

Direction "Scientific and methodological provision of golf" (Figure 5). Strategic Goal 1. Introduction of innovative approaches to the scientific and methodological provision of golf development Objective: to develop programs of scientific support for the training of leading domestic golfers and national teams of Ukraine; to organize the conduct of scientific research and the implementation of their results in the practice of golf clubs and other sports subjects; provide prevention of injuries and illnesses of golfers in the process of sports activity, as well as prevention of the use of prohibited substances and methods, etc .; to use innovative technologies for the mobilization of functional and mental reserves to increase the efficiency of the training and competitive activities of golfers; to carry out preparation and publication of methodical and scientific publications, textbooks, training manuals, videos, audio products for the assistance of trainers, judges, athletes; Participate in international conferences and seminars on topical issues of golf development.

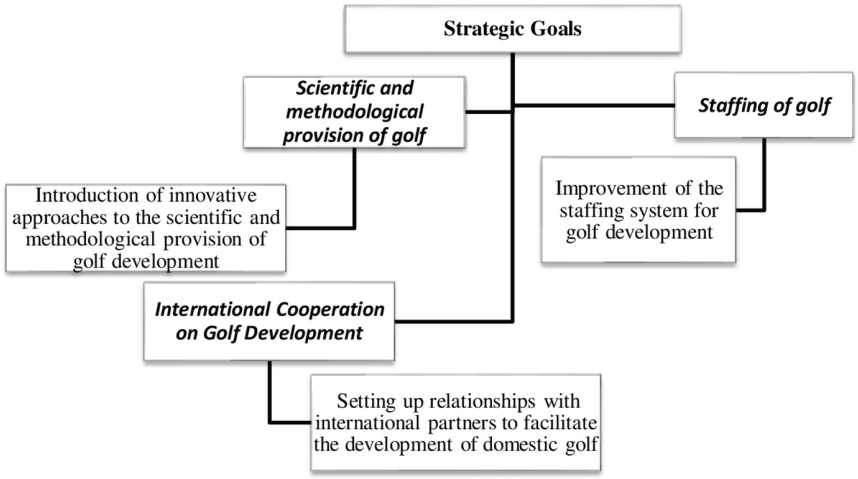

FIGURE 5. Strategic goals of "Scientific and methodological provision of golf", "Staffing of golf", "International cooperation on golf development"

The direction "Staffing of golf" (Figure 5). Strategic Goal 1. Improvement of the staffing system for golf development. Objective: To determine the need for different golf courses and to adopt a long-term plan for staffing golf development; to organize preparation of golf coaches in the leading specialized institutions of higher education; to start the work of the School of Golf Judges; to assist domestic judges in obtaining licenses of international golf organizations; to provide training for domestic golf careers and golf inventory specialists; to promote the professional growth of trainers and other golf specialists, to form a system of their certification; to develop a program of volunteer golf development for the organization of sports, recreation and sport activities.

The direction "International Cooperation on Golf Development" (Figure 5). Strategic Goal 1. Setting up relationships with international partners to facilitate the development of domestic golf. Objective: to maintain and develop business contacts with international golf organizations, national golf federations from other countries on the basis of bilateral agreements and to establish cooperation with new international partners; to ensure the participation of trainers and other golfers in international bilateral and multilateral exchange and internship programs; to expand the representation of Ukraine in international golf organizations; to ensure the participation of domestic scientists and experts in international forums, conferences and seminars on topical issues of golf development; to promote the participation of domestic golf clubs and other sports subjects in international golf support projects.

Discussion

The analysis of literary sources, normative documents (Meister, 2012; Shynkaruk, 2012, Kostiukevych et al., 2018; Tereshchuk, 2014; Golf Association of Russia, 2018; Golf Federation of Kazakhstan, 2018; EGA, 2018; IGF Golf, 2018; Official World Golf Ranking, 2018) allowed to determine the modern trends of world golf, such as: significant growth in the popularity and geography of the distribution of golf; preservation of leading US positions in golf development; in Europe, the golf system remains focused: 92% of all professional players and 90% of golf courses are in ten countries, primarily in the UK (England, Scotland, Wales), Germany and France; dynamic development of golf in the countries of eastern Europe and the Balkan countries; increasing the number of international athlete leaders from countries that had no previous traditions; development and implementation of national programs and strategies for the development and popularization of golf; existence of a unified system of competitions at the international level combining professional and amateur directions; introduction of a unified world handicap system by 2020; unification of training and certification standards for trainers (in-

structors), judges, green keepers; the rapid progress of the golf business industry (golf clubs and golf courses, the production and sale of clothing and sports equipment, the production and sale of sports sights, tourist services, information services for sports fans, earnings of professional players, the construction of cottages near the golf course, fields, etc.); certification of golf courses and golf club accreditation; opening municipal golf courses with state support at central, regional and local levels.

Further development of golf in Ukraine is complicated by a number of modern challenges:

• imperfection of legislative provision of sports development and promotion of activity of subjects of the system of domestic golf;

• instability of the socio-economic environment;

• a tense demographic situation in the state;

• Strengthening the trend to reduce the share of sports allocations from the state budget, in particular the limited financial resources for the development of golf in the country;

• low level of motivation of various population groups for golfing in the country;

• the lack of golf courses at children's and youth sports schools;

• the backlog of the material and technical base of golf development from the level of most of the country in the world that develop golf;

• imperfect regulatory and organizational provision of golf;

• inconsistency with modern requirements of scientific and methodological support of golf development;

• insufficient staffing.

• The mission of the golf system in Ukraine for the period until 2030 sees:

• ensuring the promotion of Olympic and Paralympic sports in society;

• increase of investment attractiveness of Ukraine;

• creation of conditions for the growth of the skill of domestic athletes from golf;

• Involve schoolchildren, students and other groups of the population in golf;

• strengthening of the social institution of the family by means of active rest;

• use of golf for physical and psychological rehabilitation of military and veterans of combat operations;

• promoting moral and ethical education, especially children and young people.

The mentioned challenges are deep and systematic and require coordinated actions of state authorities, the public and private structures based on the vision and mission of the golf system in Ukraine in the long-term perspective, as well as the implementation of strategic directions, goals and objectives for the further development of this sport.

Conclusions

The analysis and generalization of the research results of scientific and methodological materials, regulatory documents, the experience of national golf federations of the world's leading countries, interviews with golf experts allowed to identify the specific features of golf development and popularization trends. Considering these peculiarities, we have created a program of golf development and popularization in Ukraine by improving organizational and methodological conditions and substantiate its implementation mechanism in the country.

Realization of strategic directions, goals and tasks of further development of golf in Ukraine will allow to coordinate the activities of subjects of various sectors of the socio-economic sphere to ensure the development of golf as an effective means of forming a healthy lifestyle and to establish the international authority of Ukraine in the world sports community.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Modern Approaches to the Preparation System of Masters in eSports

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Abstract

The preconditions of the development of eSports are investigated and the content of Masters' preparation in eSports is substantiated. Analysis of scientific and methodological literature, Internet data and methods of mathematical statistics were used as research methods. The study involved 15 experts: eSports specialists, representatives of the Ukrainian eSports Federation. The research was conducted during of the 2019-2020. The analysis of the curriculums of the second level of post-graduate studies of 6 higher educational institutions of foreign countries was carried out. The analysis allowed identifying promising areas of eSports development in the educational environment. The main preconditions for its development with the projected benefits of eSports have been identified, potential threats have been identified, including problems with the locomotor system, decreased visual acuity, and deteriorating health due to irrational work schedule. The necessity of master's programs introduction for preparation of specialists in eSports is justified. It is established that along with the special practical skills of the player, eSports specialists must clearly understand the aspects of team building and organization of the eSports training process, as well as have theoretical knowledge, practical skills and abilities aimed at maintaining and improving their health. The terminology for ensuring the development of eSports science is clarified. The educational program of the second level of post-graduate studies of higher education specialty 017 "Physical Culture and Sports", specialization eSports was developed. According to the results of the expert evaluations method the content of the specialization cycle of the educational program was determined.

Keywords: *eSports, master, development, formation, prerequisites, education, maintenance, programs*

Introduction

We are currently witnessing the informatization of show business when the merger of modern culture components the perspective phenomenon emerges such as eSports which becomes increasingly popular among youth. The origin of eSports in Ukraine tracks back to the beginning of 2000th and since then is just accelerating. Competitions by eSports athletes has become increasingly exciting and spectacular, causing the rapid commercialization of eSports and its development from a hobby into a full-fledged business in the IT entertainment and gaming industry (Shynkaruk et al., 2019). Thus, the target audience for the eSports segment reaches 190 million people, primarily men between the ages of 18 and 24, who are able to spend more than $20 million monthly on quality tournaments thanks to the crowd-funding system (Horova et al., 2016).

Among the countries that take the advanced positions in the world concerning distribution and assistance to development of eSports experts, call South Korea, China, the USA and countries of Western Europe (Lazneva et al., 2018). And the greatest distribution was received by next games:

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Counter-Strike (Counter-Strike: 1.6; Counter-Strike: Source; Counter-Strike: Global Offensive); Dota (DotA; Dota 2); Warcraft (Warcraft 3: The Frozen Throne); FIFA; World of Tanks; League of Legends; Heartstone; Overwatch (Buyanova, & Kozilina, 2017).

In spite of the fact that the eSports industry in Ukraine is in the formation stage today, it has considerable financial support from investors and, according to forecasts of analysts, big financial prospects (Bajkovskij et al., 2019; Shynkaruk et al., 2019).

However, rapid development of eSports is followed by emergence of new problems. International community faced an issue concerning the need of its legal settlement, the issue of development of educational programs for referee's and trainer's preparation structure of this sports discipline was in the focus as well as the issue of defining the list of the substances forbidden for eSports athletes became aggravated (Buyanova, & Kozilina, 2017).

The demands for a large part of the society for spectacular events are satisfied through eSports tournaments, which is reflected in the unprecedented growth in the number of fans, which has an audience of over 134 million viewers and can compete with hockey or American football of fans today (Shtanko, 2017).

At the same time, there is an increasing investments in eSports: the famous businessmen from the Forbes list, in particular Warren Buffett, Jeff Bezos, Jack Ma, Alisher Usmanov invest in eSports; its potential was estimated by the leading producers of gaming equipment and TV companies (Smolyar, 2017; Chaika, 2018). The eSports sector becomes increasingly attractive economically not only for investors: the leading players receive huge bonuses, and the opportunity to gain financial independence is growing too, and for gamers who do not have enough experience.

However, professional eSports carries certain risks and threats for the athlete. It is known the spread of information and communication technologies in the entertainment sphere entailed the disorder of the static-dynamic mode of a large part of the youth, leading to the decline of their physical and mental health and increasing the level of diseases of the locomotor system (Byshevets, 2018; Imas et al., 2018; Tretiak et al., 2020).

Therefore, the eSports industry has an urgent need for specialists in physical education and sports. A highly skilled eSports team coach is not only passionate about the game himself and is a skilled player motivated enough to achieve team success, but is also responsible for the health of the team members.

Currently, there is practically no information about the organization of the training process in eSports. Moreover, it is not established what theoretical knowledge and practical skills a highly qualified eSports specialist has to have.

The aim of the research was to determine the importance of educational disciplines in the eSports specialization of the second level of post-graduate studies and to form the content of the curriculum for them.

We planned to receive the research results by analyzing the curriculums of 6 higher educational institutions of foreign countries to identify teaching disciplines, and by means of an expert assessment of the importance of these teaching disciplines for eSports professionals: teachers, representatives of federations, coaches.

Methods

Methods used include the analysis of scientific and methodical literature, Internet resources and statistics.

Participants

Fifteen (15) experts: 9 representatives of Ukrainian eSports Federation, Ukrainian Cyber Football Association, Ukrainian Professional eSports Association, 3 eSports trainers, 3 university professors have taken part in the research, particularly in the expert survey.

Study Organization

Studies were conducted during the preparatory period of the seasons 2019-2020 using the methods described below. The special literature and Internet data analysis and synthesis was used for the theoretical study eSports problem. The analysis of educational programs of the second level of post-graduate studies of 6 institutions of higher education of foreign countries was carried out. 6 foreign eSports sites were analyzed. The analysis allowed to identify promising areas of eSports development in the educational environment.

The aim of the expertise was to determine the importance of educational disciplines in the eSports specialization of the second level of post-graduate studies for the subsequent formation of the content of the curriculum for them. The evaluation was conducted on a 5-point scale.

Method of expert evaluations was used, when experts can evaluate different disciplines with the same number of points (Kostyukevich, & Shynkaruk, 2019). The place of each subject was determined by the number of points it received: the higher the sum of points, the more significant this subject is. The consistency of the experts' opinions was checked by Kendall's concordance coefficient.

The methodology of the group expertise included: formulating the tasks, selecting and composing the group of experts, creating the expertise plan, interviewing the experts, analyzing and processing the obtained information (Kostyukevych, & Shynkaruk, 2019).

There was a selection of specialists in curriculum development at the stage of the expert group's formation. Analysis of curriculums of higher educational institutions in foreign countries allowed us to form a list of 25 educational disciplines, which were offered to the experts to determine the significance (Table 1).

Concordance of experts' opinions was checked by means of Kendall's concordance coefficient calculation under the condition of non-strict sequence of ranking according to the formula:

$$W = \frac{12\,S}{m^2\left(n^3 - n\right) - m\sum_{j}^{m}\sum_{t_j}\left(t^3_j - t_j\right)}, \quad (1)$$

where, m – number of experts; n – sample size; tj – number of identical ranks assigned to different alternatives by the j-th expert, S – sum of squares deviation from the mean, which was calculated according to the formula:

$$S = \sum_{i=1}^{n}\left(\sum_{j=1}^{m} x_{ij} - \overline{s}\right)^2, \text{ where } \overline{s} = \sum^{n}\frac{s_i}{n}, \quad s_i = \sum^{m} x_j \quad (2)$$

To verify the concordance coefficient, which describes the average level of the consistency of the experts' opinions, the relevance was checked using Pearson's consistency criteria — χ2- criteria. The necessity of such evaluation arises because we use the sampling data (not all experts are involved, but only a group of experts, that is why the obtained result can be accidental).

Table 1. Expert evaluation of the content of Masters' preparation in eSports (n=15)

№	Educational discipline	Indicators; point		
		W=0.82; $\chi^2 = 295{,}05$; p=0.0000<0.01		
		$\bar{r}$	$\bar{x}$	SD
1	Information Technologies in eSports*	21.07	4.93	0.26
2	The Fundamentals of Ergonomics in eSports*	20.03	4.80	0.41
3	Sports Law, Management and Marketing in eSports*	20.07	4.80	0.41
4	The Fundamentals of Programming, Software Design and Construction of Computer Systems *	19.50	4.73	0.46
5	The Strategy and Tactics of Professional Gaming *	20.13	4.80	0.41
6	The Theory of Computer Gaming *	20.50	4.87	0.35
7	Training and Competitions System in eSports*	20.53	4.87	0.35
8	Psychological Support of Sports Activities in eSports*	19.03	4.67	0.49
9	The Scientific Research Methodology and Analytics in eSports*	20.03	4.80	0.41
10	Control and Management System of the eSports Athletes Training	14.43	4.13	0.35
11	Functional Systems and Their Adaptation in the Sports Training Process	12.97	3.93	0.46
12	Muscle Memory and Motion Area in the Technical Training of eSports Athletes	4.00	2.67	0.49
13	Preparation and Competitions in Extreme Environmental Conditions	4.83	2.87	0.35
14	Motion Skills and Physical Training of eSports Athletes	10.13	3.60	0.51
15	Modern Research Methods in eSports	10.80	3.67	0.49
16	Information Technologies in Scientific Activities in Physical Training, Sports and eSports	10.40	3.60	0.51
17	Scientific and Methodological Support for the Athletes Training	12.53	3.87	0.52
18	Current Trends in eSports Development	11.90	3.80	0.41
19	Project Activity in eSports	4.60	2.80	0.41
20	Current Problems of Enterprises in Physical Culture, Sports and eSports	4.30	2.67	0.49
21	Management of Civil Protection and Labor Protection	3.90	2.60	0.51
22	Management of Human Resources in Physical Culture, Sports and eSports	5.23	2.93	0.26
23	Current Problems of Global Communications in eSports	14.60	4.13	0.52
24	Physiology of Physical Activity	12.30	3.87	0.35
25	Professional Activity of eSports Specialists	7.17	3.20	0.41

Note: * - academic disciplines formed the content $\bar{r}$ - average rank; $\bar{x}$ - average point; SD - standard deviation

Statistical analysis. The obtained data were processed by mathematical statistics using Statistica, MS Excel software. Expert assessment was carried out by the method of preference (Byshevets et al., 2019; Byshevets et al., 2019).

Results

The rapid development of eSports is accompanied by a number of prerequisites. One of the most important factors in the eSports promotion is the development and worldwide diffusion of technology. This led to the emergence of new, more advanced computer games, and gave the impetus to the mass youth fascination with them. It is necessary to note that eSports is a platform where Ukrainian athletes have all chances to take leading positions. Thus, the government pays great attention to eSports during recent years as a means of increasing the country's prestige in the international arena.

Due to the above, it is clear that higher education institutions in sports are able to prepare highly qualified specialists, who deeply understand the theory and methods of athletes training, according to the specifics of eSports as a social phenomenon (Figure 1).

Directing resources to e-sports specialists preparation was the higher education institutions' response to the public's appeals.

We reviewed eSports professional preparation areas in the world (Tokyo Anime School, UC Irwin, Chung-Ang University in Seoul, Robert Morris University in Chicago, and Chongqing University in Chongqing, China)), which could serve the be examples of professional education (Official website: Chongqing University, 2020; Chung-Ang University, 2020; Robert Morris University, 2020; Tokyo Anime School, 2020; University of California, Irvine, 2020; Russian Cyber Sports, 2020).

The lead higher educational institutions of Ukraine that train specialists in physical education and sports began to implement the new direction (Denisova et al., 2018, 2020).The significant role of the coach is recognized, in particular, in team-tactical games. Therefore, it is possible to extend their long-term experience in training coaches in various sports to expand the accumulated theoretical knowledge and practical skills to solve the problem of preparing highly qualified coaches in eSports. In the National University of Ukraine in Physical Education and Sports by the order from 21.05.2019 № 132 (according to the decision of the Academic Council from May 21, 2019, the protocol № 10) was approved the educational and professional program "Esports" of the second level of postgrad-

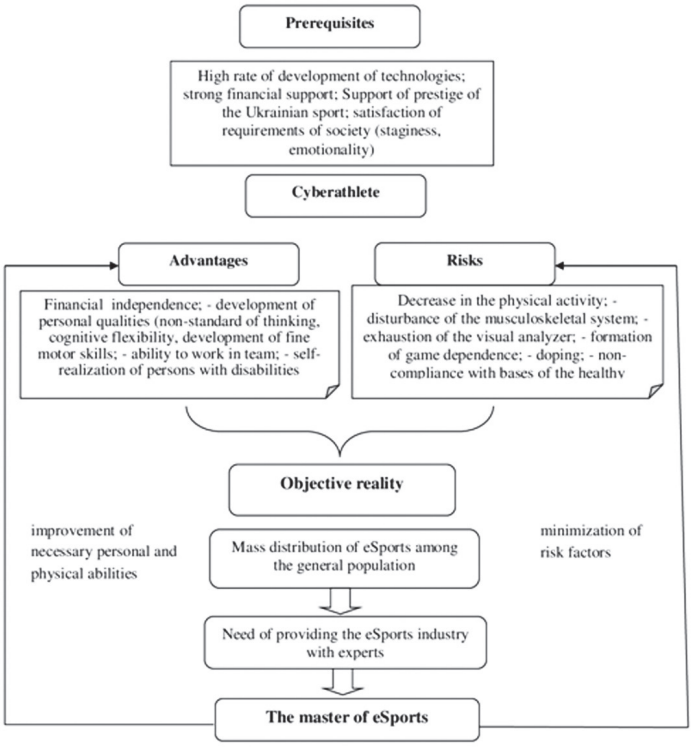

FIGURE 1. Prerequisites and consequences of the cyber industry development

uate studies for the specialty 017 "Physical Culture and Sports".

Developing the curriculum for eSports Masters, we supposed the future specialist has a positive experience as a gamer and has a passion for the game when entering the second level of postgraduate studies.

The developed curriculum includes both general (specialty cycle, specialization cycle) and elective components. The specialty cycle consists of academic disciplines, master's practice and qualification work designated by the specialty code 017 Physical Education and Sports. To determine the list of educational disciplines of the specialty cycle a survey of experts was conducted. As a result of the survey, the content of the special Master's preparation was worked out, and the competences of the specialty "eSports" were established. Development of the curriculum forming the specialization cycle was carried out by studying and analyzing the curriculums for the second level of postgraduate studies of the specialty 017 Physical Education and Sports of other Specializations, in particular, "Sports and Coaching in Olympic Sports", "Sport", "Olympic Sports and Education", etc. The expert evaluation of the importance of the proposed educational disciplines of eSports specialization is presented in Table 1.

The experts' opinion was concordant (W=0,82; p=0,0001). The major educational disciplines are "Information Technology in eSports", "Strategy and Tactics of Professional Games" and "Training and Competition System in eSports". The specialization cycle included academic disciplines, which were evaluated by the experts with more than 4 points. 5 points ("Information Technology in eSports", "Training and Competition System in eSports", " The Theory of Computer Gaming", "The Fundamentals of Programming, Software Design and Construction of Computer Systems", "The Strategy and Tactics of Professional Gaming", "Sports Law, Management and Marketing in eSports", "The Fundamentals of Ergonomics in eSports", "Psychological Support of Sports Activities in eSports" and "The Scientific Research Methodology and Analytics in eSports"). The program includes a 32-credit course in eSports specialization cycle.

The study and analysis of international and native pedagogical experience (Korobchinsky et al., 2017; Briskin et al., 2015; Korchenaya, 2017; Denisova & Shynkaruk, 2020), and also the results of the expert survey, allowed to determine the main content of the Master's preparation in eSports.

Experts have identified educational competencies for masters in e-sports (W=0,79; p=0,0001), they took into account the Guidelines for the development of profiles of degree programs (Rashkevich, 2016):

- to be aware of information support related to physical education and sport;
- to know the formation history and the development stages of eSports in the world and, in Ukraine particularly;
- to have knowledge about the laws and provisions defining the modern understanding of computer games, their variations and features, and the evolution of views on their improvement;
- to know about modern methods and technologies of predicting the eSports -competitions results;
- to be able to estimate the efficiency of eSports athletes actions;
- to understand the specifics of organizing competitions, tournaments and championships at different levels in eSports;
- to have the knowledge, organization skills, planning and direct control of the training and competitive process of eSports athletes;
- to have a clear understanding of the team building and team management aspects by resolving internal conflicts timely;
- be able to create the prerequisites for the formation of the team and the management of the team; to be able to create the prerequisites for eSports athletes to develop resistance skills against external influences;
- factors in the aspiration to achieve the goal.

Except the knowledge and skills, directly related with eS-

ports, as the specialist in physical education and sport, future highly qualified specialist in eSports has to have enough knowledge and skills to prevent risks of occupational diseases and to maintain good health of eSports athletes, namely:

- to know about potential threat which occupations by eSports have;
- to be able to provide operating and current control of the physical and psychoemotional condition, and also biogeometrical position of the working pose of eSports athletes;
- to plan and carry out measures of prevention of occupational diseases of eSports athletes;
- to develop the measures directed to health maintenance and promotion of health of eSports athletes;
- to carry out the measures directed to prevention of over fatigue and psychoemotional burning out.

Discussion

The preparation of highly qualified specialists in eSports provides the development of eSports science, and this is impossible without clarifying the conceptual framework with which the phenomenon and processes associated with the eSports industry can be unambiguously interpreted.

To ensure the eSports development in the educational environment, we identified the terms which were established, and the definition and concepts of the limits of eSports science were developed.

Analyzing the modern scientists' representation of the concept of "eSports ", we found the lack of its unambiguous interpretation. In particular, in the modern edition of the Law of Ukraine "On Physical Culture and Sports" from 16.07.2019 a definition for eSports is not provided. Usually this concept is interpreted by scientists in terms of the philosophical aspect. Thus, Briskin (2015) considers eSports to forms of socialization, as close as possible to innovation, in which the most effective methods of organizing and conducting competitions are applied. In turn, Lazneva (2018) calls eSport a phenomenon that has become one of the elements of modern digital youth culture.

However, within our study we are most interested in the interpretation of eSports in the measurement of competitive activity. By comparing eSports and the computer game, Vishnevsky (2014) indicates the main difference and proves that in eSports the computer game acts not as a venue for competition, but as a link between man and computer. As Shtanko (2017) defines it, eSports is a progressive modern and innovative method of wrestling. Khasanova (2014) sees eSports as a new sphere of economic relations at the intersection of sports, the media industry, and the Internet. According to the official definition in Russia, eSport is a type of competitive activity and special practice of preparation for competitions based on computer and/or video games, where the game provides an environment of interaction between control objects, providing a level playing field for face-to-face or team-to-team competitions.

To summarize in terms of the eSports component the following definition can be given: eSports is an innovative sport aimed at the organizing and conducting sports competitions based on computer games, where eSports athletes are professional gamers, earning through participation in tournaments (Denisova et al., 2019).

Thus, the eSports science is an innovative sphere of human activity, aimed at the development of a system of knowledge associated with the support of the eSports industry, dynamically developing in the contemporary information space.

The eSports industry is an industry of material and intellectual production, providing the eSports functioning. A highly qualified eSports specialist is an expert in the theory and technique of computer sports, who carries out the activities of team organizing, their maintenance during training and competitive activities, and takes measures to maintain and improve the health of each team member.

Highly qualified specialists in eSports will fill a virtually empty niche and will become the leader of the future victories of Ukrainian eSports athletes, as we see it.

Conclusions

There is an extreme personnel shortage in the native multicomponent eSports segment in the eSports industry: managers, broadcast organizers, psychologists and commentators. Highly qualified referees, coaches, organizers of competitions, developers of computer games remain the most demanded specialists nowadays. To be able to perform professional functions at a high level, everyone has to have a clear understanding of the game and the peculiarities of team organization, as well as have a gamer's experience.

Through a long study and analysis of best pedagogical practices, as well as through our own research, it has been established that a highly qualified specialist in eSports has to have the appropriate theoretical knowledge, practical skills and abilities. In addition, in fact, the ability to organize the team and provide the training process, a highly qualified specialist in eSports has to know about the ways to increase the longevity of athletes creative and sports activities, as well as to plan and implement measures for the prevention of occupational diseases.

A conceptual framework is defined to ensure the development of eSports science. The eSports is defined as an innovative sport aimed at organizing and conducting sports competitions based on computer games, and a highly qualified eSports specialist is an expert in the theory and technique of computer sports who carries out activities to organize eSports teams, their maintenance during training and competitive activities, and takes measures to preserve and enhance the health of each team member.

The professional educational program of the higher educational level for the specialty 017 "Physical Education and Sports", specialization "eSports" was developed. Based on the methodology of expert evaluations the content of education and the list of academic disciplines for students of the second level of postgraduate studies (master's degree) were determined and the list of components of the educational program was developed. High concordance of experts' opinions (W=0,82; p=0.00) allowed to implement the proposed disciplines of eSports specialization in the educational process.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Identification of Informative Physical Condition Indicators for Self-Training Exercise Programs Design for Middle-Aged Overweight and Obese Women

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Abstract

The objective of this study was to identify informative anthropometric and functional indicators for designing self-training exercise programs for middle-aged obese women. The study involved 105 women with an average age of 38.9 and was conducted at the Scientific Research Institute of NUPESU. The physical fitness profile of the middle-aged overweight and obese women was assessed by use of factor analysis. The dominant factor was the anthropometric status (42.1% of the total variance) and included 14 indicators. The second factor (21.2% of the total variance) included ten indicators characterising functional state of the cardiorespiratory system. The third and fourth factors (18.1% of the total variance) included eight indicators characterising physical fitness and coordination abilities. Five indicators were selected based on the factor analysis: waist circumference, abdominal circumference, waist to hip circumference ratio, adaptation potential, and VO_2max. Correlation analysis performed to verify the informative value of the selected markers showed that the waist circumference significantly correlated with 28 studied indicators; the abdominal circumference correlated with 29 indicators; the waist to hip circumference ratio correlated with 24 indicators of physical condition; the adaptation potential correlated with 24 indicators; and VO_2max significantly correlated with 18 indicators. Informative markers selected based on the factor and correlation analyses can be used for designing and assessing the effectiveness of physical exercise programs for middle-aged overweight and obese women.

Keywords: *exercise, overweight, obesity, physical conditions, middle-aged women*

Introduction

There is a growing interest in self-dependent physical exercise among middle-aged women due to body weight gain and the tangible consequences of age-related involution processes (Mazur, 2020). It has been found that body weight gain in women over 35 years of age is caused by a decrease in physical activity (Nagornaya, & Andreeva, 2018). The age of 46-55 is characterised by significant hormonal changes in a woman's body, which along with a decrease in general morpho-functional status often lead to a disruption of adaptive processes and a steady deterioration of health condition (Garmash, 2017). After the age of 45, there is a significant deterioration in

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physical performance, motor skills, dynamic balance, lumbar spine mobility, etc. Each subsequent five years of life are characterised by an increase in the number of people with stress and disruption of cardiovascular adaptation (Ruiz-Montero, & Castillo-Rodríguez, 2016).

Researchers have noted that excessive physical exercise without appropriate monitoring can bring about a negative effect (Galan et al., 2020; Kashuba et al., 2020; Quindry, Williamson-Reisdorph, & French, 2020). This is the main risk when it comes to organizing self-training exercise among the population. It is known that the optimal effect of physical exercise can be achieved only when the focus, intensity, volume, and frequency of physical activity are selected individually, taking into account the level of the trainee's physical condition. In this regard, it is of paramount importance to use correct methods for assessing, monitoring, and self-monitoring of physical development and health status when designing self-training health-improving activities for middle-aged women targeted to manage body weight (Lazareva, Aravitska, Andrieieva, Galan, & Dotsyuk, 2017). Thus, it is relevant to determine informative criteria that can be used to assess the effectiveness of exercise programs for middle-aged obese women.

The objective of this study was to identify informative anthropometric and functional indicators for designing self-training exercise programs for middle-aged overweight and obese women.

Methods

The study was conducted in the National University of Ukraine on Physical Education and Sport (Kyiv, Ukraine). Ethical approval was obtained from the Ethics Commission of the NUUPES (No. 2 on 16.12.2020). Participants of the study were informed about the objectives, methods, and procedures of the study and their written informed consent was obtained.

Inclusion criteria for the women were as follows: women between the ages of 25 and 45, overweight and obese (the Body Mass Index (BMI) from 25.00 to 32.10 kg/m^2), received medical clearance to participate, and provided informed consent. Exclusion criteria were diagnosis of type I diabetes mellitus and/or hypertension; decompensated state at the beginning of the study; taking weight-loss, antihypertensive or insulin-resistance drugs; pregnancy; inflammatory disease in the acute phase. At the beginning of the study, women were inactive and led a sedentary lifestyle.

Anthropometric methods that ensured quantitative measurement of physical development indicators were used in compliance with international standards. Body Mass Index (BMI) was calculated by the formula: BMI=Body weight (kg) / Body height (m)2. The waist-to-height ratio (WHtR) was calculated by the formula: WHTR=Waist circumference (cm) / Body height (cm). The waist-to-hip ratio (WHR) was calculated by the formula: WHR=Waist circumference (cm) / Hip circumference (cm). Body composition was assessed using a body composition analyzer Tanita (Tanita Europe GmbH, Japan). To assess the cardiorespiratory system, physiological methods were used. Measurements were performed using a digital blood pressure and heart rate monitor UA 767 (AND, Japan). Heart rate (HR) was assessed using Polar RS800G3 (Finland) and Garmin Forerunner 305 heart rate monitors. Oxygen saturation was measured using a Beurer PO 80 pulse oximeter (Germany). To assess the level of physical fitness and to determine maximum oxygen uptake (VO_2max), aerobic and anaerobic thresholds, a cardiorespiratory test (Hanson, 1984) was performed on a treadmill LE-200 CE (Jaeger, Germany). During the cardiorespiratory exercise test, the following conditions were applied: for women with BMI≤30 kg/m-^{2}, initial speed and incline were 5 km/h and 0%, speed and incline were increased by 1 km/h and 0.5%, respectively, and after reaching the speed of 20 km/h, only incline were increased; for women with BMI≥30 kgm-^{2}, initial speed and incline were 4 km/h and 0%, incline were increased by 1%. The adaptation potential (AP) of the cardiovascular system was calculated using the Bayevsky's method (Bayevsky, Berseniyeva, & Paleyev, 2001) by the formula:

AP=0.011×HR+0.014×BPsyst+0.008×BPdiast+0.009×Body weight(kg)+0.0014×age(years)-0.009×Body height (cm)-0.27.

The index of physical condition (IPC) of the body was calculated by the Pirogova (1989) as follows:

IPC = (700-3×HR-2.5×BPav-2.7×age+0.28×Body weight)/(350-2.6×age+0.21×Body height)

The Oxycon Pro Ergospirometry System (USA) was used to determine the lung vital capacity (VC). Physical fitness testing included performing several motor tests from the Eurofit battery (Adam, 1988). The results of the study were analysed using conventional tools of Statistica 10.0 statistical software (StatSoft, Inc., USA). The statistical analysis of experimental data was started with the verification of the assumption of normality using the Shapiro-Wilk test. Factor analysis was used in the study as an independent research method. To measure the strength of the relationships between normally distributed variables, correlation analysis was used. Since the analysis of correlation fields showed the presence of linear relationship, we used the Pearson correlation coefficient.

Results

To identify the major factors, which determine the structure of physical condition in middle-aged obese women, and to select the most informative criteria for designing self-training exercise programs, we used factor analysis (Table 1). Calculations yielded a four-factor structure, which explains 81.4% of the variance of the initial data.

Factor I contributed 42.1% to the total sample variance and identified 14 indicators of physique. With direct weighting factors, the following indicators were included: inspiratory chest circumference (CC) (r=0.875 at p<0.01), expiratory CC (r=0.848 at p<0.01), muscle mass percentage (r=0.777 at p<0.01), chest excursion (r=0.768 at p<0.01), and basal metabolic rate (r=0.711 at p<0.01). Using inverse weighting factors, the following indicators were included: abdomen circumference (r=-0.927 at p<0.01), waist circumference (r=-0.926 at p<0.01), WHR (r=-0.922 at p<0.01), CC (r=0.893 at p<0.01), WHtR (r=-0.884 at p<0.01), BW (r=-0.820 at p<0.01), BMI (r=-0.807 at p<0.01), and hip circumference (r=-0.732 at p<0.01). The second factor contributed 21.2% to the total sample variance and identified ten indicators of the energy potential of aerobic function and functional state. Factor II revealed a statistically significant direct correlation with maximum oxygen uptake (VO_2max) (r=0.945 at p<0.01), vital capacity (VC) (r=0.791 at p<0.01), vital capacity-to-body weight ratio (r=0.715 at p<0.01), and index of physical condition (IPC) (r=0.714 at p<0.01). With inverse weighting factors, factor II included adaptive potential (AP) (r=-0.936 at p<0.01), HR recovery time after 20 squats (r=-0.837 at p<0.01), Robin-

Table 1. Factor loading matrix of physical condition variables of middle-aged obese women (n=105)

Parameter	F I	F II	F III	F IV
Body height, cm	0.111	-0.594	-0.038	0.027
Body weight, kg	**-0.820**	-0.186	-0.032	-0.116
BMI, kg·m^{-2}	**-0.807**	-0.228	-0.019	-0.043
CC, cm	**-0.893**	0.159	0.234	-0.106
Inspiratory CC, cm	**0.875**	0.095	0.210	-0.112
Expiratory CC, cm	**0.848**	0.180	0.201	-0.136
Chest excursion, cm	**0.768**	0.127	0.102	0.045
Waist circumference, cm	**-0.926**	-0.095	-0.073	-0.075
Abdomen circumference, cm	**-0.927**	-0.167	-0.296	-0.181
Hip circumference, cm	**-0.732**	-0.131	-0.299	-0.161
Waist-to-hip ratio (WHR), arb. units	**-0.922**	0.236	0.311	-0.012
The waist-to-height ratio (WHtR), arb. units	**-0.884**	-0.308	-0.090	-0.069
Grip strength (dominant hand), kg	-0.090	0.431	**-0.795**	0.435
Grip strength (non-dominant hand), kg	-0.032	0.384	**-0.782**	0.509
Fat mass, kg	-0.457	-0.321	-0.021	-0.116
Fat mass, %	**-0.800**	0.131	0.077	-0.007
Muscle mass, kg	0.178	0.324	0.369	0.019
Muscle mass, %	**0.777**	-0.189	-0.075	-0.091
Basal metabolic rate, kcal	**0.711**	-0.369	-0.037	0.097
Heart rate, bpm	0.286	**-0.812**	-0.164	0.003
BPsyst, mmHg	0.416	**-0.824**	0.087	0.495
BPdiast, mmHg	0.263	**-0.806**	-0.014	0.189
AP, arb. units	0.651	**-0.936**	-0.004	0.345
VC, mL	0.106	**0.791**	0.219	0.227
VO_2max, mL·kg·min^{-1}	0.339	**0.945**	0.110	0.544
Bayevsky's stress index, arb. units	-0.452	**-0.820**	-0.087	-0.107
Oxygen saturation, %	0.226	0.202	0.041	0.350
IPC, arb. units	0.213	**0.714**	0.107	0.136
Robinson index, arb. units	-0.413	**-0.832**	-0.081	0.242
Vital capacity-to-body weight ratio, mL·kg^{-1}	0.526	**0.715**	0.150	0.276
Strength index, arb. units	0.446	0.484	**0.785**	0.331
HR recovery time after 20 squats in 30 s, min	-0.121	**-0.837**	-0.213	-0.230
Sit and reach flexibility test, cm	0.218	0.082	0.412	0.367
Sit-up test for 30 s, number of reps	0.277	0.053	**0.771**	0.407
Static strength of the back muscles, s	0.239	0.032	**0.770**	0.463
Shuttle run test 10x5 m, s	-0.307	-0.160	**-0.798**	-0.540
Sharpened Romberg test, s	0.423	0.229	0.315	**0.777**
Flamingo test, number of reps	0.374	0.189	0.425	**0.741**
Total variance	**14.9**	**7.4**	**3.7**	**3.2**
D (F). %	**42.1**	**21.2**	**9.8**	**8.3**

Legend: FI-FIV – are the major factors, which determine the structure of physical condition in middle-aged obese women. Factor I is associated with physique; Factor II – with energy potential of aerobic function and functional state; Factor III – with endurance and strength; and Factor IV – with coordination abilities.

son index (r=-0.832 at p<0.01), systolic blood pressure (BP) (r=-0.824 at p<0.01), Bayevsky stress index (SI) (r=-0.820 at p<0.01), resting HR (r=-0.812 at p<0.01), and diastolic BP (r=-0.806 at p<0.01). Factor III contributed 9.8% to the total sample variance and identified six indicators of endurance and strength. The structure of this factor is based on indicators

with high inverse correlations: 10×5m shuttle run test (r=-0.798 at p<0.01), grip strength (dominant hand) (r=-0.795 at p<0.01), and grip strength (nondominant hand) (r=-0.782 at p<0.01). Direct correlations with this factor included strength index (SI) (r=0.785 at p<0.01), sit-up test for 30 s (r=0.771 at p<0.01), and static strength of the back muscles (r=0.770 at p<0.01). Factor IV with a contribution of 8.3% to the total sample variance is based on indicators characterizing coordination abilities and has a statistically significant direct correlation with sharpened Romberg test (r=0.777 at p<0.01) and Flamingo test (r=0.741 at p<0.01).

Based on the use of multidimensional statistics, we found indicators that determine the physical fitness in middle-aged obese women: physique, aerobic performance, physical condition (endurance and strength), and coordination abilities. These results are consistent with the point of view that there is no single integral parameter that characterises the overall physical condition of an individual. We found that indicators of physique play an important role in the physical condition of middle-aged women (factor I). An anthropometric study is the most comprehensible method that allows evaluation of physique and identification of parameters that need correction. In comparison with other data, the group of variables characterizing the total body dimensions is distinguished by a large factorial weight that exceeds the value of all other indicators.

Furthermore, factor I indicators, such as VO_2max, AP, and recovery time after a dynamic load, have a significant factor load. This indicates the key role of these anthropometric and physiological variables for the structure of physical condition of obese women. The correlation structure of the selected indicators with the main components of physical condition was established to determine the effectiveness markers for health fitness program. The correlation coefficients between the selected indicators and factor I indicators are shown in Table 2. The correlation analysis indicated a clear direct relationship between the circumferences of the waist and abdomen, waist-to-hip ratio, and AP and almost all the physique indicators and body composition. Waist circumference has high direct correlations with BM, BMI, CC, inspiratory CC, expiratory CC, abdomen circumference, hip circumference, all body composition indicators, and basal metabolism. Correlation coefficients ranged from r=0.455 at p<0.001 to r=0.852 at p<0.001. A high inverse correlation was observed only for muscle mass percentage. Waist circumference did not correlate with body height (BH) or chest excursion. Similar high correlations were observed between the abdomen circumference and the indicators that are included in factor I. Both abdomen and waist circumferences have no correlation with BH or chest excursion. WHR has high and medium correlations with most indicators of physique and body composition.

Table 2. Correlation between the markers of physical condition and factor I indicators

Indicators of the factor I that characterise physical development	1	2	3	4	5
Body height, cm	0.161	0.099	-0.100	**0.321*****	-0.096
Body weight, kg	**0.811*****	**0.723*****	**0.371*****	**0.585*****	**-0.437*****
BMI, kg·m^{-2}	**0.724*****	**0.688*****	**0.436*****	**0.357*****	**-0.361*****
CC, cm	**0.818*****	**0.726*****	**0.625*****	**0.385*****	-0.177
Inspiratory CC, cm	**0.816*****	**0.715*****	**0.610*****	**0.397*****	-0.194
Expiratory CC, cm	**0.768*****	**0.688*****	**0.596*****	**0.353*****	**-0.207*****
Chest excursion, cm	0.013	-0.028	-0.048	0.061	0.063
Waist circumference, cm	**1.000**	**0.852*****	**0.792*****	**0.545*****	**-0.282****
Abdomen circumference, cm	**0.852*****	**1.000**	**0.533*****	**0.501*****	**-0.337*****
Hip circumference, cm	**0.622*****	**0.728*****	**0.217***	**0.511*****	**-0.281****
Fat mass, kg	**0.443*****	**0.401*****	**0.226***	**0.466*****	-0.136
Fat mass, %	**0.656*****	**0.691*****	**0.367*****	**0.412*****	**-0.239***
Muscle mass, kg	**0.489*****	**0.356*****	**0.257****	**0.379*****	**-0.211***
Muscle mass, %	**-0.630*****	**-0.696*****	**-0.380*****	**-0.418*****	0.089
Basal metabolic rate, kcal	**0.455*****	**0.331*****	**0.274****	**0.466*****	-0.184

Legend: 1 – waist circumference, cm; 2 – abdomen circumference, cm; 3 –WHR, arb. units; 4 – AP, arb. units; 5 – VO_2max, mL·kg·min^{-1}. n=105; rcr=0.195; r=-0.207 at p<0.05; r=0.257 at p<0.01; r=0.321 at p<0.001. * – correlation coefficient is statistically significant at the p<0.05 level; ** – correlation coefficient is statistically significant at the p<0.05 level; *** – correlation coefficient is statistically significant at the p<0.001 level.

AP values in middle-aged women were also reliably correlated with almost all indicators that were included in factor I. AP is an integral estimate indicator that considers six indicators: three of them characterise the cardiovascular system and the rest take into account anthropometric data and age. This indicator enables the evaluation of individual's adaptive responses. AP had no correlation with chest excursion. AP had an inverse relationship with muscle mass percentage. The correlation coefficients between AP and BM, BMI, CC, inspiratory CC, expiratory CC, abdomen circumference, hip circumference, all body composition indicators, and basal metabolism ranged from r=0.327 at p<0.001 to r=0.585 at p<0.001. This can be explained by the fact that the AP level depends on the parameters of physique and body composition. VO_2max is another indicator that was selected as an effectiveness marker. This indicator had high and medium inverse correlations with BM, BMI, abdomen circumference, fat mass percentage, waist circumference, and hip circumference with correlation coefficients ranged from r=-0.281 at p<0.01 to r=-0.437 at p<0.001. Overweight and abdomi-

nal obesity adversely affect aerobic performance. There were several correlations between the indicators included in factor II that reflect the state of functional systems and indicators selected as effectiveness markers (Table 3); the correlations were mainly between directly measured indicators and indicators derived from them.

Table 3. Correlation between the markers of physical condition and factor II indicators

Indicators of the factor II that characterize functional state and aerobic performance of the body	1	2	3	4	5
BP_{syst}, mmHg	**0.483*** **	**0.403*** **	**0.201***	**0.892*** **	**-0.363*** **
BP_{diast}, mm Hg	**0.246***	**0.213***	**0.310*** **	**0.641*** **	**-0.341*** **
Heart rate, bpm	**0.231***	**0.234***	**0.203***	**0.683*** **	**-0.214***
VC, mL	**-0.203***	-0.166	**-0.422*** **	0.134	**0.229***
HR recovery time after 20 squats in 30 s, min	**0.210***	**0.242***	0.139	**0.299***	**-0.453*** **
Oxygen saturation, %	-0.130	**-0.211***	0.094	-0.075	0.156
Vital capacity-to-body weight ratio, $mL \cdot kg^{-1}$	**-0.629*** **	**-0.552*** **	**-0.546*** **	**-0.238***	0.052
IPC, arb. units	**-0.384*** **	**-0.332*** **	-0.115	**-0.902*** **	**0.282*** *
Robinson index, arb. units	**-0.402*** **	**-0.365*** **	-0.045	**0.900*** **	-0.187
Bayevsky stress index, arb. units	**0.244***	**0.283*** *	0.087	**0.343*** **	-0.100
AP, arb. units	0.645***	0.567***	0.261**	1.000	-0.219*

Legend: 1 – waist circumference, cm; 2 – abdomen circumference, cm; 3 –WHR, arb. units; 4 – AP, arb. units; 5 – VO_2max, $mL \cdot kg \cdot min^{-1}$. n=105; r_{cr}=0.195; r=0.201 at p<0.05; r=0.261 at p<0.01; r=-0.332 at p<0.001. * – correlation coefficient is statistically significant at the p<0.05 level; ** – correlation coefficient is statistically significant at the p<0.05 level; *** – correlation coefficient is statistically significant at the p<0.001 level.

Waist and abdomen circumferences directly associated with systolic and diastolic BP, resting HR, HR recovery time after 20 squats in 30 s, stress index, and AP. Overall, the absolute values of the above indicators immediately increased with an increase in the circumference body dimensions, which adversely affect the cardiovascular system. Reverse correlations were observed between waist circumference, VC, vital capacity-to-body weight ratio, IPC, and Robinson's index. Correlation coefficients ranged from r=-0.203 at p<0.05 to r=-0.629 at p<0.001. Similar inverse correlations were observed between abdomen circumference and oxygen saturation, vital capacity-to-body weight ratio, IPC, and Robinson's index. In women aged 36-45, the indicators characterizing the external respiration system, the oxygen transport system, and adaptation potential of the body significantly decreased with an increase in waist and abdomen circumferences. WHR had a much lower correlation with the indicators that were included in factor II. High inverse correlations were observed with VC and vital capacity-to-body weight ratio at the levels of r=-0.422 at p<0.001 and r=-0.546 at p<0.001, respectively.

The direct dependence of WHR on systolic and diastolic BP, resting HR, and AP indicated a negative effect of obesity on cardiovascular fitness. It is known that the risk of developing high BP in obese people is three times higher than in people with a normal body weight. According to the INTERSALT study, there is an increase in systolic BP by 4.5 mm Hg for every 4.5 kg of weight gain.

The VO_2max showed high inverse correlations with the indicators for resting condition, namely, systolic BP at r=-0.363 at p<0.001, diastolic BP at r=-0.341 at p<0.001, and HR recovery time after 20 squats within 30 s at r=-0.453 at p<0.001. There was also an inverse correlation with resting HR and AP. The VO_2max in middle-aged obese women directly depended upon VC and IPC. VO_2max depends primarily on the capabilities of the cardiorespiratory system. Our findings are consistent with the scientific statement from the American Heart Association recommending that cardiorespiratory fitness, quantifiable as VO_2max, be regularly assessed and used as a clinical vital sign. The coeffi-

Table 4. Correlation between the markers of physical condition and factors III and IV indicators

Indicators of the factors III and IV that characterize physical fitness	1	2	3	4	5
Static strength of the back muscles, s	-0.225*	-0.327***	-0.072	-0.147	0.768***
Sit-up test for 30 s, number of reps	-0.283**	-0.325***	-0.227*	-0.124	0.523***
Grip strength (dominant hand), kg	-0.010	-0.298*	-0.249*	-0.106	-0.064
Grip strength (non-dominant hand), kg	0.083	-0.388***	-0.157	-0.005	-0.056
Strength index, arb. units	-0.449***	-0.131	-0.364***	-0.455***	0.107
Shuttle run test 10x5 m, s	-0.285**	-0.322***	0.096	0.222*	-0.872***
Sharpened Romberg test, s	-0.390***	-0.286**	-0.249*	-0.091	0.152
Flamingo test, number of reps	0.355***	0.229*	0.233*	0.109	-0.088

Legend: 1 – waist circumference, cm; 2 – abdomen circumference, cm; 3 –WHR, arb. units; 4 – AP, arb. units; 5 – VO_2max, $mL \cdot kg \cdot min^{-1}$. n=105; r_{cr}=0.195; r=0.222 at p<0.05; r=0.283 at p<0.01; r=-0.322 at p<0.001. * – correlation coefficient is statistically significant at the p<0.05 level; ** – correlation coefficient is statistically significant at the p<0.05 level; *** – correlation coefficient is statistically significant at the p<0.001 level

cients of correlation of the selected markers with the indicators included in factors III and IV are shown in Table 4. There was a small number of significant correlations between the indicators characterizing physical fitness and selected indicators.

The static strength of back muscles and the strength of abdominal muscles in middle-aged women directly correlated with VO_2max and inversely correlated with waist and abdomen circumferences. This can be explained by the fact that overweight leads to a decrease in both static and dynamic endurance. The results of the grip strength test for dominant and non-dominant hands had an inverse correlation with abdomen circumference, indicating that overweight and obesity are the main factors that reduce muscle strength. The results of shuttle run test showed inverse correlations with the waist and abdomen circumferences, and VO_2max and a direct correlation with AP. Coordination abilities also significantly depended on waist and abdomen circumferences and WHR. These findings suggest that overweight and obesity lead to inaccuracy in movements and adversely affect the functions of balance and static endurance. The results of the correlation analysis indicated that the overwhelming majority of indicators of physical condition and coordination abilities depend on the waist and abdomen circumference and VO_2max. The absence of correlations with AP can be explained by the fact that this is an estimate indicator, which is inappropriate to use as an efficiency criterion when analysing physical condition.

Discussion

Body weight is an important indicator of a person's physical health (World Health Organization, 2016; Wiklund, 2016). Overweight causes an increased risk of disease (Van Gaal, & Maggioni, 2014; Sairenchi, Iso, Yamagishi, & Irie, 2017). It was reported that BMI does not always provide comprehensive information on the risk of morbidity associated with excess weight (Moroz, 2011, Runenko, Razina, Shelekhova, & Mushkabarov, 2018). It does not reflect the individual characteristics of body composition, the changes in which often precede the increase in total weight and have a negative impact on the cardiorespiratory performance of a person (Lamarche, Notley, Poirier, & Kenny, 2017). Statistics indicate that women are more prone to being overweight: overweight is 1.7 times more common among women than among men (Nagorna & Andrieieva, 2018). Several studies have highlighted the particular dangers of being overweight to women's health (Peeters, Dobson, Deeg, & Brown, 2013; Maslyak, 2015). The issue of designing preventive and health-improving exercise programs for adults, including middle-aged women has been widely discussed in scientific literature (Moroz, 2011) along with the issue of overweight (Bilyak, 2012; Nagorna, 2018; Drapkina, Kupreyshvili, & Fomin, 2017). However, the issue of managing overweight in middle-aged women remains insufficiently substantiated (Erakova, 2017; Neto, de Walsh, & Bertoncello, 2020). Recommendations on the type and optimal modes of exercise training that has been developed to normalize body weight are mainly imperfect and fragmentary (Beqa, Elezi, & Elezi, 2019; Chen, Ismail, & Al-Safie, 2016; Drozdovska, Andrieieva, Yarmak, & Blagii, 2020). There is a lack of substantiated criteria for the effectiveness of health-improving programs for this population. Increased attention to the dosage of exercise for overweight people is associated with the predominant use of self-training exercise, which lack consistent monitoring from a trainer or physician (Drozdovska et al., 2020). Therefore, the opportunities of applying self-training exercise should be based on precise recommendations for assessing both the physical condition and the parameters of training loads. In this study, we have identified the most significant factors in the structure of the physical condition of overweight women. The factor structure of the physical condition of people of different age groups has been investigated by many authors (Andrieieva et al., 2020; Galan, Andrieieva, Yarmak, & Shestobuz, 2019). The effectiveness of this approach has been reported in a number of studies (Ostojic et al., 2011; Gurieieva & Klopov, 2014; Yarmak et al., 2019). We confirmed the previously reported data (Güler, Yüksek, & Göksu, 2020; Paliichuk et al., 2018) on the relationship between overweight and the functional state of the body. The tolerance of the cardiovascular system to exercise loads depends on the fat mass even more than on the value of BMI (Moroz, 2012). In persons with abnormal morphological status, it does not exceed 65% of VO_2max (Belyak, 2012). Our findings confirm the data on the significance of the VO_2max in the structure of women's physical condition (Justine, Ishak, & Manaf, 2018). The validity of this conclusion is also confirmed by the results of earlier studies (Peeters et al., 2013).

Our study extended previous findings on the relationship between the parameters of body weight and the indicators of physical health in women, as well as on the multifactorial etiology of body weight disorders that necessitate the use of comprehensive health-improving programs for its correction. We also confirmed high informativeness of morphological parameters for predicting disease risk. This study extended our knowledge on the relationships between the physique and physical fitness of overweight women and substantiate the appropriateness of the use of exercise training in programs for preventing overweight (Andrieieva et al., 2019; Kashuba et al., 2019). We demonstrated the appropriateness of using the identified markers for designing health-improving programs for middle-aged women. It was demonstrated that proper monitoring over the identified markers of physical condition in the course of exercise training can increase the safety and effectiveness of health-improving activities.

Conclusion

Informative markers selected in this study based on the factor and correlation analyses can be used for designing and assessing the effectiveness of physical exercise programs for middle-aged overweight and obese women.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Technology for Improving the Technical Skills of Skilled Long Jumpers

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Abstract

The improvement of technical skills is closely associated with a focus on the informative biomechanical indices upon which the achievement of high sports results in the long jump depends: speed of run-up before take-off, kinetic energy at the moment of foot placing on the support for take-off; speed of the body general center of mass "departure" at the moment of leaving the support; total energy at the moment of foot placing on the support for take-off; duration of take-off phase; kinetic energy at the moment of leaving the support; total energy at the moment of leaving the support; maximum height of the body general center of mass during flight; height of the body general center of mass during foot placing on the support for take-off; angle of the body general center of mass departure; length of the third stride before take-off; take-off power. The majority of participating experts (n=30) consider the most rational to be the performance of various athletic exercises, which in their structure and manifestation of motor qualities are as close as possible to long jumps and allow to influence certain informative biomechanical indices: long jumps with different run-up distance: from short (eight running strides) and medium (10–14 running strides) to full and increased (from 16 to 24 running strides) (W=0.741, p<0.01). The efficiency of the process of improving technical skills depends on the dominance of particular sensory system indices. Among athletes (n=33) specialized in long jump, the key sensory system is visual in 42.42%, audio - in 27.27%, kinesthetic – in 18.18%. The same indices of visual and kinesthetic perception of information are observed in 12.12% of athletes.

Keywords: *long jump, technical skills, technique, sensory system, biomechanical index*

Introduction

Improvement of athletes' technical skills represents an important constituent of the athlete preparation system (Bobrovnik & Kozlova, 2010). There are different definitions of the term technical skills. Under technical skills, the improved possession of the most rational biomechanical structures during focusing on a maximum in the conditions of aggravated sports competition is understood (Dyachkov, 1972). Technical skills are considered as the art of performing a system of movements by an athlete, which corresponds to the specific features of a particular sports event and is aimed at the realization of motor capacities ensuring the achievement of high sports results (Platonov, 2015). The process of improving the athletes' technical skills is closely associated with competitive activity specifics. Long jumps are referred to speed-strength, complex coordinated track and field events. Studying the problem of improving the athletes' technical skills, we proceeded from the general provisions concerning the training process management (Wang & Kozlova, 2019), which applies to all components of the subsystem of an integral system, including technical skills. In the scientific and methodological literature dealing with this scientific problem, the issues of determining the technique biomechanical characteristics that affect the achievement of high sports results, especially by highly skilled athletes have been widely highlighted (Brüggemann, Koszewski, & Müller, 1999; Mendoza & Nicoford, 2011). Not

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least important is the study of the regularities of movement construction by athletes of I, II categories, and candidates master of sports (CMS) being at the stage of specialized basic training. The process of improving technical skills necessitates the knowledge of both the biomechanical structure and the mechanism of management and regulation, which provides a high and sustainable result of the means of pedagogical influence and psychological aspects of management. Thanks to the introduction into sports practice of up-to-date achievements of science, complex high-frequency equipment capable of recording all the necessary motion parameters, compact measuring systems, the technology of the process for improving technical skills is being changed today, which requires further research.

The objective of the studies: Improving technical skills of skilled long jumpers on the basis of determining the informative biomechanical characteristics of competitive exercise execution technique, substantiation of training means, and approaches to the improvement of movements.

Methods

The following methods were used to achieve the objective of the study: analysis of scientific and methodological literature and the Internet resources; biomechanical video computer analysis; expert evaluation; testing (identification of the key sensory system); methods of mathematical statistics.

The technology of biomechanical video computer analysis included two main stages: video camera shooting (GoPro HERO4 Silver) with a frequency of 120 frames s-1 at the Kyiv Championship, in accordance with metrological requirements (Laputin, 2001); the processing of the received videograms by means of the specialized software "Dartfish" (Switzerland), Motion Analysis Tools and "BioVideo" (Kozlova, Wang, & Kozlov, 2020; Kozlova & Wang, 2020; Khmelnytska, 2001). The error in determining the time characteristics of the long jump did not exceed the duration of the interframe time interval, i.e., when shooting at a frequency of 120 frames s-1 (PAL format), this error constituted 1/120 s = 8 ms (Kozlova & Wang, 2020).

The study involved 15 male athletes, aged 18-21 years, including 4 candidate master of sports CMS, 6 athletes of the I category, and 5 athletes of the II category, who gave consent to serve as the subjects and allowed to use their personal data. The results of 60 competitive long jumps at the Championship of Kyiv were obtained, which permitted identification of the biomechanical indices influencing the achievement of high sports results in the long jump.

The relationship between the registered kinematic and energy indices with sports result in the long jump was determined by means of correlation through calculating the Pearson correlation coefficients and estimating their statistical significance according to Student t-test at the level of significance α=0,05 ($p<0,05$). The decision on the choice of the parametric method of statistics was based on the result of checking the data for compliance with the normal law of distribution according to Pearson's chi-squared test ($\chi 2$) (Kashuba et al., 2020).

To determine the means of improving technical skills the method of expert assessment was used with the participation of 30 well-known experts (China) in the preparation of skilled long jumpers working at Shanghai Minhang District Youth Sports School, East China Normal University Chengdu Sport University Chizhou University and having work experience of 5-20 years.

To improve the quality of the expert group formation, methods of formal assessment of experts' competence degree were used (Derengovsky, 2007). Data from the scientific and methodological literature (Bobrovnik & Kozlova, 2008; Popov, 2006; Hilliard, 2007) and the method of written brainstorming were used in the development of the questionnaire (Chinese) when experts were asked to send their suggestions by e-mail regarding the most efficient exercises for combined improvement of the take-off technique and development of explosive power of long jumpers. The suggestions repeated by several experts were included in the answer options. In the final version, approved by the experts, the questionnaire contained 9 possible answers. Then the method of preference (ranking) was applied, when experts evaluated athletic exercises by rank in descending order of importance (minimum rank - 1, maximum - 9 points; to assign the same ranks or leave the answer without rank were not allowed). The degree of consistency of experts' opinions was checked by calculating Kendall's concordance coefficient W followed by the assessment of its statistical significance according to the Chi-square criterion at the selected significance level α=0.05 ($p<0.05$) (Byshevets, 2018). The conclusion on the quality of expert evaluation was made depending on the degree of consistency of the experts' opinions. The concordance coefficient W was in the range from 0 (complete lack of consistency) to 1 (absolute consistency).

Mathematical processing of findings was performed using IBM SPSS Statistics software.

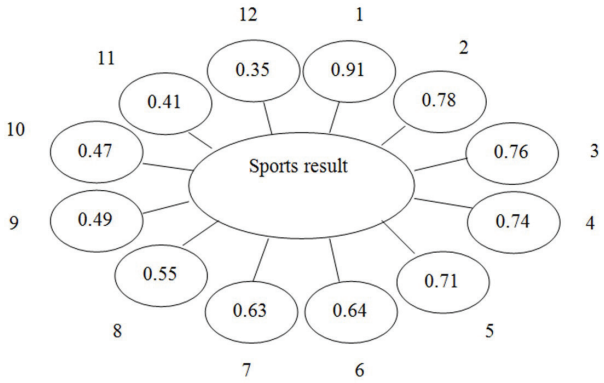
"The key human sensory system" test was used to determine the key sensory system (Karelin, 2007). The study involved 33 skilled long jumpers, among them: 26 athletes of the II category, 2 athletes of the I category, 3 masters of sports, 1 - candidate master of sports (CMS).

In accordance with the international principles of the Helsinki Declaration of the World Medical Association, the UNESCO Universal Declaration on Bioethics and Human Rights (2005), all participants in the study were informed of the content of the measurement procedures and gave their consent to participate in the and to use their personal data with consent forms signed accordingly

Results

The construction of movements is subject to biomechanical regularities, without accounting for which it is impossible to design a purposeful process of improving technical skills (Kozlova et al., 2020).

As a result of the analysis of the long jump technique of 15 skilled athletes (60 competitive trials) on the basis of correlation analysis, the technique informative indices influencing the achievement of high sports results in long jump were determined (Kozlova et al., 2020; Wang et al., 2020). There is a high correlation with the sports result in the long jump of the following parameters: run-up speed ($r = 0.91$, ($p<0.05$), kinetic energy at the moment of foot placing on the support for take-off ($r = 0.78$, ($p<0.05$), speed of the body general center of mass departure at the moment of leaving the support ($r = 0.76$, ($p<0.05$), the duration of take-off phase ($r = -0.71$, ($p<0.05$), the total energy at the moment of foot placing on the support for take-off ($r = -0.74$, ($p<0.05$) at the set criterion of significance ($r = 0.35$), as well as with other biomechanical indices shown in (Figure 1).



Legend: 1 — run-up speed before take-off, m·s⁻¹; 2 — kinetic energy at the moment of foot placing on the support for take-off, J; 3 — the speed of the body general center of mass departure at the moment of leaving the support, m·s⁻¹; 4. — total energy at the moment of foot placing on the support for take-off, J; 5 — duration of take-off phase, s; 6 — kinetic energy at the moment of leaving the support, J; 7 — total energy at the moment of leaving the support, J; 8 — maximum height of the body general center of mass during flight; 9 — the height of the body general center of mass at the moment of foot placing on the support for take-off, m; 10 — the angle of the body general center of mass departure; 11 — length of the third stride before take-off, m; 12 — take-off power, W; average sports result — 6,80 m

FIGURE 1. Correlation of informative indices of long jump technique with sports result (r=0.35)

Regularities of organizing rational biomechanical structure in long jumps in the course of sports results improvement are connected with: increase of run-up speed before take-off, take-off power, angular and amplitude characteristics in joints, angle and speed of departure, kinetic and total energy, and also with a decrease of departure time (Kozlova et al., 2020).

Revealed biomechanical indices and regularities of their change, underlie the organization of a rational biomechanical structure of long jump technique, are objective criteria for designing a training process and control over the improvement of technical skills of qualified athletes (I category, CMS).

The next important step in coaching after revealing the informative characteristics of the long jump technique is the choice of a rational composition of special means that are as close as possible to the competitive exercise in structure and manifestation of kinetic and energy characteristics. To determine such means, an expert assessment was conducted with the participation of 30 Chinese experts in the field of sports (Wang & Kozlova, 2019). Kendall's concordance coefficient constituted W = 0.741, p <0.01, which indicated the consistency of the experts' opinions.

As a result of conducted studies, most experts put in the first place the performance of long jumps from short (eight running strides), medium (10-14 running strides) to full and increased by two to four running strides (16-24 running strides) run-up, with a gradual increase in the length of the run-up to the end of the result increase (252 points) (Wang et al., 2019). The following exercise was considered not least important by experts: from four to six running strides of run-up on a bench (or another stable surface) landing on a take-off leg followed by a leap, jump on a swinging leg, step and landing on foam mats (224 points). Then the answers of experts on the importance are arranged in the following sequence:

• long jump from six to eight running strides of run-up with getting in the highest point of flight of the suspended subject by a hand homonymic to a swinging leg, with focus on performing natural running movements (205 points);

• from four-six running strides of run-up on a bench (or another stable surface) landing on a take-off leg followed by a leap, jump on a swinging leg, step, and landing on foam mats (203 points);

• forward-upward taking-off from four-eight running strides of run-up with jumping over the bar from a direct run with gradual raising the bar height or moving off the take-off place while controlling the direction of action in take-off with landing on the mat or in the sand pit (133 points);

• forward-upward taking-off from four-six running strides of run-up with jumping on a raised support (mats) gradually increasing the distance to the support (97 points);

• take-off with the opposite swing of the hands from four-six running strides of run-up with circular hand motions and touching a suspended object (basketball ring) in a flight (96 points);

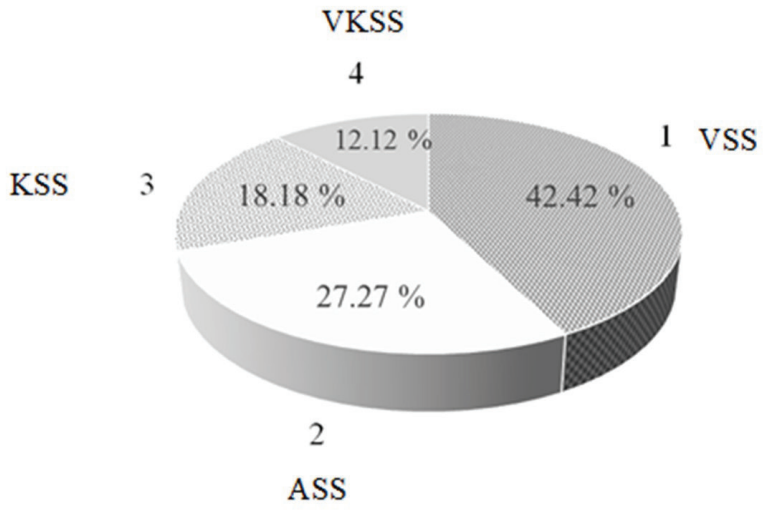
• take-off from two-three running strides of run-up with touching a suspended object in a flight (75 points);

• getting an object by leg bent in the knee joint from three-five strides of run-up with opposite hand swing (69 points) (Wang et al., 2019).

While choosing training means, there are great opportunities for the coach to use a creative approach, but before starting to select exercises, one should clearly define the task.

Guidelines are important in improving technical skills (Kozlova et al., 2020). One of the approaches is their formulation, depending on the way the athlete perceives information (Kozlova et al., 2020). The type of sensory system of athletes influences the peculiarities of perception, and hence the process of learning and improving motor actions. There are different types of real world perception: auditory (focused on the perception of information by ear), visual (predominant vision), kinesthetic (focus on tactile sensations) (Vysochina & Kozlova, 2014; Kozlova et al., 2020). It should be noted that pure types are extremely rare; it is about dominance (Bjorklund, 2010).

In order to manage the process of improving technical skills, the preferred method of perceiving the information provided to the athlete by the coach was determined. It was found that among 33 athletes specialized in the long jump the key sensory system was visual in 14 athletes (42.42%). In 9 jumpers (27.27%) who took part in the research, the indices of the auditory sensory system prevailed, whereas in 6 athletes (18.18%) – those of the kinesthetic sensory system. The same indices of visual and kinesthetic perception of information were noted in 4 athletes (12.12 %) (Figure 2).



Legend: 1 – athletes with dominance of visual sensory system indices (VSS); 2 – athletes with dominance of auditory sensory system indices (ASS); 3 – athletes with dominance of kinesthetic sensory system indices (KSS); 4 – athletes with similar indices of visual and kinesthetic sensory systems of information perception (VKSS).

FIGURE 2. The ratio of skilled long jumpers (n=33) with dominance of different sensory systems of information perception

The findings indicate the dominance of the visual sensory system in qualified athletes; most of them have the qualification of the second sports category (long jump). Of the three athletes (masters of sports), the indices of the kinesthetic sensory system dominated in one of them, whereas in the other two - the same indices of visual and kinesthetic sensory systems of information perception were noted. One may assume that the role of the kinesthetic sensory system of information perception tends to increase along with improving the qualification, however, this assumption needs further verification.

In the process of improving technical skills, athletes with the dominance of the visual sensory system of information perception, should focus mainly on visual landmarks during exercise performance (for instance, during take-off to look at a particular object, place landmarks on the track to improve the tempo-rhythmic structure of the run-up, accuracy of hitting the take-off board, etc.), watch videos, observe the technique of elite athletes, control the technique based on a video recording of the long jumps or other exercises, and after their execution to watch the video, draw diagrams of the long jump, etc. (Kozlova et al., 2020).

In jumpers with the auditory sensory system dominance, the process of improving technical skills will be most effective if the coach uses the verbal method more often, i.e., provides feedback through words, intonation, voice instructions for special exercises, individual elements, and long jump as a whole. Listening to audio recordings with eyes closed, repeating the trainer's instructions in a soft voice, using different sound landmarks to master the tempo-rhythmic structure of the run-up, sound guide (a device that allows the athlete to control the exercise time, focusing on sounds at intervals), the musical accompaniment can also be useful for athletes with a predominant perception of information by ear (Kozlova et al., 2020).

The kinesthetic sensory system dominance in long jumpers allows to focus the process of improving movements on the feeling of one's body, the feeling of interaction with the support during take-off, the sense of time, space (for instance, performing a long jump with different run-ups, on a hard, soft track, executing special exercises with a change of pace, performing exercises with closed eyes, etc.) (Kozlova et al., 2020).

Discussion

The study identified informative biomechanical indices of technique, which are objective criteria for improving the technical skills of skilled long jumpers. These indices can be used to develop prognostic biomechanical models of technique. As in highly skilled athletes, according to the data (Bobrovnik et al., 2010; Brüggemann et al., 1999; Mendoza et al., 2011), there is a high degree of correlation between run-up speed and sports result ($r = 0.91$). A high correlation between the energy characteristics of the technique and sports result has been established. However, it is not correct to compare the scientific achievements of different authors in a particular case, taking into account the application of different conditions for the fixation of necessary motion parameters and measuring systems.

The concepts of using special means in the training process of skilled athletes (Bobrovnik et al., 2008; Shiffer, 2011), which can simultaneously increase the level of speed and strength capacities and influence the improvement of long jump technique have been supplemented. They are as close as possible to long jumps and allow influencing certain informative biomechanical indices.

The visions (Vysochyna et al., 2014) of managing the process of technical skills improvement on the basis of determining the dominant sensory system of information perception have been expanded with relevant recommendations.

Conclusions

The process of improving technical skills is closely associated with a focus on the informative biomechanical indices upon which the achievement of high sports results in the long jump depends: speed of run-up before take-off, kinetic energy at the moment of foot placing on the support for take-off; the speed of the body GCM "departure" at the moment of leaving the support; total energy at the moment of foot placing on the

support for take-off; duration of take-off phase; kinetic energy at the moment of leaving the support; total energy at the moment of leaving the support; maximum height of the body GCM during flight; the height of the body GCM during foot placing on the support for take-off; angle of the body GCM departure; length of the third stride before take-off; take-off power.

2. The process of improving technical skills is aimed at the use of various track and field exercises, which in their structure and the manifestation of motor abilities are as close as possible to long jumps and allow to influence certain informative biomechanical indices. Most experts (n=30) consider it the most rational to perform long jumps from different run-ups: from short (eight running strides) and medium (10-14 running strides) to full and increased (from 16 to 24 running strides) ($W = 0.741$, $p < 0.01$).

3. Among 33 long jumpers the visual, auditory, and kinesthetic systems were the key sensory systems in 42.42%, 27.27%, and 18.18% of athletes, respectively. The same indices of visual and kinesthetic information perception were noted in 12.12% of athletes. The efficiency of the process of technical skills improvement depends on the dominance of indices of a certain sensory system.

4. Athletes with visual sensory system dominance of information perception should focus preferentially on visual landmarks during exercise performance. In long jumpers with auditory sensory system dominance, the most efficient feedback between the coach and the athlete is through words and intonation. Kinesthetic sensory system dominance allows to focus the process of motion improvement on the feeling of one's body, that of interaction with the support during take-off, the sense of time, space.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Changes in Physical Status of Young Women in Response to Exercise Training

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Abstract

Fitness-related benefits result in essential changes in physical fitness level in young women. This study was conducted with fitness centre clients (35 women with an average age of 26.4±2.2 years). The results of the experiment made it possible to evaluate the short-term response of the body to the training loads of different intensities in different blocks of the training session. The following six main blocks were distinguished in the structure of the exercise sessions including: aerobic, dance, variable, corrective, warm-up, and relaxation; and two additional ones. The aerobic and dance blocks were characterized by the highest intensity: HRav was 75.6±1.71% of HRmax, VO2 was 63.5±1.64% of VO2max, and energy expenditure (EE) was ranged from 465.28 to 524.36 kcal/hour. The relaxation block had the lowest intensity: HR was 57.31±0.56% of HRmax, VO2 was 34.2±6.25% of VO2max, and EE was of 252.6±49.24 kcal/h. We found that the percentage contribution of fats to energy production was higher in the warm-up (78.24%), relaxation (68.93%), and corrective (42.65%) blocks. The largest percentage of CHO utilization for energy metabolism was found in additional (92.8%), variable (91.82%), and dance (86.54%) blocks. The data obtained allowed to experimentally substantiate and methodologically structure a number of fitness means used in exercise sessions, by dividing them into specialized blocks that made it possible to selectively effect on different components of the physical condition.

Keywords: *physical fitness level, acute effect, fitness training, mature age women*

Introduction

Nowadays, there are a wide variety of physical activity forms. Therefore, the number of scientific studies in area of fitness-related benefits are increasing. Investigators in different fields of sports science and medicine interact with each other, and professionals strive to use the latest scientific advances and successful finds of fitness and health promotion practitioners.

Various type of fitness training such as aerobics, dance aerobics, etc. are the most popular among women in the health promotion practice (Blagii, & Lysakova; 2013; Yarmak et al., 2018).

The physical fitness of women and approaches to improve it through the use of various forms of health-promoting activities have been studied by many authors (Gubareva, 2001; Baechle, & Earle, 2008; Ivaschenko, 2008; Bulatova, Andrieieva, & Blagii 2017; Drozdovska, Andrieieva, Yarmak, & Blagii, 2020; Hakman et al., 2020). At present, the effects of rhythmic gymnastics training are described quite well, methodological characteristics of step aerobics programs are identified (Gubareva, & Levitsky, 2000). There has been a tendency to systematize and generalize the accumulated experience (Howley, & Franks, 2003; Baechle, & Earle, 2008; Bulatova et al., 2017). However, the contradictions in the methodology of various forms of fitness classes do not allow the integrated use of their capabilities.

Unfortunately, the use of new forms of fitness is not always sufficiently substantiated. Furthermore, various instructor training courses and fitness conventions in their methodological sections do not take into account the fundamental principles of designing exercise classes using various forms of fitness

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training. The continual change of emerging fitness activities creates a problem for clients who have to make the appropriate choice of individual means of health improvement. While trying to keep up with the trends of the time, fitness instructors have to change their workout routine frequently. Obviously, there is a need for the rational use of all the capabilities inherent in various methods.

The aim of this study was to investigate the acute effects of fitness training on physical fitness variables in active young women.

Methods

The study involved 35 women aged from 21 to 30 with an average age of 26.4±2.2 years. The women were found to have no health abnormalities during the medical examination. The selection criteria included women's willingness to participate in the experiment, participation in health fitness activities for at least one year, and high levels of physical activity and physical fitness. The exclusion criteria included pregnancy, acute respiratory diseases, and chronic diseases in the acute phase. The study was conducted in accordance with the ethical principles of the World Medical Association Declaration of Helsinki. The study was conducted at the National University of Ukraine on Physical Education and Sport (Kyiv, Ukraine). Ethical approval of research protocol was obtained from the Ethics Commission of the NUUPES (No. 2 on 16.12.2020). All the participants gave their written informed consent to the personal data processing, as well as to further processing of the obtained data for scientific purposes.

Body composition and physiological parameters measurements were carried out with a focus on identifying characteristics of the acute effects of physical exercise classes designed using different methodologies.The study of the effects of various modes of exercise training on the body in terms of heart rate (HR) changes (using the "Polar" heart rate monitor) included comparisons of different subjects participating in the same model sessions and functional responses of individual subjects during different model sessions. To measure physiological parameters, the wearable metabolic system for assessing cardiorespiratory function Cosmed K5 was used. The following body parameters were recorded: oxygen uptake (VO_2 in $mL \cdot kg^{-1} \cdot min^{-1}$); HR (bpm); carbon dioxide output (VCO_2, $mL \cdot kg^{-1} \cdot min^{-1}$); lactate level (La, $mmol \cdot L^{-1}$); fat utilization as percentage of the total energy production (FAT%); carbohydrates (CHO) utilization as percentage of the total energy production (CHO%); energy expenditure (EE) per minute (EE_m, $kcal \cdot min^{-1}$); EE per hour (EE_h, $kcal \cdot hr^{-1}$); daily EE per kilogram of body weight (EE/kg, $kcal \cdot kg^{-1} \cdot hr^{-1}$); daily EE per body surface area (EE/BSA, $kcal \cdot m^{-2} \cdot hr^{-1}$). METs are multiples of basal metabolic rate, 1 MET is equal to approximately 3.5 $mL \cdot kg^{-1} \cdot min^{-1}$.

A group of the subjects (n=35) performed two different model exercise sessions with a fitness instructor. In addition to the video recording of the session, HR changes and gas exchange variables were recorded every 15 seconds for every subject. Then, the following indicators were calculated: EE_m, EE_h, CHO and fat utilization as percentage of the total energy production (CHO% and FAT%). Blood lactate concentration (HLa, $mmol \cdot L^{-1}$) was measured using an LP-400 biochemical analyzer (Dr.Lange, Germany). Blood HLa values were measured at the beginning, middle, and end of the workout. Blood samples were obtained by the staff at the NUUPES Research Institute.

The study was focused on assessing the training effect of the model exercises; comparing the sessions #1 and #2; evaluating the relative effectiveness of the blocks composing the sessions; and assessing the individual response of the subjects to the standard training load during the sessions.

Statistical analysis of the data was performed using a software package Statistica 10.0 (StatSoft, Inc., USA). With an average sample size ($30 \leq n \leq 100$), the normality of the distribution was tested by several methods including the Shapiro-Wilk test as well as asymmetry and excess kurtosis. One-dimensional statistical analysis, which involved calculating the mean and standard deviation (SD), was applied in the research. The parametric Student t-test was used to determine the significance of the difference between the groups participated in two different exercise sessions. The significance for all statistical tests was set at $p \leq 0.05$.

Results

During the study, we assessed the acute effects of two model exercise sessions with different fitness goals. We have developed a generalized structure of health-enhancing exer-

Table 1. Characteristics of exercise load in the blocks of training session ($\bar{x}$±SD)

T, min	V	I	AE			HRav		HR range
			D	S	Str	bpm	% HRmax	HRmin - HRmax
Warm-up block								
7.6±1.46	171.1±21.31	0.304±0.04	67.4±4.13	11.1±1.62	21.2±1.13	119.2±3.91	62.2±1.32	98-135
Aerobic block								
16.4±0.42	504.3±21.16	0,85±0.01	100	0.0	0.0	155.7±6.14	80.8±1.04	142-168
Dance block								
9.1±1.03	464.2±60.1	0.76±0.01	99.0	1.0	0.0	141.7±3.04	74.2±0.91	132-157
Preventive block								
8.4±1.06	199.5±96.2	0.31±0.12	54.0±2.11	42.5±10.42	3.5±1.14	103.2±4.12	53.6±4.32	93-116
Relaxation block								
6.6±0.68	17.1±12.4	0.03±0.01	30.0±9.61	15.0±2.71	55.0±44.6	97.0±4.62	50.0±2.11	87-105
Additional block								
7.1±0.32	273.1±41.1	0.45±0.11	85.5±4.12	14.5±1.40	0.0	131.0±9.0	68.0±5.4	91-145

Legend: T– time; V – volume of training elements; I – intensity, elements per second; AE – amount of exercise, % of total time; D – dynamic, S – static, and Str –stretching exercise; HRav – HR average.

cise sessions on the basis of the block principle of design. The blocks are characterized by different fitness goals, which together cover the full range of health-enhancing fitness tasks and take into account the preferences of participants. The following blocks were distinguished in the structure of the exercise sessions including warm-up, aerobic, dance, corrective, preventive, relaxation, additional, and variable. Pedagogical and medical biological characteristics of the exercise blocks (Table 1) demonstrated their specialized effects on the body of the women.

Table 2. Parameters of the model sessions in comparison with the other forms of exercise training (n=35), ($\bar{x}$±SD)

Type of activity	VO_2 (mL·kg·min^{-1})	% VO_2max	HR, bpm	% HRmax	Fat %	CHO%	EEh, kcal·hr^{-1}
Spinning	33.7±2.18	67.4±4.28	164.7±11.34	85.0±6.81	8.1±2.04	92.1±6.18	529.9±64.18
Fitball aerobics	32.9±3.24	65.2±3.29	163.5±14.26	84.0±5.33	30.2±2.32	70.2±6.34	516.7±55.23
Slide aerobics	32.4±2.43	64.7±5.14	162.4±10.55	84.0±7.18	36.5±3.09	63.4±5.78	511.2±46.61
Step aerobics	30.5±1.18	61.6±4.38	146.3±11.87	76.0±4.39	46.1±3.19	54.1±4.19	475.3±58.21
Model session 1							
Aerobic block	27.9±2.14	66.6±5.22	145.2±12.51	75.0±6.89	33.2±2.76	67.2±6.27	525.8±44.16
Corrective block	21.3±2.21	48.6±3.67	143.1±13.32	74.0±6.92	40.3±3.84	59.8±3.61	373.5±41.27
Model session 2							
Aerobic block	27.3±3.45	64.9±6.58	141.7±12.98	72.0±7.11	30.1±1.54	70.1±5.27	498.2±52.17
Relaxation block	16.0±2.54	39.9±3.54	115.1±10.47	57.0±5.07	34.2±2.27	66.1±5.84	286.8±48.32

The obtained results were compared with the available data on the response to the exercise load in various aerobics workouts (Table 2).

The experimental sessions, which lasted for 45 min, consisted of 6 blocks: 1. Warm up (introductory block, 5 min). 2. Functional training (aerobics and dance blocks, 15 min). 3. Recovery (restorative block, 5 min). 4. Training of the musculoskeletal system (corrective block in the session #1 and preventive block in the session #2, 10 min). 5. The development of creative skills and motor abilities (variable block in the session #1 and additional block in the session #2, 5 min). 6. Relaxation (cool down block, 5 min). The session #2 differed from the session #1 in two blocks: the preventive block was used instead of the corrective, and the additional block was used instead of the variable one.

Relaxation block was used twice in both sessions. This block included walking, breathing exercises, and stretching in a standing position.

For the second time, the relaxation block was used in the final parts of the sessions aimed at reducing fatigue and psycho-emotional stress and consisted of stretching exercises, yoga postures as well as elements of autogenic training and massage.

The results of the study revealed that the experimental sessions #1 and #2 provided an equal exercise load. Significant differences between the sessions ($p<0.05$) were found only in HR values.

HRav in the session #1 was 135.4±8.2 bpm or 69.7±2.8% of HRmax. VO_2 was 22.1±3.1 ml·kg^{-1}·min^{-1} or 49.5±3.7% of VO_2max, and EE was 379.9±98.76 kcal·hr^{-1}. About 56.7% (more than 25 min) of the total duration of sessions was performed at HR of 149.0±5,4 bpm (75.9±2.1% of HRmax) and VO_2 of 24.9±0.12 mL·kg^{-1}·min^{-1} (61.2±3.1% of VO_2max) that confirms the sufficient load on the cardiovascular system.

The HRav in the session #2 was 129.2±10.4 bpm (67.12±5.04% of HRmax); VO_2 was 23.01±.2.18 mL·kg^{-1}·min^{-1}, 6.01 METs respectively (51.4±8.51% of VO_2max).

The mixed aerobic-anaerobic nature of the exercise load was indicated by the lactate levels: 3.67±1.21 mmol·L^{-1} (in the middle of the session #1); 4.55±1.79 mmol·L^{-1} (at the end of the session #1); 3.75±0.22 mmol·L^{-1} (in the middle of the session #2); and 3.15±0.58 mmol·L^{-1} (at the end of the session #2).

The experimental sessions were less intense than spinning, fitball, and slide aerobics sessions and had an intensity similar to that of step aerobics sessions (Table 1).

During the experiment, 8 blocks with different fitness goals were examined, and the results are presented in table 2. When comparing the same blocks in the sessions #1 and #2, no statistically significant differences were found ($p>0.05$). This indicates the sessions had a well-balanced plan and division of exercises into the blocks. Exercises of the same block caused a similar physiological response with close values of HR, VO_2, EE, and the proportion of CHO and fat utilization in energy metabolism. Exercises of different blocks differed from each other.

The difference in the goals and specialized impact of the studied blocks was confirmed by the study of their effects. The intensity of the model exercise sessions developed using block design was sufficient to stimulate aerobic metabolism and corresponded to HR of 68.6±1.32% of HRmax, VO_2 of 51.4±1.46% VO_2max, EE of 383.5±61.12 kcal·hr^{-1}, and a metabolic rate of 6.2 MET. Rational alteration of different blocks in exercise sessions increased the effectiveness of addressing specific objectives of fitness training.

The intensity of the exercise load in the dance block was close to anaerobic threshold: HR ranged from 145.0 to 150.0 bpm (74.85-77.61% of HRmax), VO_2 varied from 21.77 to 26.12 mL·kg^{-1}·min^{-1} (56.84-62.77% of VO_2max). The aerobic block was performed primarily in aerobic and partially in mixed mode: HR was from 141.0 to 146.0 bpm (73.21-75.82% of HRmax), VO_2 was from 27.38-27.93 mL·kg^{-1}·min^{-1} (65.12-66.73% of VO_2max).

The greatest EE was during the aerobic block: 524.36±19.32 kcal·hr^{-1}. We found that the percentage contribution of fats to energy production was higher in the introductory (78.24%), relaxation (68.93%), and corrective (42.65%) blocks. The largest percentage of CHO utilization for energy metabolism was recorded in additional (92.8%), variable (91.82%), and dance (86.54%) blocks. In these blocks the exercise training mode was closer to the anaerobic and intensity was higher.

Table 3. Functional indicators and energy expenditures of middle-aged women in model sessions (n=35), ($\bar{x}$±SD)

Block	VO_2	HR	%VO_2 max	%HR max	EEm Kcal/ min	EEh Kcal/h	EEkg Kcal/ Kg/day	FATg g/day	CHOg g/day	FAT% %	CHO% %	FAT mg mg/min	CHO mg mg/min	MET
Model session 1														
1	18.0± 1.24	124.0± 8.53	42.8± 8.26	63.7± 7.16	5.52± 0.87	326.2± 93.26	127.4± 28.33	198.6± 21.18	1429.4± 93.37	24.1± 6.81	75.1± 4.53	137.7± 25.16	993.3± 95.21	5.2± 0.36
2	27.9± 1.33	146.0± 9.38	66.7± 6.82	75.8± 5.39	8.7± 1.17	524.4± 76.31	203.3± 47.29	431.3± 75.12	2039.5± 98.14	33.5± 4.11	67.1± 5.22	301.2± 64.91	1415.8± 98.82	8.0± 0.47
3	26.1± 2.18	150.0± 9.71	62.8± 3.85	77.6± 4.82	7.8± 5.73	465.3± 74.28	184.5± 26.72	422.9± 89.56	1734.7± 99.24	33.6± 2.11	67.0± 3.42	291.2± 43.92	1204.7± 97.14	7.6± 1.48
4	13.5± 1.42	110.0± 7.33	30.2± 3.17	56.2± 4.67	3.6± 1.07	217.4± 76.53	84.3± 10.25	394.3± 85.29	356.9± 83.76	68.9± 7.32	30.6± 2.69	273.0± 94.75	247.2± 83.91	3.8± 0.95
5	21.3± 2.35	141.0± 8.95	47.9± 5.16	72.1± 8.41	6.2± 1.05	374.1± 95.34	143.5± 28.48	483.5± 75.31	103.8 ± 31.06	42.6± 4.11	60.0± 5.04	333.3± 63.27	732.1± 58.37	6.1± 1.07
6	22.0± 2.87	139.0± 9.36	51.7± 4.68	71.7± 6.34	6.6± 0.84	394.9± 73.91	154.8± 18.24	281.5± 48.94	1661.4± 75.48	27.2± 1.49	73.3± 8.55	193.7± 18.93	1153.5± 82.79	6.4± 1.02
Model session 2														
1	19.6± 1.31	117.0± 9.61	48.9± 4.28	60.72± 5.18	5.8± 1.09	339.7± 58.29	131.1± 19.37	736.7± 69.93	303.3± 45.28	78.2± 7.33	23.2± 4.86	513.1± 48.83	213.4± 48.49	5.6± 1.05
2	27.3± 1.16	141.0± 9.28	65.1± 5.16	73.2± 7.84	8.4± 1.36	495.8± 68.74	192.4± 22.87	393.8± 75.72	1968.5± 201.46	30.2± 1.54	70.4± 5.90	274.7± 54.89	1371.7± 98.65	7.8± 0.97
3	21.7± 2.18	145.0± 9.54	56.8± 8.36	74.8± 5.88	7.1± 1.09	426.7± 77.12	163.5± 18.26	152.5± 14.53	2132.2± 204.21	13.0± 0.78	86.5± 6.43	104.6± 11.21	1472.6± 45.28	6.5± 0.65
4	15.9± 1.13	113.0± 8.59	41.2± 4.78	58.1± 5.21	4.8± 0.41	285.7± 48.91	113.4± 22.19	263.2± 18.28	1061.4± 97.14	34.2± 2.18	65.7± 3.75	182.4± 12.67	734.6± 42.46	4.6± 0.61
5	18.2± 1.87	127.0± 9.45	44.8± 2.18	66.2± 7.03	5.4± 0.88	323.1± 87.12	125.6± 14.59	194.6± 20.84	1431.5± 86.21	21.2± 2.65	78.9± 4.13	135.6± 18.59	992.5± 51.13	5.1± 0.82
6	23.2± 2.17	138.0± 8.49	59.2± 3.11	71.1± 6.38	7.3± 1.25	434.2± 56.74	161.6± 12.45	112.6± 10.21	2260.2± 215.67	7.4± 1.82	91.8± 8.39	77.9± 4.63	1568.3± 37.81	6.6± 1.22

Legend: 1 – Warm-up block, 2 – Aerobic block, 3 – Dance block, 4 – Preventive block, 5 – Relaxation block, 6 – Additional block

During the experiment, blocks with similar exercise intensity were identified that can replace each other in the session (table 3).

Such interchangeable blocks include:

1) aerobic block at HRav of 146.0 bpm (75.82% of HRmax) and dance block at HRav of 150.0 bpm (77.61% of HRmax); these blocks have the same objective of functional training, but through the use of different means;

2) corrective block at VO_2 of 21.35 mL·kg^{-1}·min^{-1} (47.93% of VO2max) and preventive block at VO_2 of 18.21 mL·kg^{-1}·min^{-1} (44.76% of VO_2max) often consist of the same exercises, which can be focused on addressing different objectives. For example, the exercises for the abdominal muscles from the corrective block may be the same as the exercises for the muscles of the pelvic floor from the preventive block;

3) warm-up block at HRav of 124.0 bmp (63.73% of HRmax) and relaxation block at HRav of 110.0 bpm (56.24% of HRmax);

4) additional block at VO2 of 23.26 mL·kg^{-1}·min^{-1} (59.21% of VO_2max) and variable block at VO_2 of 22.01 mL·kg^{-1}·min^{-1} (51.72 % of VO_2max).

The results of this study showed that the same exercises and the same exercise sessions may affect the body of the subjects in different ways.

Thus, it was found that the body can utilize different sources for energy production depending on the initial level of physical fitness of the subjects (with a volitional effort to continue the exercise).

The higher the intensity of exercise, the lower the proportion of fat contribution to energy production. In addition, the lower the level of physical condition, the lower should be the intensity of exercise. This confirms the need for taking into account the level of physical condition when completing groups and programming self-training workouts.

The differences in utilization of energy sources that was identified experimentally must be taken into account when designing exercise sessions. The transition from low-intensity to high-intensity workouts is possible only on the basis of increasing the level of physical condition.

The lactate threshold is defined as the point when blood lactate begins to substantially accumulate above resting concentrations during exercise of increasing intensity. Increased exercise load results in a faster accumulation of lactate. Table 4 presents the blood lactate concentration data. During the exercise session, the intensity of exercise can exceed the anaerobic threshold and the body switches to aerobic-anaerobic energy metabolism. For example, during spinning classes, blood lactate reaches 6.07±2.04 mmol/L in the middle of the session and 5.30±1.79 mmol/L at the end of the session. Activities during fitball, slide aerobics, and step aerobics classes mainly depend on aerobic production of energy.

Based on the obtained average lactate measurements (3.15±0.58; 3.67±1.21; 3.75±0.22; and 4.55±1.79 mol/L), the model sessions were performed at intensity levels below the

Table 4. The changes in blood lactate during various forms of exercise sessions (n=35)

Forms of sessions	Blood lactate level ($\bar{x}$±SD, mmol/L) ($x_{min} \div x_{max}$)		
	Baseline (at the beginning of a session)	Intermediate (in the middle of a session)	Final (at the end of a session)
Spinning	0.93±0.24	6.07±2.04 (3.25÷8.03)	5.30±1.79 (3.19÷7.55)
Fitball	1.26±0.15	2.39±1.04 (1.46÷3.72)	2.07±0.82 (1.36÷3.11)
Slide aerobics	1.94±0.10	2.41±0.30 (1.97÷2.58)	2.45±0.46 (1.83÷2.75)
Step aerobics	1.52±0.11	1.84±0.11 (1.75÷1.97)	2.40±0.14 (2.21÷2.61)
Model session #1	1.14±0.29	3.67±1.21(1.81÷6.52)	4.55±1.79 (2.64÷8.73)
Model session #2	1.03±0.22	3.75±0.22 (2.86÷4.68)	3.15±0.58 (2.51÷4.12)

anaerobic threshold. However, an analysis of individual values of lactate level showed that in the middle of the session a number of the subjects switched to the anaerobic mechanism of energy production due to their level of physical condition. This indicated a mismatch between the exercise load and functional capabilities of the subjects.

When assessing the proportion of substrates utilized for energy production during the warm-up (session #1), preventive, and recreational (session #2) blocks, measurement artifacts were identified, namely, an overestimated carbohydrate utilization (CHO%). These blocks included moderate and low intensity exercises. When changing the exercise intensity, for example, by changing from a standing starting position to a sitting or lying position, or when finishing dynamic exercises, breathing typically is enhanced that is accompanied by the release of CO_2. The so-called 'false increased CHO%' does not occur due to the increased metabolism of the energy substrates, but due to the buffer activity of the device, i.e. its inertia. This results in the error in the estimation of CHO%.

Discussion

The range of fitness classes and the objectives which they address is very wide. This fact, as well as the availability of fitness equipment, the opportunity for year-round training, and low-cost requirements make fitness training a preferred form of health-promoting physical activity.

In health-promoting fitness training, two directions can be distinguished: strength training and aerobic training (dance fitness). The first is focused mainly on improving body shape, while the focus of the second is beauty and originality of movements and movement compositions. Their well-thought-out combination is the most successful.

There is a lot of publications on the influence of health-promoting exercise on the body (Baechle, & Earle, 2008; Bulatova et al., 2017; Drozdovska et al., 2020; Galan, Andrieieva, & Yarmak, 2019a; Gubareva, 2001; Hakman et al., 2020). There have been extensive medical and biological studies of the functional response of the body to exercise load (Powers, & Howley, 2007). A number of researches covering individual health-promoting techniques and their options have been completed (Blagii, & Lysakova, 2013; Galan, Andrieieva, Yarmak, & Shestobuz, 2019b; Nagorna, & Andrieieva, 2019). The general principles for designing health-promoting exercise training programs have been developed (Ivashchenko et al., 2008). Nevertheless, the technology for designing exercise sessions has not been sufficiently developed, and the effectiveness of the influence of aerobic and strength training on the body has not been fully studied. The contradictions between the level of knowledge reached in the field of health-promoting fitness training and the development of technology for designing exercise workouts create obstacles to the integrated use of these types of fitness training among the population groups which differed in the health-promoting exercise interests and in the levels of physical condition. An analysis of different forms of fitness classes suggests that there are many methodological approaches to design and development of physical exercise programs, each of which has its own advantages and disadvantages. Each of them has a right to exist, but there is no one universal approach suitable for addressing the whole range of various objectives of health promotion plans. Depending on the goals, exercise sessions can address pedagogical, health-promoting, aesthetic, developmental, rehabilitation, autogenic training, and other objectives (Zoeller, 2007; Ciccolo, Carr, Krupel, & Longval, 2010; Kashuba et al., 2019). The diverse objectives of the exercise sessions are due to the numerous and diverse motives and interests of the involved women.

Our main findings are that the rational alteration of different blocks in exercise sessions can increase the effectiveness of addressing specific objectives of health-promoting exercise training. The intensity of the model exercise sessions developed using block design was sufficient to stimulate aerobic metabolism and corresponded to HR of 68.9±2.13% of HRmax, VO2 of 52.1±2.11% VO2max, EE of 386.0±62.0 kcal·hr-1, and a metabolic rate of 6.2 MET. Our results confirmed the data reported on the effectiveness of the influence of strength and aerobic training on the functional condition of the body in young women.

The data obtained allowed us to identify, experimentally substantiate, and methodologically structure a set of training means used in exercise sessions, by dividing them into specialized blocks that made it possible to selectively affect different components of the physical condition. Rational alteration of different exercise blocks in the workouts allows to program exercise sessions with different goals and intensity depending on the age, fitness level, and interests of women. Our study confirmed the available data that the block structure is the most rational choice for an integrated exercise session design. This research extended the data on the effectiveness of the influence of integrated health-promoting exercise sessions with different physical condition goals in young women. Furthermore, new data were obtained to experimentally substantiate the use of specialized blocks that make it possible to selectively affect various components of the physical condition of young women.

Conclusions

The data obtained allowed to experimentally substantiate and methodologically structure a number of fitness means

used in exercise sessions, by dividing them into specialized blocks that made it possible to selectively effect on different components of the physical condition. The results of assessing short-term effects of the exercise sessions allowed us to substantiate the optimal values of volume and intensity of conditioning training for young women.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

The Motor Activity Status and Students` Self-Assessment of Health During a COVID-19 Pandemic

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Abstract

In the context of distance learning, physical activity and social contacts of students decreased to minimum The aim of the research was to determine the self-assessment of health and well-being, physical activity status and behavioral aspect of a healthy lifestyle of PE students during quarantine, as well as to determine whether these indicators depend on place of students` education. The research involved 226 students (139 male and 87 famale subjects average age – 19.7 years), receiving a Pedagogical Specialty in Physical Education at the Bachelor's level of higher education. Independent samples included 77 students from a University in Ukraine; 74 – from Poland; 75 – from Italy. The study was conducted online in October-November 2020, during the period of quarantine in these countries. System analysis, questionnaire survey, survey analysis and descriptive statistics were used. The e-questionnaire included a set of methods: Health Self-Assessment Questionnaire (HSAQ), Health Attitude Index (HAI), Lifestyle Survey (LS) Leisure-Time Self-Assessment Questionnaire during quarantine (LTSAQ). It has been established that 23.4% of Ukrainian students have a tendency to be careless about their health. The majority of all students (Ukrainian – over 70%, Polish and Italian – over 90%) have adequate self-assessment of their own health. A high level of health-forming behavior dominate in all three groups. Italian students were not completely satisfied with their own physical activity during the quarantine. Most of the students in all samples exercised individually 3 times a week or more often. The dominant motives to excercises ere increasing physical fitness or improving the stature.

Keywords: *quarantine, questionnaires, health, motor activity, students*

Introduction

A new challenge for modern society is the COVID-19 pandemic, the scale and severity of which reach the level of threat to the health of the world's population. An unprecedented phenomenon of voluntary social isolation has emerged as a way to effective fighting for the spread of the coronavirus. In such conditions, the life of each person undergoes the significant transformations that affectthe health status (social isolation, prolonged stay indoors, forced decreasing physical activity level).

Students` youth is one of the most active strata of society. Motor activity is an important tool for them to prevent not only physical but also mental disorders, in particular, helps to withstand emotional overload, which is especially relevant today (Azhyppo et al., 2018; Mariam & Mazin, 2019; Tsos, Berhier, & Sabirov, 2015). Undoubtedly, COVID-19 became a challenge for the educational process organization, which moved to a remote learning environment. In the context of distance education, students` physical activity and social contacts have decreased to minimum. This state of affairs causes detraining of various body systems, which causes a decrease disease resistance and physical capacity deterioration in general (Bielikova et al., 2020; Kastrati, & Georgiev, 2020). At the same time, higher education quality is equated with the train-

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ing quality of of able-bodied specialists, which is ensured by the proper state of their health. Therefore, an important condition for the normal physical and spiritual development of the student's personality are certain guidelines for a responsible attitude to their health. These guidelines are a motivational stimulus for the optimization of motor activity through regular independent exercises, provided the student's self-organization. Our research is actualized by these factors.

The main purpose of the study was to determine the self-assessment of health and well-being, motor activity status and behavioral aspects of a healthy lifestyle of students during the quarantine period, as well as to determine whether these indicators differ in terms of students` study location (higher education institutions of Ukraine, Poland and Italy).

Methods

The research involved the convenience sampling of 226 students (139 male and 87 female subjects) majoring the Pedagogy specialty in Bachelor's degree. Independent samples included 77 students of Lesya Ukrainka Volyn National University, Ukraine (educational program on Secondary Education. Physical Culture) – group 1 (G1); 74 students of the Jan Dlugosz University in Czestochowa, Poland (Physical Education) – Group 2 (G2); 75 students of the University of Naples "Parthenope", Italy (educational program on Sciences on Physical Exercises) – group 3 (G3). The average age of students was 19.7±1.1 years. The study was conducted online in October-November 2020, during the period of quarantine restrictions on the COVID-19 pandemic in these countries, under the conditions of students' distance education. The study was performed in compliance with the basic provisions of the GCP (1996), the Council of Europe Convention on Human Rights and Biomedicine (04.04.1997), the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects (1964-2013). Voluntary consent for participation in the research was received from all participants, providing fully anonymity of the respondents.

The following research methods as systematic analysis, questionnaire survey, survey analysis and mathematical statistics were used to obtain the necessary data on the motor activity status and students` health self-assessment during the pandemic. An electronic questionnaire included a set of question techniques: HSAQ (Ware, Wright, & Snyder, 1974); HAI (Vachkov & Deriabo, 2004); LS (Rozhnov, 2006); LTSAQ), administered by the researchers.

The HSAQ was used to examine students' health and well-being according to their self-assessment. The questionnaire included 24 statements that respondents rated on a 5-point Likert scale: Strongly agree; Probably agree; Neither agree nor disagree; Probably not; Strongly disagree. The total score ranged of 24 to 120. The questionnaireor rate of well-being for persons who do not suffer from severe chronic diseases did not exceed 69 points.

HAI was used to identify the level and characteristics of students' attitude toward their health and healthy lifestyles. It makes possible to calculate a degree of health attitude components manifestation under the scales: emotional, cognitive, practical and scale of actions. The Intensity Index is formed by summing the scores on four scales demonstrating the general attitude to health and power of its manifistation. The maximum value on each scale for this test is 18 points. The methodology allows to calculate the general level of students' attitude to their health. In total, according to the test, it is 72 points.

To study the level of students` health-forming activity during the pandemic, the LS Methodology was used forassessing the behavioral, ie conscious, component in the formation of a healthy lifestyle. The methodology included 11 statements that reflected healthy actions. The scale for their evaluation included list of answer options – "constantly", "often", "sometimes", "never". The total score less than 20 points corresponded to a low (deviant) level of health-forming activitiy, from 21 to 29 points – average (adaptive) level, above 29 points – a high level of health-forming activity, which corresponded to the creative self-realization of the respondent in the health culture behavioral aspect.

LTSAQ allowed to investigate the students` motor activityfeatures uder the quarantine restrictions. It included 5 statements with closed answer options, from which students chose the most optimal option for them.

The results of the electronic questionnaire were processed using quantitative and qualitative methods of descriptive statistics using OpenOffice Calc. The arithmetic mean, the standard deviation (SD), the variable were calculated.

Results

The research results of the self-assessment of students`health and well-being revealed (Table 1) a significant number of students having the average level of health self-assessment, indicating on an adequacy. The normalwell-being was recorded at 71.4% of G1 students, 94.6% of G2 and 90.7% of G3. Students with a low level self-assessment (such in G1 – 23.4%, in G2 – 5.4%, in G3 – 9.3%) characterized by a tendency to careless attitude to their health, which is typical for

Table 1. HAS and SHFB during a pandemic (G1, n=77; G2, n=74; G3, n=75)

Methodology	Groups	Levels		
		High (%)	Medium (%)	Low (%)
HSA	G1	5.2	71.4	23.4
	G2	0	94.6	5.4
	G3	0	90.7	9.3
HAI	G1	28.6	64.9	6.5
	G2	12.2	70.3	17.5
	G3	22.7	77.3	0
LS	G1	94.8	5.2	0
	G2	97.3	2.7	0
	G3	81.3	12.0	6.7

young age. Such students are the most vulnerable to the negative impact of environmental, demographic, social and other factors. The high level of self-assessment, which was found at only 5.2% of G1 students, indicates an increased level of health anxiety; various painful or unpleasant sensation presence; pessimism about the improving their health in the future.

The distribution of the students by levels of their health and healthy lifestyle attitude (Table 1) suggested the highest number of students with an average level in all groups. Students with a high level in G1 – 28.6%, in G2 – 12.2% and in G3 – 22.7%, which indicated that these respondents had a highly formed, "good" attitude to their health and healthy lifestyle. The least number of students with low level was found accordingly – 6.5% in G1 and 17.5% in G2. These results indicated that these respondents hada bad attitude to health, they were in the "risk zone. In this case, there is a high probability not leading a completely healthy lifestyle.

Regarding the results of assessing the students` health-forming behavior (SHFB) during the pandemic (LS), high indices were found in all three students groups, which indicatedtheir creative self-realization in the behavioral health culture aspect. The average (adaptive level) of health-forming activity was established only in 5.2% of G1 students, 2.7% – G2 and 12.0% – G3. In G1 and G2 there were no respondents with a low (deviant) level of health-forming activity. Only 6.7% of such students were in G3.

According to the HAI Methodology, the severity degree of health attitude components under the scales was determined (Table 2). The results obtained in the studied samples under an emotional scale indicated the dominance in all groups an upper limit of the severity average level of this indicator. Its high level indicates that the surveyed is able to enjoy their health, get aesthetic pleasure of a healthy status, free from negative emotional stereotypes that exist in society accordingly a healthy lifestyle. A low level indicates that a person's attitude to health is mental in nature, has a little effect on the emotion, and caring for the health is simply a necessity.

Table 2. Expressiveness of students' attitude to their health (points), p=0.05

Scale type	Group 1 (n=77)			Group 2 (n=74)			Group 3 (n=75)		
	Mean±SD	Max	Min	Mean±SD	Max	Min	Mean±SD	Max	Min
Emotional Scale	11.39±1.09	18	0	12.26±2.1	18	6	10.56±1.11	15	3
Cognitive Scale	8.78±0.84	18	0	7.15±1.23	12	0	9.12±1.82	18	0
Practical Scale	12.55±1.20	18	0	12.85±2.20	18	3	12.72±2.54	18	3
Scale of Actions	8.01±0.77	18	0	6.06±1.04	12	0	8.52±1.7	9	0
General Health Care Intensity	40.73±3.90	66	3	37.94±6.5	54	21	37.72±7.54	51	24

The cognitive component (cognitive scale) characterized the understanding of the value of health, knowledge of the main factors that had a negative or positive impact on human health. According to this indicator, slightly lower values in all groups have been obtained, but also all of them are corresponded to the average level. The high level of the cognitive component development indicated a great interest of the respondent. The low level indicated that the respondent's attitude to health had a little effect on the cognitive area.

The practical component analysis makes it possible to determine a person's attitude to health and a healthy lifestyle in practice. Slightly higher results on this indicator in all groups evidence the readiness of students to engage in practical activities taking care of their health. The high level under this component indicates that the respondent tends to attend various sports sections, do special exercises, engage in health procedures, lead a healthy lifestyle in general. A low level evidences that a person is ready to engage something in the practical activities of caring for their health, which are organized by other people.

The active component (scale of actions) determines the extent to which a person's attitude to health, a healthy lifestyle in the field of actions. The lowest indicators under this scale in the three groups evidence that students are not able to change their health attitude. The high level of this component suggests that the test subject is actively seeking to change their environment: trying to lead a healthy lifestyle, in general, creates a healthy environment. A low level indicates that the test subject`s attitude to the health remains a "personal issue" without seeking to change the environment.

The general scale indicates a holistic formation of a conscious attitude to health. In total, the student`s maximum score is 72 points. In our case, the average test indicators in all three groups generally evidence that respondents have a well-developed "good" attitude towards a healthy lifestyle.

The results of the students` survey on the level of daily activity during the quarantine period differed depending on the respondents` place of residence. It was noted that 40.26% of G1 students and 22.97% of G2 were completely satisfied with their own motor activity under quarantine conditions. No such students were found in G3. In G1 there were no dissatisfied with their own motor activity, such answer was given by 20.27% of G2 respondents, 46.66% of G3 students.

G1 respondents (45.45%) and only 9.46% of G2 estimated their leisure time under the quarantine as "mostly physically active" (no such students were found in G3). G1 students (14.29%), 45.95% of G2 respondents and 77.33% of G3 believed that their leisure time was "more physically passive than active". Low imdicators were found under assessing leisure as "mostly passive". Thus, such G1 students are only 5.19%, they are not detected in G2 at all and in G3 – 4.0% of respondents.

It is important in the current period to individually perform physical exercises during a long-term self-isolation. To the question "How often did you exercise individually at least 30 minutes during the quarantine?" The answers were distributed as follows (Figure 1): only 9.09% of students in G1 2-3 times a day exercised, 12.16% of students – in G2 and respondents in G3 did not exercise. Once a week, 24.68% of students in G1, 22.97% in G2 and 8.0% in G3 individually exercised. The most number of students exercised three times a week or more: 48.5% in G1, 35.15% in G2, 66.67% in G3. Almost the same minor number of students in all groups exercised 1-2 times a week or less. Only 3.9% of G1 students exercised individuallyat all.

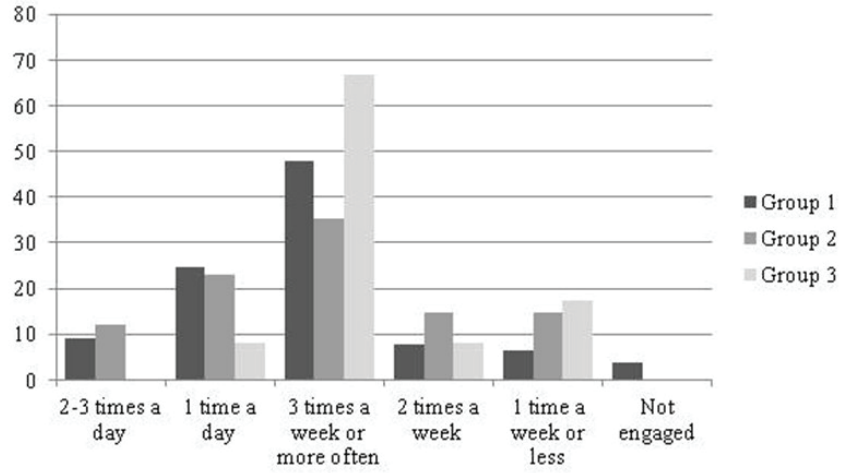

FIGURE 1. Frequency of individual exercising during the quarantine (%)

As the purpose of individual physical exercises, students named different motivators (Figure 2). The moststudents of G1 (49.35%) and G2 (52.7%) chose answer "to improve physical status"; such answer was chosen by only 20.0% of G3 respondents. Only 20.78% of G1 students and 12.16% of G2 students were interested in high sports results; nobody in G3 interested at all. 37.67% of G1 students, 20.27% of G2 respondents and 32.0% of G3 were involved with a purpose of improving their health. In order to normalize body weight, 25.97% of G1 were engaged, 17.57 of G2, and the most – 44.0% of G3 respondents. Similar results were found in the distribution of answers "for the purpose of improving the stature". Only 15.58% and 14.86% of G1 and G2 students iexercised individually with enjoyment of motor activity, respectively, and 48.0% of G3 respondents.

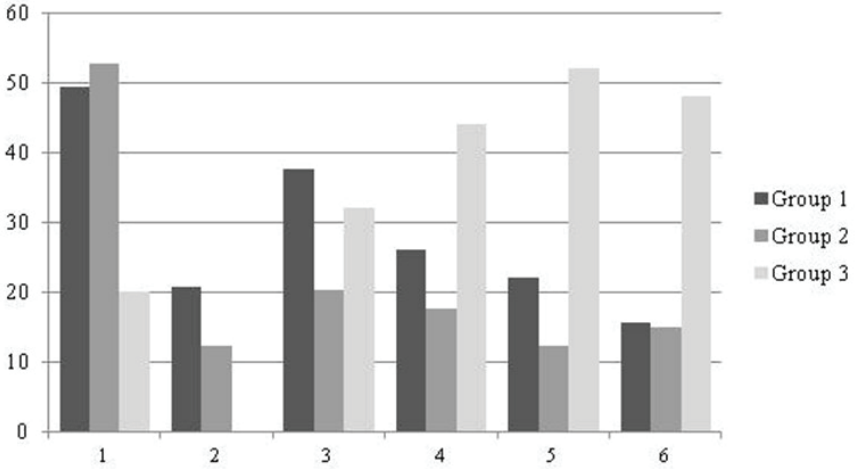

FIGURE 2. The purpose of exercising during the quarantine (%). 1 – To increase physical fitness; 2 – To achieve high sports result; 3 – To improve the health; 4 – To normalize body weight; 5 – To improve the stature; 6 – To enjoy motor activity.

In conditions when it is forbidden to attend sports clubs and it is impossible to practice personally with a coach, digital home training programs helped students to increase motor activity in self-isolation. The students have been polled about Facebook, YouTube and other sports home training programs usage. The answer "yes" was given by 36.36% of G1 students, 29.73% of G2 respondents and 65.33% of G3 students. Only 20.78% of G1 students and 20.27% respectively answered "no". 42.86% of G1, 50.0% of G2 and 34.67% of G3 partially used programs for home training.

Discussion

The COVID-19 pandemic has led to significant changes in education during 2020. The vast majority of countries have closed all educational institutions for at least some time, moving to the educational services provision remotely. The students became the most vulnerable part (Rogowska et al., 2020), thus COVID-19 has made significant adjustments and has become a test of discipline, clarity and timeliness of feedback from key actors of the educational process. According to the research results of the COVID-19 effects on the mental health of college students in the USA (Son, Hegde, Smith, Wang, & Sasangohar, 2020), 71% of respondents reported increased stress and anxiety due to a outbreak of the coronavirus.

The main forms of students` motor activity in conditions of prolonged hypokinesia were individual physical exercises. In this sense, it is interesting to study the impact of specialized education and the level of physical activity on the quality of life of Polish students (Posadzki, Musonda, Debska, & Polczyk, 2009). It was found that students of the Faculties of Physical Culture, Physiotherapy, Tourism and Recreation had not only a good health, but also a high quality of life, as well as higher resistance to stress and depression associated with significant mental load, compared with students of Polish or English

Philology Faculties. The results of such research demonstrated a clear relationship not only between physical but also mental health and physical activity. Students of Physical Education and Health Specialities study the basic principles of improving the quality of life according to their academic programs, and this contributes to a deep understanding of the impact of lifestyle and physical activity on the health and well-being level.

Our research involved students receiving pedagogical qualifications on Physical Education in higher education institutions of different countries (Ukraine, Poland and Italy). This allowed to identify common features and differences in the obtained results for students of different nationalities. These results evidenced that the entire sample, despite receiving a future physical education specialization, did not always manifest a sufficiently constructive attitude to their health during the pandemic and self-isolation. In particular, the fact that 23.4% of Ukrainian students have a tendency to be careless about their health, believing that they have sufficient physiological resources, is alarming. However, the majority of all students (Ukrainian – more than 70%, Polish and Italian – more than 90%) have adequate self-esteem, despite the public panic about it. Most of the students in the Ukrainian (over 1/4) and Italian (about 1/4) samples have a highly formed, "good" attitude to their health. According to this indicator, the low level (about 1/5 of students) in the Polish sample is somewhat alarming. The assessment of students' health-forming behavior (SHFB) is quite optimistic: a high level dominated in all three groups. Only five Italian students with low (deviant) health education were identified. The analysis of the components intensity degree of the attitude to health revealed that the highest averages dominate in all samples under the "practical scale", and the lowest – under the "scale of actions". These results indicated an increased willingness of students to engage in various practical activities aimed at caring for their health. However, they are reluctant to change their environment in accordance with their existing attitudes toward health.

The most important formative influence on students` health and healthy lifestylehas a behavioral (conscious) aspect of purposeful health-forming behavior. Italian students` self-criticism was manifested in the fact that in this sample there were no respondents who were completely satisfied with their own physical activity during the quarantine. On the contrary, the situation among Ukrainian students was even and the distribution of answers among Polish students was equable. The most of students in all samples exercised individually 3 times a week or more often. The dominant motives of the physical activity were: for Ukrainian and Polish students – increasing physical fitness, for Italian – improving stature. Italian students used home training programs from various information resources the most; 1/5 of Ukrainian and Polish students did not use them at all.

The results of the reseach evidenced some differences of indicators depending on the student`s nationality, which obviously reflected the socio-cultural peculiarities, mentality and characteristics of the national education systems of each country. We suppose that distance learning classes promotes good health and motivates a healthy lifestyle, for student`s consciously self-organize and a purposeful health-forming behavior.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Psychological Readiness of Elite and Well-Trained Billiard Players for the Main Competitions of the Macrocycle

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Abstract

Planning of integral preparation for athletes of national billiard teams should be carried out comprehensively, taking into account the level of psychological preparedness of players for the main competitions of the macrocycle. The aim of the study is to determine the model indicators of elite billiards players` psychological readiness for the main competitions of the macrocycle. Research methods: to analyse and generalize special scientific and methodological literature, surveys, psychological, pedagogical, methods of mathematical statistics. Results: our study allows us to determine the model characteristics of the athletes` psychological preparedness during competitive stress and to assess the billiard players` mental state before and after undergoing a course of autogenic training. The psychological parameters` dynamic of the billiard players` functional state such as "mental activation", "interest", "emotional tone", "tension" and "comfort", which significantly correlates with the special preparedness of athletes for the main competitions of the macrocycle. Scientifically substantiated indicators of balance function with and without visual control, productivity, stress resistance, volume of voluntary attention, efficiency of attention, and coefficient of motivational, volitional and typological component of elite athletes who show high sports results at main competitions of macrocycle. The obtained data allows to improve the psychological control system of athletes while taking into account their individual characteristics.

Keywords: *billiard players, psychological preparation, psychological preparedness, stressful situation*

Introduction

Modern researchers recognize that nowadays worldwide society is under pressure from a systemic crisis, which manifests itself in a negative impact on the physical, moral and mental health of the population (Bjelica, Popović, & Gardašević, 2016; Eime, Young, Harvey, Charity, & Payne, 2013; Laaksonen, Finkenzeller, Holmberg, & Sattlecker, 2018; Romanova, & Astaf'ev, 2014; Ziv & Lidor, 2013). In the context of socio-political transformations in Ukraine, the physical and mental health of individuals are getting the most acute acknowledgment. And in the field of sports, effective psychological training becomes a prioritization for achieving the highest results. Special attention has to be paid to solving the problem of organizing effective psychological training for athletes of the national teams. The question of psychological readiness, first of all, relates to sports with intellectual and difficult-coordinating components. Above-mentioned sports - are the types of billiards and its disciplines.

Billiard game requires the player to have precise movements and total control of his emotional state during a long period of competition. That is why, a fairly homogeneous lev-

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el of technical and tactical training of the best billiard players from different countries at international competitions, the advantage is given to those athletes who show the optimal level of psychological readiness for the main competitions. To determine the player`s "optimal state", it is necessary to assess the impact of competitive stress on the athlete`s psycho-emotional state and to develop a monitoring method for the psychological readiness of well-trained billiards to the main competitions of the macrocycle (Baich, Polischuk, & Nagorna, 2014). This analysis will determine the model characteristics of the well-trained billiards players` psychophysiological state at the time of the technique implementation in a stressful situation.

The work`s purpose is to determine the model indicators of elite and well-trained billiards players` psychological readiness for the main competitions of the macrocycle.

Methods

The total of 40 athletes, members of Ukrainian National Team of billiards, were examined. The first group – 20 elite billiard players (masters of sports of national and international class), aged 22-38, the second group – 20 well-trained players (candidates for masters of sports of Ukraine), aged 16-21. Methods of research: theoretical analysis and generalization, pedagogical observation, pedagogical testing, the study of psychophysiological parameters of the players, methods of mathematical statistics.

The permission for information usage was received from all athletes before the research started. Written authorization has been received in accordance with the recommendation of ethical committees.

Survey was conducted among 40 billiard players of the national teams of Ukraine on psychological preparation for the main competitions of the macrocycle. We developed and put into practice in December 2019 a specialized questionnaire for billiards to determine the subjective indicators of the mental state of players before the main tournament of the macrocycle. The respondents` answers in the questionnaires in a special form, which was provided to each participant of the training camp just before the competition of the Ukrainian pool championship and the final pyramid Cup of Ukraine in December 2019, were determined by points and provided for the probability assessment of the obtained results using the methods of non-parametric statistics. Therefore, the nonparametric Mann-Whitney method was used, and the Spearman rank correlation method was used to study the interdependence between the respondents' conclusions on each question. Determining the influence of a single cause on the final result, each respondent's answers to the formation of a single model of the billiards player's mental state before the main tournament, the coefficient of determination was calculated, which can have a value from 0% to 100%, the cause does not affect the result and only this cause causes the result.

The agreement of opinion of 40 athletes, members of Ukrainian National Team of billiards, was calculated by the reliable expert opinion and was determined using the standard deviation and the coefficient of variation. The consistency of the experts' opinions was determined using the concordance coefficient and amounted to W=0.78, which indicates the homogeneity of the group of specialists.

Results

Over the last decade, Ukrainian billiard players have made significant achievements in the international arena, both in the pyramid and in the pool. And 2020 was a significant year for the national snooker team - our athletes won the gold medal at the European Championship and the silver medal at the World Championship.

A survey of 40 billiards players from the national teams, on psychological preparation for the main competitions of the macrocycle, revealed problematic components of athletes' training, namely: low mental readiness of most respondents to the tournament, which leads to a negative trend. At the same time, we determined that more successful athletes either use the services of a sports psychologist or perform special exercises to correct their mental state under the guidance of their coach. Continuing the analysis of the obtained data, we determined the main subjective indicators of the players' mental state during billiards competitions (Table 1). It was found that during the tournament the majority of respondents have a feeling of "sports excitement" (32.5%).

Table 1. Subjective characteristics of psychological training of elite and well-trained billiards players for the main competitions of the macrocycle (in % to the number of respondents)

	Mental state	%
1.	Feeling of "sports excitement", the desire to win	32.5
2.	Feeling of aggression	0.5
3.	Feelings of apathy	12.5
4.	Feelings of insecurity, tremor	7.5
5.	Feeling irritated	7.5
6.	Optimal level of mental readiness	17.0
7.	Low level of mental readiness	17.5

The results of the expert assessment and literature data's analysis allowed to identify the following psychophysiological criteria that affect the quality of competitive activities of billiard players: attention (speed of information processing, switching); memory (operational); speed of mental processes; latent period of complex visual-motor reaction; latent period of simple visual-motor reaction; strength and mobility of nervous processes; differentiation of muscular efforts.

As can be seen in Figure 1, the dominant qualities of the psychological preparedness of billiard players to compete, women and men results do not have significant differences. However, emotional stability, according to female experts, has greater importance in competitive activities (2.5 points), while according to male counterparts it is less important (4 points). From this we can conclude that women are more emotional because of their physiological properties and allot more weight to the emotional state.

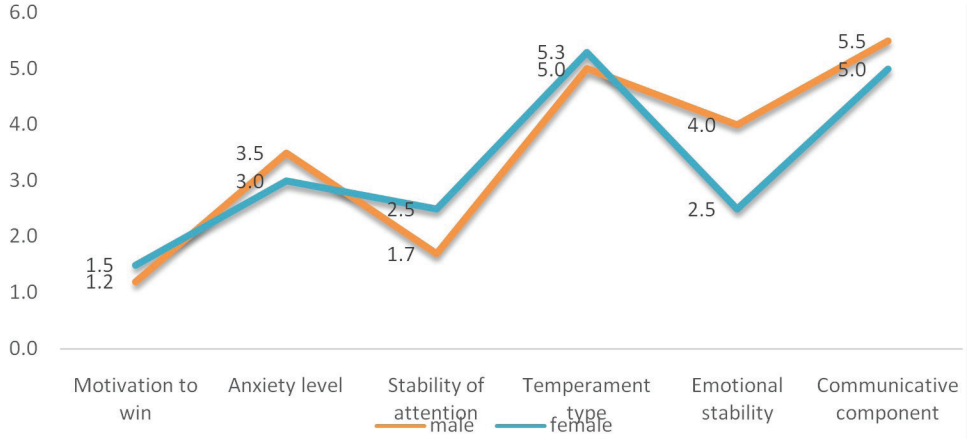

FIGURE 1. Dominant qualities of psychological preparedness of billiard players for competitions according to athlete's opinion (n=40)

As we can see in Figure 2, with amplification of special training's level, and more specifically, the effectiveness of the billiards player's competitive activities, the time spent searching for the first ball (when using a specialized billiard test for attention) decreases. Athletes underwent three stages of testing: the first was conducted before the introduction of special autogenic exercises in the training process, the second - after a month of experimentation, the third - just before the main competitions. Henceforth, the focus of billiard players improves as the results grow.

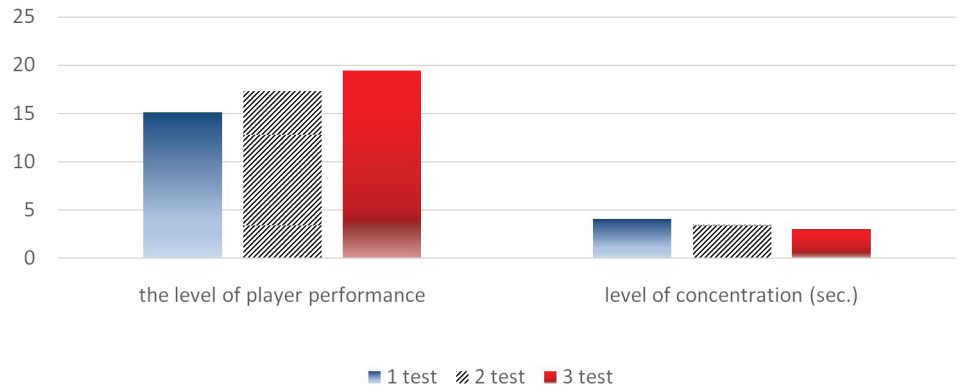

FIGURE 2. Characteristics of the impact of increasing the level of performance of the player on the concentration of his attention (n = 40); 1 - the first testing; 2 - the second testing; 3 - the third testing;

In billiards, technical training is closely linked to the tactics of the game. Therefore, individual plans for the preparation of athletes for the main competitions of the macrocycle should contain technical and tactical elements in combination with exercises that regulate the athlete's optimal mental state. We would like to make a tentative suggestion of setting the duration of classes as two meetings in competitions, the usage of the optimal number of breaks for rest (filled with theoretical material) between specific exercises, a large number of approaches to one exercise, as well as the introduction of competitive and game elements in the training process. We believe it will help psychological and physical loads in billiard training sessions.

Peculiarities of athletes' psychological adaptation to competitive loads are covered in the subjective state of billiard players, which we analyzed by using the methodology of well-being (W), activity (A) and mood (M).

We found that the billiards players' emotional state in the period of adaptation to the competitive process is subjected to specific burdens associated with the tournament environment and limited time to transform old or develop new tactical patterns of behavior. During the study of the well-trained billiard players' emotional states with dynamics in the period of adaptation to the competitive mesocycle, we conducted a series of experiments.

At the beginning and at the end of the training session, with the autogenic exercises to correct emotional state, the analysis of athletes' responses was registered indicators of well-being, activity, mood according to the method of WAM (used the principle of Osgood semantic differential). It was determined that the dynamics of the athlete's mental state is reliably correlated with the dynamics of their special preparedness. The assessment method of mental states like "emotional tone", "mental activation", "interest", "stress" and "comfort" is based on the evaluation of athlete's definitions using modified stimulant material to the method of WAM.

There is a reliable pattern of changes in well-being, activity, mood, depending on the stage of testing. We obtained the following results:

Stage I: the average score of the well-being category a month before the start of billiards competitions is 3.78, which indicates a slight level diminishment; activity category – 5.86; mood category – 4.68.

Stage II: well-being after a course of training sessions with the use of autogenic exercises increased to 7.58; activity – 6.48, a slight increase; mood – 8.42, but this indicator cannot be considered an objective criterion of effectiveness for the study period.

The method of expert assessments of the characteristics of well-trained billiard players' (n=40) psychophysiological state at the time of technical action during competitive pressure allowed to determine the dominant qualities of psychological readiness to win: anxiety, stability of attention, motivation (Klestov et al., 2020). The concordance coefficient (W=0.76) confirms the homogeneity of the athletes' group. Players were asked to simulate the situation during the tournament: a billiards player must play a "match ball" with an equal score on frames with his opponent.

Having analyzed the athletes' answers to the questionnaire, we were able to identify well-trained billiards players' mental state's main features at the time of precise technical action's implementation in the tournament stressful conditions: nervous processes (strength and mobility); concentration of attention; mental processes; coordination of movements; differentiation of muscular efforts during impact.

Most billiard players say that they have felt or still feel strong psychological pressure in preparation for the implementation of precise technical action - 83%. At the same time 73% of athletes note objective changes in the psychophysiological state at the time of the "match ball", among which 27% experience an increase in heart rate, anxiety, negative thoughts. 17% of billiards players, on the other hand, think only about victory, which leads to sport aggression. Feel the fear of defeat, tension in the muscles of the neck and shoulders, tremor of the hands - 13%. Elite athletes (33%) feel confident, focusing only on performing the technique as effectively as possible. Athletes of lower qualification, unfortunately, are dominated by negative thoughts, how not to make a mistake (Borysova, Nagorna, Shutova, & Mytko, 2019; Klestov et al., 2020). At the same time, 87% of athletes use means of mental state's correction at the critical moment of the match. The most popular means of regulation for respondents are: analysis of technical action for concentration on the impact, the usage of a special key word, modeling a positive result (Figure 3).

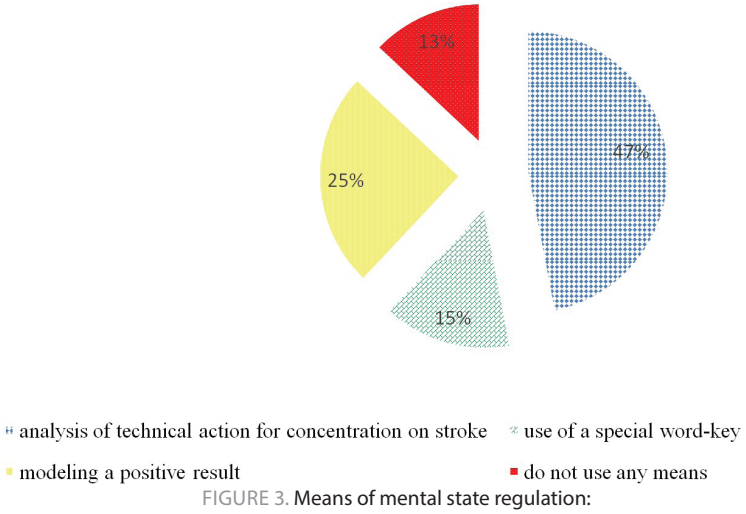

FIGURE 3. Means of mental state regulation:

We used a modified test of the balance function's quality without visual control for billiard players with simulation of the game situation "match ball". The quality of the balance function in a stressful situation is significantly higher for elite billiard players than for the well-trained sportsmen (Figure 4).

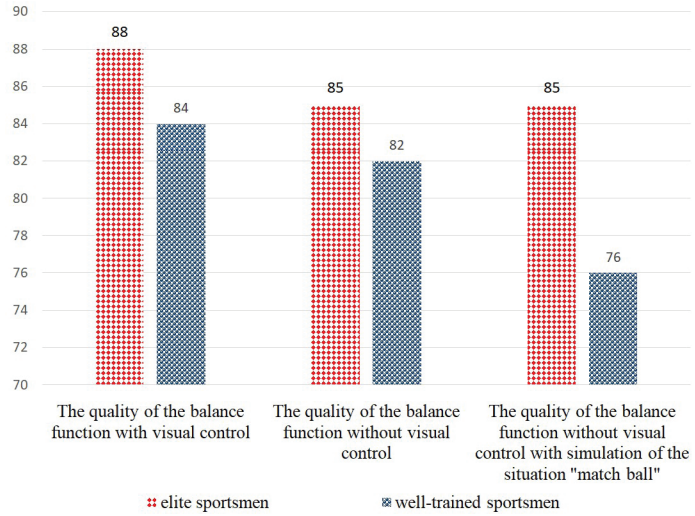

FIGURE 4. The quality of the balance function with and without visual control of billiard players:

The psychological component was also determined by assessing the motivational component of billiard players to win, namely: the most significant contribution to ensuring high performance in main tournaments with a predominance of motivational, volitional and typological components of readiness - 71%. The analysis of the questionnaire's results indicates sufficient motivation for the victory in the athletes who participated in our study.

Summarizing the above, to determine the "ideal" mental state of a billiard player, we selected athletes with high quality of balance function without visual control to the experimental group.

To determine the model characteristics of the well-trained billiard player's psychophysiological state during the implementation of the technique under stress, we used the quality indicators such as the balance function with and without visual control, attention efficiency, attention, productivity, motivational, volitional and typological components, stress resistance (Figure5).

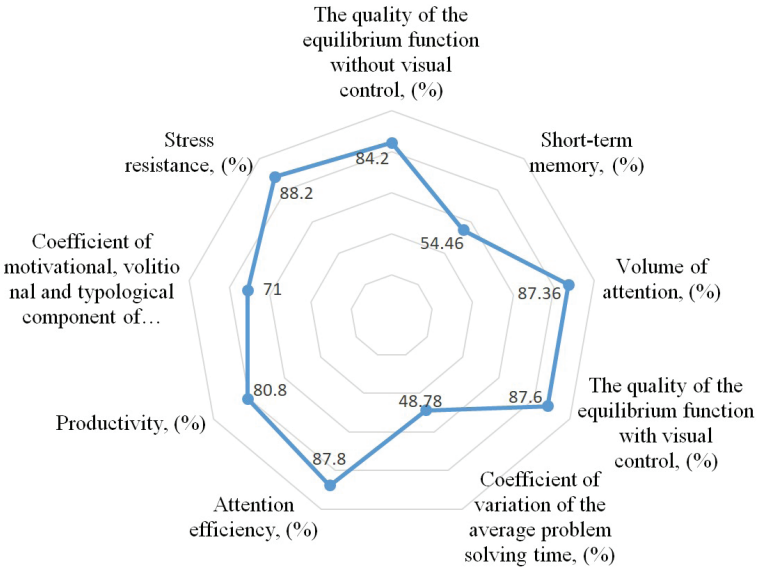

FIGURE 5. Model characteristics of the psychophysiological state of elite athletes in billiard sport at the time of the "match ball"

The conglomeration of individual features of each athlete's technical and tactical preparedness and the calendar's task of his competitive activity in comparison to the model data of mental state allows to determine the athlete's level of preparedness' reserves and means of further improvement. But in the analysis of the athlete's competitive activity effectiveness, the reliability of the billiard players' productive performances in the main tournaments is important, which indicates a high level of integral training: functional, mental, physical, mobilizing qualities of the athlete.

Discussion

The analysis of the literature sources indicates the effectiveness of the billiard players' competitive activity to a greater extent due to the analyzers' activity and the mobility of nervous processes that ensure the accuracy of movements in time and space. In the process of psychological control for a wide range of impartial indicators that is characterized by the accuracy of reproduction force and spatial movements parameters, the ability to process information effectively, well-being, mood, activity, rapid decision-making.

Assessment of well-trained billiards players' mental health before and after the course of autogenic training according to the method of WAM showed the dynamics of functional state's psychological parameters such as "mental activation", "interest", "emotional tone", "stress" and "comfort", which is reliably correlates with the special preparedness of athletes for the main competitions. At the same time, it was found that women are more emotional due to the physiological properties of their body and attach more importance to the emotional state.

We determined the average quality indicators of the balance function with and without visual control, productivity, stress resistance, volume of voluntary attention, attention efficiency, and the coefficient of motivational, volitional and typological component in highly well-trained athletes who show high sports performance at main competitions, psychophysiological condition of elite billiard players for the effective implementation of the technique in conditions of stress in the game situation.

The scientific novelty of the work is that for the first time the influence of autogenic exercises during training sessions on billiard sport on the psychophysical condition of well-trained athletes is substantiated; the influence of autogenic exercises on the functional, emotional state of well-trained billiard players in the process of competitive loads is theoretically substantiated and tested in practice; the data of complex control of the level of psychological preparedness of well-trained billiards players for the main competitions of the macrocycle have been supplemented.

The obtained results of these researches can be used in the process of theoretical and methodical approaches' development on preparation of well-trained billiard players for the main competitions of a macrocycle. The obtained research materials can be used in the practice of national teams' training sessions in billiard sport.

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There are no acknowledgements.

Conflict of Interest
The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Organizational Basics of Inclusive Education and Training Process for Karate Athletes with Disabilities

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Abstract

Physical education and sports for people with disabilities are the areas of physical and social rehabilitation. The implementation of this can be possible through the use of an inclusive approach in the training process of athletes with disabilities. Anthropometric measurements and testing of athletes with disabilities were conducted to determine the impact of an inclusive approach in the construction of the training process. The main purpose of this research was to demonstrate the positive impact of inclusive training sessions within the developed program on the development of the physical abilities of athletes with disabilities. The research used theoretical (analysis of scientific and methodological literature; analysis of sports programs for athletes with disabilities), empirical (pedagogical observation; pedagogical experiment) methods, as well as methods of mathematical statistics. The results of the research showed a positive impact from the training on the developed karate program for people with disabilities. It also presented the increase of the testing results in the exercises "Sit and reach test", "Standing long jump" and "Abdominal crunches".

Keywords: *inclusive training process, physical development, physical fitness, athletes with disabilities, karate, adaptive physical culture, adaptive sport*

Introduction

Analysis of practical experience of training in karate and scientific basis of the results of researches of national and foreign experts in the field of adaptive physical culture allowed to describe the basic theoretical and methodological foundations and provisions of training athletes with disabilities (Kohut, & Goncharenko, 2013, 2018; Greco, Fischetti, Cataldi, & Latino, 2019; Imas, Borysova, Kohut, Yarmolenko, & Shlonska, 2018). The problem of constructing the educational process for athletes with disabilities (karate athletes) is currently of sharp interest due to current national and world trends occurring in the educational, scientific and sports space (Kohut et al., 2018, 2019). In particular, the inclusive education is introduced at the educational establishments of different levels, various scientific research on determining the impact of joint trainings for people with disabilities and athletes are carried out.

In the research of national and foreign specialists in the field of physical culture and sports, some aspects concerning inclusive physical education have been shown (Mihajlovic, 2017; McGrath, Crawford, & O'Sullivan, 2019). Generalization of recent sources and materials of the internet has revealed that the problems of realization of inclusive physical education and specific principles of physical education of children of preschool age in the conditions of inclusive education are raised in the works of Pasichnyk (2017). Adyrkhaieva (2016) has written about modern technologies of physical education of students with disabilities in the conditions of inclusive education. Troyanovska (2018) has observed the theoretical aspects of physical education classes with students with special educational needs in the conditions of inclusive education. However, the issue of an inclusive training process has remained unaddressed by scientists.

It was assumed that implementation of the developed karate

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program for people with disabilities would increase the level of physical development and physical fitness of this group of people.

The aim of the research was to substantiate organizational principles of inclusive educational process for karate athletes with disabilities.

Methods

Research participants

The research involved athletes of 14-20 years old (5 boys and 5 girls) with disabilities of different genders who have cerebral palsy, physical retardation and autism. The children and their parents were informed of all the features of the research and agreed to participate in the study.

Research organization

To achieve the research objectives, the following methods were applied: analysis of scientific and methodological literature and Internet materials, pedagogical observation, pedagogical experiment (pedagogical testing), methods of mathematical statistics and processing of research results.

The test battery included four tests to determine the level of fitness: abdominal crunches maximum number in 1 min. (strength endurance), standing long jump (power), 60 meters running (speed), sit and reach test (flexibility). Anthropometric indicators were used to determine the level of physical development: height, body weight. During the experimental study athletes were engaged in the developed program "Karate - train together" for 1 year with a frequency of training of 2 times a week for 2 hours. The program of the first year of study is the one to be aimed at developing the physical qualities of athletes in its practical part, and is intended to increase the level of physical fitness of athletes with disabilities.

Statistical analysis

The statistical methods (means, standard deviations and Wilcoxon signed-rank test) were used for quantitative processing of results and allowed to draw conclusions about the effectiveness of the training program for karate athletes with disabilities, which is based on an inclusive approach. It also allowed finding out the dynamics of quantitative changes in levels of their physical development and preparation before and after the scientific research. We performed statistical analyses using Statistica 6.0 for Windows (StatSoft, USA). Since we had a small sample, Shapiro-Wilk's test of normality did not have enough power, and the histograms were far from a normal distribution we adopted non-parametric statistical tests. As a result, median and interquartile range [25%; 75%] were used to describe the data and Wilcoxon's signed-ranks test was used to compare the parameters of physical development before and after the author's training program. The threshold of statistical significance p=0.05 was accepted.

The study was approved by the Institutional Ethics Committee (№ 2/2017) and was carried in compliance with the international principles of the Declaration of Helsinki of the World Medical Association (2013) and in accordance with the Law of Ukraine "Basis of Ukrainian Health Care Legislation" (1992) on ethical norms and rules of medical research with human participation.

The research protocol was approved by the Center for Social and Psychological Rehabilitation of Children and Youth with Functional Disabilities of Darnytskyi District (Kyiv, Ukraine). In addition, children and their parents or legal caretakers were fully informed of all the features of the research and consent forms were duly signed.

Results

To determine the effectiveness of an inclusive approach to the construction of the training process of karate athletes with disabilities, anthropometric measurements and testing of athletes were conducted, which included two stages (summative assessment of I and II phases of the study). The research was conducted on the basis of the Center for Social and Psychological Rehabilitation of Children and Youth with Functional Disabilities of Darnytskyi District from October 2017 to October 2018. It was created based on the WKF karate training program for children and youth sports schools. The general principles of the organization of the educational and training process according to this program were the individual approach, the sequence and gradual presentation of the material. The methods used in the classes depended on the complexity of the tasks and the individual characteristics of the athletes. The practical part of the program was aimed at the development of physical qualities: strength, endurance, coordination,

Table 1. Anthropometric data of the studied children

Name	Age		Height (cm)		Body weight (kg)		Nosology
	I	II	I	II	I	II	
Maks*	16	17	161	165	55	59	Cerebral palsy
Bobby*	16	17	170	172	62	67	Cerebral palsy
Viola*	14	15	152	155	51	53	Physical retardation
Alexis*	18	19	166	166	60	59	Autism
Andry*	14	15	158	160	49	52	Physical retardation
Jim*	19	20	170	170	61	60	Cerebral palsy
Alex*	16	17	168	172	58	62	Cerebral palsy
Tim*	16	17	169	173	61	62	Cerebral palsy
Alice*	16	17	165	166	56	58	Cerebral palsy
Eva*	16	17	165	165	55	53	Cerebral palsy
			N = 10 Z = 2.366 p = 0.018		N = 10 Z = 1.886 p = 0.059		

Legend: * - pseudonym used; I – summative assessment of the I phase of the study; II – summative assessment of the II phase of the study.

flexibility and speed, which was characterized by the implementation of appropriate physical exercises to increase the level of physical fitness of athletes.

For the implementation of the first component (summative assessment of the I phase of the study), a study was conducted, which allowed to assess the level of physical development and health status of children with disabilities.

The results obtained are presented as a following Table 1.

The assessment of the physical development of the studied group of children was conducted when comparing the actual indicators (summative assessment of I and II phases of the study) and the necessary anthropometric indicators for the physical development of children.

The measurement results of athletes are distributed in comparison with centile intervals according to WHO recommendations.

It was found that at the beginning of the study, 90% of children had average growth rates that corresponded to 25–75% of the centile interval and 10% had low growth rates (corresponding to 3–10% of the centile interval). After comparing the results of the summative assessment of I and II phases of the study, it was determined that the number of children with average growth increased by 10%.

At the same time, it was found that 100% of the children studied had average body weight at the beginning and end of the study and it corresponded to 25–75% of the centile interval.

To carry out the second component of research (formative assessment) the educational and training process was constructed according to the developed method of training for karate athletes with disabilities. During this study, a karate training program for athletes with disabilities was developed and put into practice during from 2017 to 2018.

For the implementation of the third component of the study (summative assessment of the II phase of the study), which was conducted to identify changes in the level of physical fitness of children with disabilities using the new training program, a research of the level of physical fitness of children with disabilities was carried out. Its complexity was almost the same as the previous one. For this purpose, as well as for the first time, testing and standards of assessment of physical fitness were used (Table 2).

Table 2. Indicators of physical fitness of children of the study group

Name	Sit and reach test (cm)		Standing long jump (cm)		Abdominal crunches, 1 min, number of repetitions		60 meters running, sec	
	I	II	I	II	I	II	I	II
Maks*	6	8	98	100	16	20	12	12
Bobby*	5	9	129	130	17	22	11	11
Viola*	8	10	78	78	14	18	13	13
Alexis*	9	12	114	115	15	19	12	12
Andry*	6	11	109	113	18	24	13	13
Jim*	4	8	94	96	14	21	12	12
Alex*	6	12	131	136	19	25	10	10
Tim*	5	11	132	135	18	26	10	10
Alice*	7	12	124	128	16	20	11	11
Eva*	7	13	119	124	15	21	11	11
	N = 10 Z = 2.803 p = 0.005		N = 10 Z = 2.666 p = 0.008		N = 10 Z = 2.803 p = 0.005			

To carry out the fourth component of the research (processing and generalization of results), the analysis and systematization of the obtained results were carried out. To clearly demonstrate the effectiveness of the training program, a comparison of the results of the summative assessment of I and II phases of the study was performed.

The test "Sit and reach test" involves sitting on the floor with legs stretched out straight ahead. Both knees should be locked and pressed flat to the floor - the assistant may help by holding them down.

However, during the research, in order to assimilate the technical part of the tests, auxiliary exercises were performed for the development of flexibility, namely: angle bodies (pulling the torso with the hands to the lower leg, leaning forward with the help of a partner or with some weight on the shoulders, passive bending and extension of legs with the help of the partner with the subsequent holding of a static position, bending of straight legs in the hip joint with the help of the partner from the lying position, etc.). A significant improvement in the test technique was observed during the summative assessment of the II phase of the study. The muscle strength and elasticity have both increased, the exercise techniques have improved, which led to better-quality results.

To determine further changes in the development of flexibility of the athletes, the test "Sit and reach test" was carried out (Figure 1).

Comparison of the results of the flexibility test showed that the level of flexibility of athletes increased after training under the developed curriculum. This indicates the effectiveness of the program's lessons and the correct use of the techniques. The training before the development of flexibility required the necessary intense warm-up to improve blood flow and increase muscle elasticity. Exercises were performed with the following recommendations: use of repeated spring motions that increase the intensity of stretching, performing of the movements with the highest possible

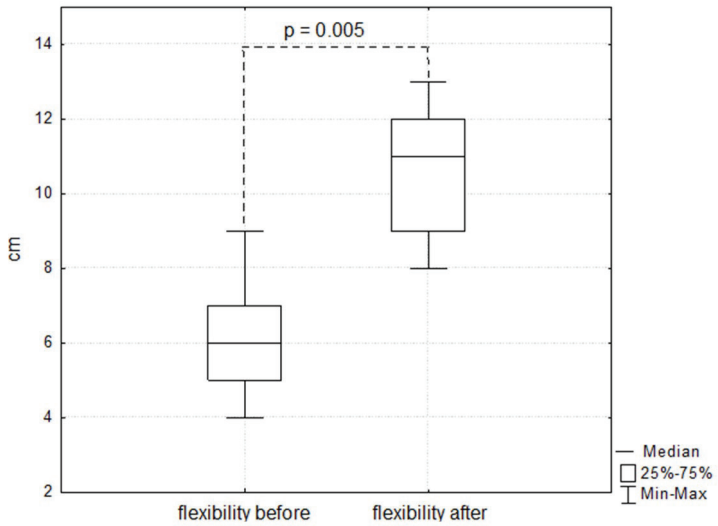

FIGURE 1. Level of development of flexibility of the athletes (Length, cm)

amplitude, use of the motion inertia of any part of the body, work with additional external support and with the active assistance of a partner.

During the first standing long jump test, it was found that 50% of the athletes made some mistakes while performing the test (line delay, loss of equilibrium on landing, etc.). To solve this problem, they were asked to perform the following exercises, namely: jumping rope, jumping on the left, right, both legs, jumping back and forth from the seated position, performing swing half-bent hands with a sharp stop at the position of the elbows at the level of the shoulder girdle, standing long jumps for accuracy and result. During the second test, the standing long jump technique improved, but not for the entire research group. This is due to the features of diseases that limit the physical capacity of children.

To determine the changes in the development of the speed and power capabilities of the athletes the test "Standing long jump" was performed (Figure 2).

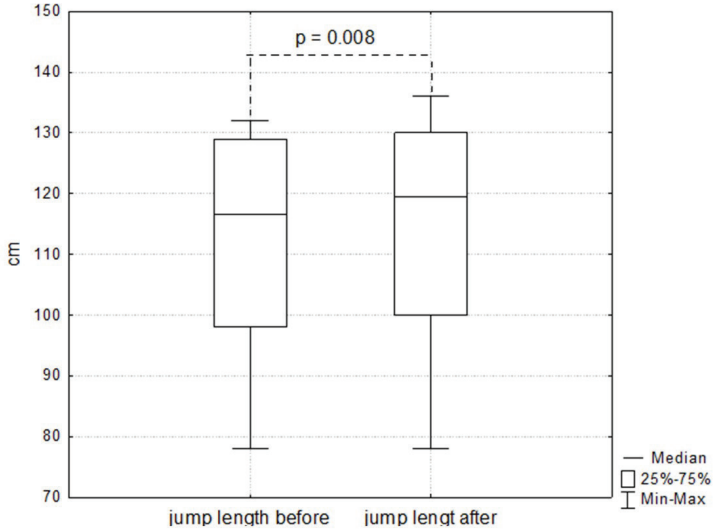

FIGURE 1. Jump length of the athletes (Distance, cm)

Comparisons of the results of the test "Standing long jump" showed that 90% of the athletes improved their speed and power capabilities. However, 10% of them remained unchanged. The data obtained indicate that the proposed method of development of the speed and power capabilities of the organism is effective, but not suitable for all groups. Research has found that children with cerebral palsy and autism have improved their rates. In the diagnosis of physical retardation, improvement of the result did not occur, which indicates the need to refine the methodology for the development of the speed and power capabilities or change the control test for this group.

When performing Abdominal crunches test, no errors were detected in any of the study, although the number of elevations counted was significantly different. This can be explained by the strengthening of the external and internal muscles of the abdomen of the athletes.

During the determination of changes in the development of the strength endurance of the athletes, the test "Abdominal crunches" was performed (Figure 3).

The results of the comparison of the test "Abdominal crunches" showed that the level of endurance was noticeably increased. The results showed a positive impact of the "Karate – train together" program on the development of the strength endurance of athletes with disabilities.

The test "60 meters running" was performed from a high

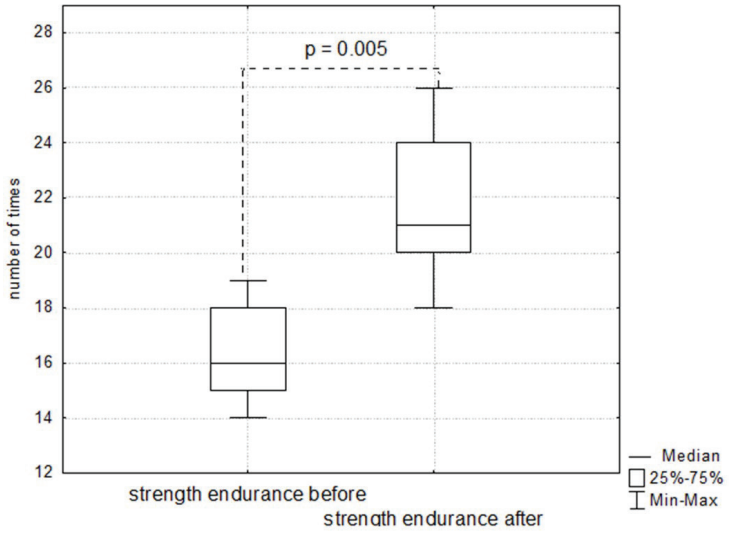

FIGURE 3. The level of development of strength endurance of the athletes (Number of repetitions)

start on special tracks in the gym. During the first run of the test, the athletes made some mistakes that were due to their level of health and physical development. In the first phase of the research, not everyone was able to run 60 metres in one attempt. To solve this problem, a series of exercises were performed throughout the research, which improved the body ability to perform it. Movement speed was improved by increasing the level of neuromuscular coordination, muscle strength, and by improving the body ability to exert great muscular effort. The following methods were used for the development of speed: repetition (exercise with maximum speed), circular training (involvement of major muscle groups), game (exercise for speed in motive games, relay and sports games), competition (performance of exercise with maximum speed while competing with each other).

To determine changes in the development of speed capabilities, the test «60 meters running» was performed. There were no significant differences in the level of development of speed capabilities of the athletes after a pedagogical experiment on the author's program.

The results of the research showed that the data of the test "60 meters running" remained unchanged in 100% of cases after training under the developed training program. The results obtained indicate that this training affects the development of flexibility, strength and endurance, but does not develop speed and only support the level of its development. However, it is important to note that during the second study, all athletes were able to perform the test on the first attempt, although they did not improve their time, which can also be considered a positive result.

Discussion

Analysis of the results of studies of specialists in the field of physical culture and sports (including karate) showed that the vast majority of researches are aimed at studying the features of technical and tactical training of athletes (Ermakov & Boychenko, 2010), the development of an individual approach to the technical training of athletes (Ashanin & Litvinenko, 2011) and a general description and analysis of techniques of tactical and technical training in karate (Sedenkov & Britvina, 2012). The features of competitive activity in karate and methods of individualization of technical preparation of athletes are presented in the aforementioned works. Most karate studies have identified the original models of competitive activity, and therefore sports training. The training process in karate (among athletes without developmental disabilities) is mainly aimed at increasing the level of technical and tactical training, which is based on an individual approach. Our research has shown that a special feature of the training process for athletes with disabilities is the use of an inclusive approach to increase the level of physical development and physical fitness of athletes.

The organization of the training process for athletes with disabilities and athletes without developmental disabilities has significant differences. First, psychological and physical training plays a significant role in the training process for athletes with disabilities, while physical, technical, tactical, psychological and integral training is equally important for athletes without developmental disabilities. Secondly, general preparation training is more prevalent for athletes with disabilities, as opposed to special training and competitive one for athletes without developmental disabilities (due to the complexity of the tasks). Thirdly, training of people with disabilities is most often used in visual (demonstration of exercises and their elements by a trainer or qualified athlete) and practical (aimed at developing motor skills) methods. To a lesser extent, karate for athletes with disabilities uses verbal methods that use specific terminology in combination with visual methods. A group of practical methods aimed at mastering of sports technique (formation of motor skills) is presented in the training process of both athletes without developmental disabilities and athletes with disabilities. The structure of practical training methods for both is presented within the framework of the continuous, interval, playing and competitive methods.

The main task of an inclusive approach in the organization of the training process of athletes is their socialization and integration into the society. It has been scientifically proven that inclusive physical education and sports have a positive impact on all participants in the training process (Klavina, Ostrovska, & Campa, 2017; Mihajlovic, 2017; McGrath et al., 2019). Today, the "Unified Sports" Special Olympics program solves similar tasks, which promotes the integration of athletes with intellectual disabilities into society and enables both Special Olympics athletes and their partners to improve their sports and social

skills. By analyzing the results of the questionnaire of parents and coaches in our research, we also proved the positive social and humanistic impact of the "Karate – train together" developed program on all participants of the training process.

Conclusions

Therefore, the results obtained, namely the improvement of the level of physical development indicators (height, body weight) and physical fitness (level of development of flexibility, speed and power capabilities, strength endurance) testify to the effectiveness of the application of the developed karate training program for athletes with disabilities during training process. While conducting the summative assessment of the II phase of the study, the athletes mastered the proper technique of performing the proposed exercises and fully performed all the physical tests without making mistakes in execution. The indicators of the test "Sit and reach test" improved overall by 73.1% with the test "Standing long jump" by 2.3% and the test "Abdominal crunches" by 33.4%. The performance of the test "60 meters running" remained unchanged. Increasing the level of physical development of children states the correctness of the selected exercises and techniques in the program, the adequacy of the load and the efficacy of using the proposed methodology when working with children with cerebral palsy, physical retardation, and autism.

The results of the study can be used by experts in the field of physical culture and sports in writing inclusive programs for other sports and working with people with disabilities.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Specifics of Organization of International Complex Competitions in Non-Olympic Sports

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Abstract

The specifics of organization of one of the largest projects in non-Olympic sports - the World Games, and novel competitions - the World Games SportAccord were considered. The main methods used were: the analysis of competitions reports, historical, systematic and comparative analysis, and an expert survey. As a result of the research there were: 1) developed the periodization of the World Games in the context of their organization (taking into account the activities of organizing committees, information, economic supply and staffing of these competitions; 2) summarized the features of complex competitions in non-Olympic sports (the World Games and the SportAccord World Games) in comparison with the Olympic Games, as well as the criteria for including sports in competition programs; 3) grounded the actual groups of problems of the organization of competitions; 4) confirmed the scientific data on the impact of current development trends of sports (professionalization, commercialization, globalization; emergence of new sports, their organizational structures and competitions; increase of the level of sporting achievements; the increasing role of the television and the Internet) on the organization of international complex competitions in non-Olympic sports .The obtained results of the research were implemented at the national level at the complex competitions in non-Olympic sports (the All-Ukrainian beach games, the All-Ukrainian martial arts games).

Keywords: *non-Olympic sport, organization of complex competitions, World Games, the SportAccord World Games, components, factors and problems of organization of competitions*

Introduction

Modern non-Olympic sport is a socio-cultural phenomenon, one of the directions of the sports movement where interconnected processes of sports training, organization and holding of sports competitions in mainly those sports that are not included in the Olympic program are realized. The fact that there are a lot of non-Olympic sports developing in different countries around the world indicates the scale of their spread.

Since the number of sports is constantly growing, the number of competitions in non-Olympic sports, including complex ones, is also increasing. There were launched the World Games (1981), the SportAccord World Games from groups of sports (2010-2019); the popularity of extreme games (Gravity and X-games) is growing, some federations organize international complex tournaments, etc. The majority of sports forming the programs of these competitions belong to the system of non-Olympic sports. The leading structures of this sports direction use the principles of "fair play" in their activities, as well as promote sports without discrimination, on the basis of peace and counteraction to the negative consequences of modern post-industrial society.

Non-Olympic sports were out of the attention of scientists for a long period of time. However, their intensive development in recent decades, recognition and support of their structures and competitions by the IOC have intensified the research aimed at studying the preconditions for their emergence and formation (Kilasov & Havrov, 2014; Platonova,

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2012), determining their place and role in the international sports movement and modern society (Dolbysheva, 2014, Imas et al., 2015), organization and holding of the main competitions - the World Games (Dolbysheva, 2012; Nurminen, 2017; Daszkiewicz, 2018).

The constant emergence of new competitions, as well as the rivalry between the existing events, makes the initiators and organizers constantly look for the ways to improve their efficiency. According to both theory and practice, the successful organization of sports competitions depends on the understanding of sports officials of modern conditions for the development of sports. The survey of works devoted to the organization of competitions allowed to establish that a number of scientists (Zuev & Suleimanov, 1997; Evseev, Kurdybailo, & Suslyaev, 2007; Altukhov, 2008; Balabanova, Ukraintseva, & Koshcheev, 2008; Chalip, 2004; J. R. Gold & M. M. Gold, 2016) consider the organization of competitions as a process and distinguish six main components (organizational and managerial, material and technical, personnel, legal and regulatory, economic, and information). The analysis of scientific and methodical literature revealed the lack of research on the peculiarities of the implementation of the components of the organization of complex competitions in non-Olympic sports, which keeps current the consideration in this direction.

Methods

The research methodology was based on a comparative analysis of two international complex competitions in the system of non-Olympic sports: the World Games - one of the largest projects having been developed during 40 years, and the SportAccord World Games that are rather new competitions. The analysis of literature sources, documentary materials and information on the Internet allowed to systematize modern ideas about holding complex competitions, to identify the main components of their organization. The reports on the World Games (1981-2017) and the SportAccord World Games (2010-2014), as well as their regulatory support were analysed; the features of implementation of the basic components of the organization of these competitions were revealed. The study of the reports helped to identify changes in approaches to the organization of the World Games from 1981 to 2017 and allowed to develop periodization in the context of their organization. Quantitative and qualitative parameters that were analysed and compared in the reports: the structure and activities of the organizing committees, the formation of competition budgets, coverage of competition events, and volunteering. In addition, the comparison and analogy helped to identify common and distinctive features of the World Games and the SportAccord World Games, as well as to compare the problems of the organization of the Olympic Games.

The expert survey with the participation of four members of the organizing committee of the X World Games in Wroclaw (Poland) allowed to identify the main groups of problems affecting the process of organizing these competitions. For the selection of experts the following criteria were taken into account: the expert had to hold senior positions in the organizing committee, coverage of all major activities. In the structure of the organizing committee of the X World Games, 4 main departments were created (Finance & Administration, Marketing, Sport & Venues, Games Service), the head of each of them took on the role of an expert.

The methods of mathematical statistics were used to determine the consistency of experts' opinions (concordance coefficient - W, verification of its statistical reliability).

The concordance coefficient (W) was determined according to the formula:

$W = \frac{12S}{m^2(n^3 - n)}$, where: W - the concordance coefficient, m - number of experts, n - number of examination objects, S - the sum of the squares of the deviations of the ranks:

$S = \sum_{i=1}^{n} ((\sum_{j=1}^{m} x_{ij}) - \bar{x})^2$, where: – the average score set by m experts on all n objects of examination, was determined according to the formula: = m (n + 1) / 2

The statistical significance of the concordance coefficient was estimated using the χ^2 – a criterion according to the formula: χ^2 = m (n - 1) W. The degree of freedom ν was estimated according to the formula: ν = n - 1. The result of calculations of the consistency of experts' opinions was W = 0.86, χ^2 criterion = 24.5 at p <0.05).

Results

The analysis of reports on the preparation and holding of the World Games (from 1981 to the present) allowed to establish significant changes in approaches to their organization, which became the basis for determining the relevant periods (Figure 1). There was determined the specifics of the structures and directions of activities of organizing committees, approaches to attracting private investment, media coverage, funding received from the host cities, volunteering, which confirmed the complexity of the process of organizing these and similar projects, the need to take into account the experience of previous competitions.

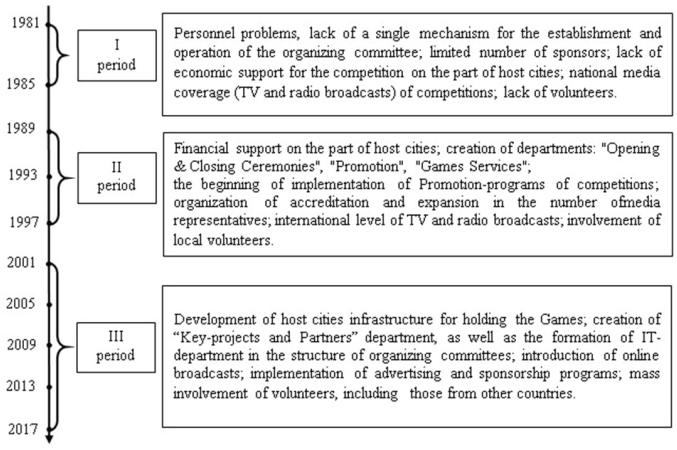

FIGURE 1. Periodization of the World Games in the context of their organization

A comparative analysis of the organizational and managerial structures that coordinate the holding of the World Games and the SportAccord World Games revealed that the process of organizing the World Games is accompanied by the creation of a 5-level management structure similar to the one of the Olympic Games. New projects, such as the SportAccord Games, are defined by a 6-level management structure (Figure 2).

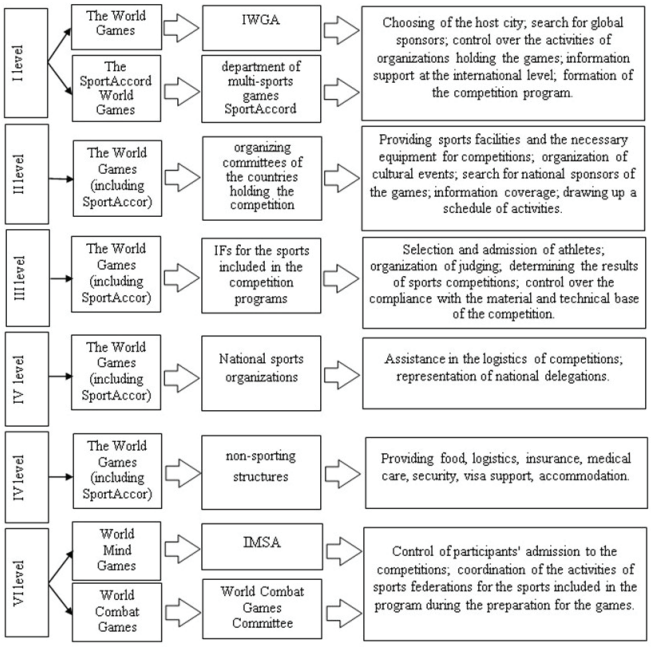

FIGURE 2. The system of organization and management of the World Games and the SportAccord World Games

As a rule, the sixth level includes federations of sports included in the competition program. For example, in order to hold the 1st SportAccord World Combat Games there was created a committee of the same name. Again, the International Mind Sports Association (IMSA) is involved into the preparation and holding of the SportAccord World Mind Games. The need for creation of such structures is confirmed by the fact that the SportAccord Association entrusted the organization of the I World Art Games to the World Federation of Dance Sports. However, the games scheduled for March 2013 did not take place. This indicates the need to create a governing body that unites all International Sports Federations (IFs) for the sports included in the competition program.

The policy of the International World Games Association (IWGA) on the requirements for the material and technical base has remained unchanged since the founding of their competitions. The host city is not required to build sports facilities; it is recommended to use the existing facilities for holding the competitions. However, the practice of holding the World Games shows that they are increasingly held on the reconstructed and in some cases on new sports facilities.

For example, for the organization of the VIII World Games 2009 in Kaohsiung (Taiwan), the local administration improved the city's infrastructure by creating a high-speed transport line and building the country's first solar-powered sports stadium. For the organization of the X World Games 2017 in Wroclaw (Poland), all sports facilities for holding the competitions were reconstructed, as well as a new skate park was built. The expense item for the development of sports infrastructure of the host city amounted to over 10 million dollars.

Again, the budgets of the SportAccord Games are much smaller than those of the World Games, so their organizers often faced some logistics problems. On the other hand, the understanding of the need for holding the competitions in modern facilities to enhance their image encourages the search for opportunities to hold the competitions in the cities having appropriate conditions. Thus, the I SportAccord World Combat Games and the SportAccord World Mind Games were held at the same sports facilities as the XXIX Olympic Games.

One of the important factors in forming a positive image of the competitions is their information supply. For example, the 2013 World Games in Cali, Colombia, were covered by more than 900 accredited journalists, and the competitions were broadcast on 25 channels in more than 120 countries of the world. However, the sale of rights to telecast competitions in non-Olympic sports does not bring significant profits. Usually the right to cover the sports events is bought by national and regional TV companies. For example, the 2012 SportAccord World Mind Games in Beijing (PRC) were broadcast by more than 90 channels, 78 of which operated exclusively in Asian countries. Thus, the involvement of larger television companies, the organization of online broadcasts may become promising areas for improving the information support of the competitions.

In addition, finding volunteers is an important task of information support. Their massive involvement in the organization of the World Games, including those from other countries, began in 2001 (Akita, Japan), due to the need for a large number of assistants speaking English well and a small percentage of the Japanese population who spoke it.

The organization of international complex competitions is impossible without significant financial investment. Therefore, among the priority areas of activities of the organizers are the calculation of the competition budget, the implementation of marketing strategy, the search for new sponsors and more. The research showed that competitions in non-Olympic sports are associated with the problem of limited funding. This is due to low popularity and, consequently, a small audience. The

implementation of advertising and sponsorship programs is accompanied by the involvement of a small number of sponsors at the national level. Thus, the sponsors of the 2017 World Games were 12 national companies and only 3 international ones. Restrictions in the competition budget necessitate the search for the ways to save which may affect the quality of the event. For example, economic problems in preparation for the 1993 World Games led to the denial of centralized accommodation for all delegations. Besides, sports facilities were not completely ready for the competition. Miscalculations in the implementation of the PR-campaign (leaflets and advertising posters were printed and distributed after the games had started) had a negative impact on the number of audience. Therefore, when forming the competition budget, it is necessary to take into account and correlate the sources of income and the expenditure items, to identify priority areas of economic support, as well as to predict situations that may require additional funding. As practice shows, a large contribution to the gaming budget is provided by advertising and sponsorship programs. Therefore, their development should be carried out by experienced marketers taking into account the capabilities of future sponsoring companies.

The success of complex competitions largely depends on the content of their programs. The results of the research allowed to generalize the criteria for the inclusion of sports in the programs of the World Games and the SportAccord World Games and to determine the main factors influencing the formation of the programs of these competitions (Figure 3).

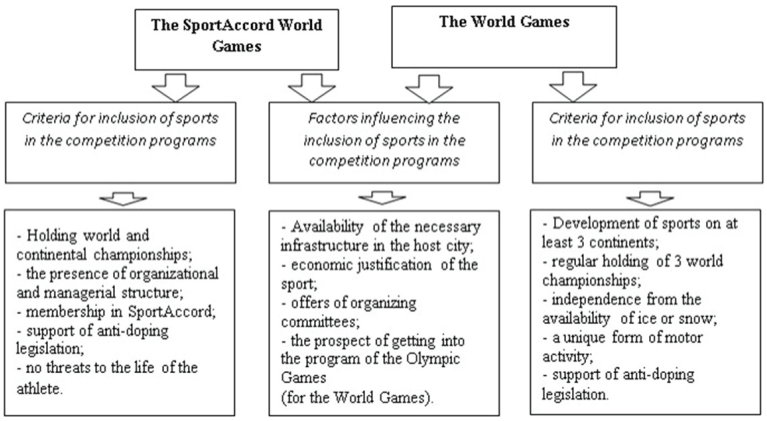

FIGURE 3. Conditions for the formation of programs of complex competitions in non-Olympic sports

The conducted researches allowed to define two groups of the basic problems of the organization of international complex competitions:

1. Direct (numbers 1 - 6 on the Figure 4) – related to the organization of the event (it is logical to consider them in conjunction with the main components of the preparation of the competitions).

2. Indirect (numbers 7 - 9 on the Figure 4) – not related to sports, but having a significant impact on the quality of the competitions, therefore they are certain to be taken into account.

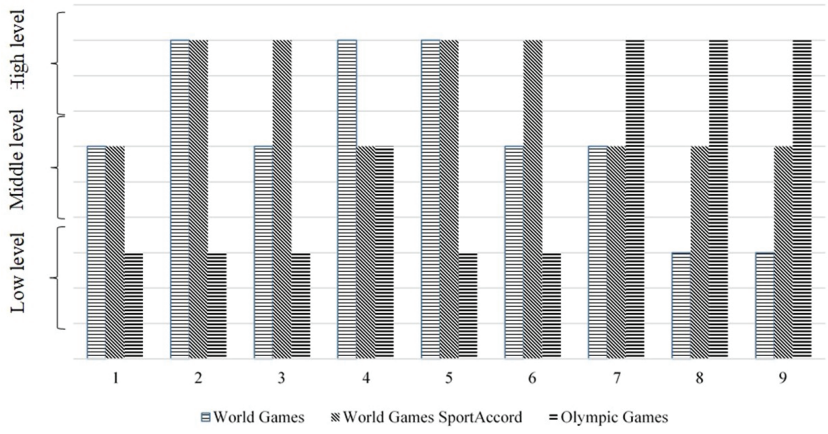

FIGURE 4. Groups of the basic problems of the organization of international complex competitions:
1 – organizational, 2 – economic, 3 – personnel, 4 - material and technical, 5 – informational,
6 – legal, 7 – political, 8 – ecologic, 9 - safety-related

According to the analysis of the largest international complex competitions, the accumulated experience of their organization allows to reduce significantly the acuteness of direct problems. On the other hand, the ever-increasing popularity and the increase in scale keep current a group of indirect problems.

In the process of organizing competitions in non-Olympic sports, the dominant part of the problems is direct. And the less experience of competitions is, the more relevant they are. The results of the expert survey of members of the organizing committee of the 2017 World Games confirm the existence of this trend. Thus, according to the experts, the most relevant groups of problems for the World Games are informational (7.6 points), material and technical (7.5 points) and econom-

ic (7.3 points); groups of political (4.1 points), ecologic (2.6 points) and safety-related issues (2.3 points) are less evident ($W = 0.86$ and $\chi 2$ criterion = 24.5 at $p < 0.05$).

As a result of the analysis and generalization of international experience and practice of holding complex competitions in non-Olympic sports, as well as the survey of members of the organizing committee of the 2017 World Games allowed to identify both causes and consequences of direct problems of organization of complex competitions in non-Olympic sports (Table 1).

Table 1. Causes and Consequences of Direct Issues of Organization of Complex Competitions in Non-Olympic Sports

Groups of issues	Causes	Consequences
Organizational	Lack of a general mechanism for preparing and conducting competitions; lack of qualified specialists.	Failure to hold competitions; failure of terms of holding competitions; inconvenient schedule, etc.
Legal	Short history of competitions; lack of necessary documents.	Lack of a mechanism for choosing the host city, general rules for the inclusion of sports in the program of competitions, requirements for places
Informational	Low popularity of competitions; absence or poor work of the PR-department of the organizing committee.	A small number of spectators; absence or poor coverage (TV and radio broadcasts); disinterest of sponsors, etc.
Financial	Ineffective marketing strategy of the organizers; limited assistance on the part of the state and the host city.	Small competition budget affecting the efficiency and effectiveness of other components of the organization; insufficient PR-company, etc.
Personnel	Lack of staff training centres; lack of special volunteer training programs; ineffective advertising policy.	Lack of staff; low-quality work of competition services (food, security, medical care), etc.
Material and technical	Limited competition budget.	Lack of necessary sports complexes; formation of a negative image of the host city, etc.

Taking into account the possibility of occurrence and the level of manifestation of the above problems in the organization of complex competitions will simplify the process of preparation of these projects. In addition, the systematization and evaluation of the problems of organization of the World Games contributes to the search for a mechanism for solving them.

Discussion

Our research confirmed the opinion of a number of specialists (Dolbysheva, 2012, Imas et al., 2015) that one of the latest trends in the development of the international sports system is the formation of a new direction, the non-Olympic one. In the works of Krylasov and Havrov (2011), the tendency of increase of the number of new non-Olympic sports in the second half of the XX century is emphasized. The constant emergence of new forms of physical activity, the restriction of programs of existing events and the globalization processes stimulate the emergence of new complex competitions.

The analysis of the works of scientists in the sports field (Borysova, 2011; Zenkova & Kohut, 2013; Platonov, 2015) identified a number of trends characterising modern sports. The main ones include: professionalization, commercialization, globalization; emergence of new sports, their organizational structures and competitions; increase of sporting achievements; the increasing role of the television and the Internet, etc. All these changes actively affect the organization and holding of competitions.

The process of preparation of complex competitions includes six main components: organizational and managerial, material and technical, legal and regulatory, economic, personnel, and information (Zuev & Suleimanov, 1997; Altukhov, 2013; Manikhin, 2010). Our research on the example of competitions in non-Olympic sports confirms the existing scientific knowledge and complements it in terms of the allocation of the sixth level of management.

According to Evseev et al. (1997) the entire material and technical base of sports competitions can be divided into 2 groups: the means necessary for the organization of the sports part of the competition (sports facilities, equipment, etc.) and the means necessary for the implementation of the activities out of the competitions (infrastructure of the host city, opportunities for the television, etc.). As the practice of organizing the Olympic Games, where there are clear and strict requirements for the development of the infrastructure of the host city, shows the host country of the Olympic Games has to spend a significant part of the competition budget on the infrastructure development. In turn, the organization of international complex competitions in non-Olympic sports is more economical and does not require such financial costs. Yes, the IWGA does not demand to build new sports facilities and develop infrastructure from the host city, and the competition program is formed depending on the capabilities of the host city.

The analysis of the works of Balabanova et al. (2013), Zenkova and Kohut (2013), Dereka (2016) showed that nowadays staffing and training of volunteers is an important element of the organization of competitions. Researchers note that more than 20 qualification groups are involved. The modern practice of holding the Olympic Games and the globalism of these competitions encourage the organizers to recruit about 70 thousand of volunteers. The number, selection criteria, and training of volunteers in non-Olympic sports are smaller.

Genusov (2010), Manikhin (2010), Shannon (1999), Smith, Graetz and Westerbeek (2006), Speed and Thompson (2000) note that an important component of the organization of competitions is their financial support. Compared to the Olympic Games, international complex competitions in non-Olympic

sports are characterized by less funding on the part of both the state and sponsors. Only in the year 1997, during the World Games advertising and sponsorship programs, mainly aimed at national business companies, began to be implemented. Non-Olympic sports competitions are not characterized by large profits from the sale of television broadcasting rights due to the small audience of these events compared to the Olympic Games.

Our research confirms the opinion of Filippov and Ermylova (2009), Bruce (2004) concerning the fact that today one of the most important factors in the organization of competitions is their information coverage. The need to form well-thought-out and versatile advertising companies, to organize TV and Internet broadcasts of competitions in order to increase the popularity and growth of audience is emphasized.

Regarding the legal component of the organization of international complex competitions in non-Olympic sports, it is proved that it is similar to the Olympic sports competitions and also includes 3 main groups of documents (international law, legislation of the countries hosting the competitions and "Lex sportive") (Alekseev, 2008).

Thus, the current practice of organizing large-scale international complex competitions in non-Olympic sports were analysed, the features, including those common with the Olympic Games, were revealed, the current problems that accompany this process were identified.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

The Use of Ergometry in the Kayakers´ Special Physical Conditioning

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Abstract

The main objective of this research was to determine the individual parameters of the ergometric working capacity, aimed at increasing the functionality and special performance of kayakers. Subjects in the research were 20 elite male kayakers, leading athletes of Jiangxi provinces, age =21.9±2 years. Testing of special working capacity and functional readiness of kayakers, shows the individual and statistical characteristics of ergometric power and energy supply of work corresponding to the level of training of skilled athletes. A number of indicators (VO_2max – 6.0 l·min^{-1}, La test 30 s– 12.0 mmol·l^{-1}. La test CP – 16.0 mmol·l^{-1}) indicated the high potential of kayakers who corresponded to the world-class model. The given individual and statistical characteristics of the kayakers' readiness testify that the increase of efficiency of functional maintenance of a particular area affects the working capacity and functional capabilities of the kayakers in the process of overcoming all segments of the competition distance. Increasing special working capacity based on the relationship between the structure of special functional readiness and the structure of competitive activity is one of the most effective ways to form and to realize functional reserves of special readiness of kayakers.

Keywords: *kayakers, ergometric power, aerobic power supply capacity, functionality testing, working capacity*

Introduction

The main condition for effective functional training is the formation of training load modes, which are based on the high accuracy of measuring the parameters of the work and functional capabilities of athletes in accordance with the structure of the functional support of the special performance of athletes in a specific competitive discipline (Droghetti et al., 1998). Observance of high accuracy of measurement makes it possible to form modes of training exercises in which the highest (necessary) level of the body's reaction was achieved (Lysenko, Shinkaruk, & Samuilenko, 2004). This can be achieved only through the implementation of control as a system component of management of the training process, when its functions allow assessing the level of training, to form the direction of sports training, and to determine individual parameters of training work (Mac Dougall, Wenger, & Green, 1991).

The special literature presents the means and methods of testing athletes, which make it possible to form load conditions, where the components of the functional support of special working capacity are fully manifested. The special literature presents testing methods, which show the conditions of implementation of the components of anaerobic energy supply - anaerobic lactate and lactate power and capacity (Mac Dougall et al., 1991), aerobic power (Diachenko et al., 2020), aerobic capacity (Bourgois & Vrijens, 1998; Droghetti et al, 1998), functionality in terms of compensation for fatigue during critical power loads (Hill, 1993) and others.

The problem is that with a wide choice of testing methods, the issue of applying test results in practice remains little studied. The test results are focused on assessing the readiness of athletes, who, as a rule, determine the direction of correction of the training process.

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There is a clear lack of methods that allow simulating training loads in accordance with the individual level of the athlete's response. Training loads, as a rule, are focused on the maximum parameters of intensity (power) and duration of work. At the same time, the individual norms of the body's reaction to specific training and competitive ones, which underlie the optimization of the "dose-effect" ratio of the impact, are little taken into account. This negatively affects the formation of training effects. This is well illustrated by the example of the development of aerobic energy supply. The development of aerobic energy supply requires the exact correspondence of the work parameters to the functional support of working capacity in the threshold zones of the reaction of the cardiorespiratory system and aerobic energy supply (AT, VO_2max). It is well known that exceeding the level of reaction leads to a change in the structure of the reaction and, accordingly, to a change in the effects of training tools (Bourgois & Vrijens, 1998; Michael, Rooney, & Smith, 2008; Paquette, Bieuzen, & Billaut, 2018).

Many authors associate the solution with the use of ergometry as a control of functional readiness and a tool for managing training loads (Bourdin, Messonnier, Hager, & Lacour, 2004; Carrasco, Martinez Diaz, De Hoyo, Sanudo Corrales, & Ochiana, 2010; de Klerk, Velhorst, Veeger, van der Woude, & Riemer Vegter, 2020). Modern ergometry is based on the use of special simulators, which, according to the kinematic and dynamic structure of locomotion, simulate the conditions of competitive activity and allow real-time recording of work parameters (Dal Monte, Faina, & Menchinelli, 1992; Steer, McGregor, & Bull, 2006; Šarabon, Kozinc, Babič, & Marković, 2019). In the control system and in the process of training in cyclic sports, simulators are used that allow an athlete to independently (without program correction) develop the ergometric power of work in accordance with his individual efforts. This opens up new possibilities for the implementation of the main principle of functional training - the use of conditions for achieving and maintaining the level of reaction necessary for the development of athletes' functional capabilities.

In kayaking, the "Dansprint" ergometer simulator is widely used. The technical parameters of the ergometer make it possible to model the parameters of the competitive activity of kayakers at distances of 200 m, 500 m and 1000 m, as well as the conditions for the implementation of the components of the functional support of special working capacity (Carrasco et al, 2010; Wang, Rusanova, & Diachenko, 2019). Comprehensive testing of kayakers using ergometry and biological methods of measuring functional capabilities allows determining with high accuracy the parameters of work at which kayakers have reached maximum power and reaction capacity. Under the conditions of testing with the use the "Dansprint" ergometer, informative characteristics of the threshold of anaerobic metabolism (AT), maximum consumption of O_2 (VO_2 max), pulmonary ventilation (VE), CO_2 release (VCO_2), calculated reaction characteristics (EqO_2 and $EqCO_2$) and other reaction characteristics were recorded organism on model loads (Diachenko et al., 2020). An important condition for the implementation of ergometry as a tool for monitoring and modeling training loads is the measurement of changes in reaction in the process of a steady state and compensation of fatigue. The use of ergometry makes it possible to measure with high accuracy and apply in practice the working conditions aimed at the development of these highly specific manifestations of the functional support of special working capacity. In theory and practice, such approaches are presented in the process of modeling various load cases "critical" power (CP) work (Hill, 1993).

This gives grounds to use the data of testing functional capabilities for the formation of individual parameters of training work and use them in accordance with the patterns of stimulation of adaptation processes under the influence of intense physical loads.

Purpose of the study was to determine the individual parameters of the ergometric power of work, aimed at increasing the functionality and special performance of kayakers.

Methods

Subjects

Twenty (20) elite male kayakers, leading athletes of Jiangxi provinces, age =21.9±2 years. All participants were informed of the requirements prior to the study, and gave their informed written consent to participate. The local research ethics committee in the spirit of the Declaration of Helsinki approved all procedures.

Research protocol

For standardizing the measurements of special performance, the "Dansprint" kayakers´ ergometer were used VO_{2max}, La, and ergometric power (EP) of work were recorded. The specialists of the Scientific Sports Management Research Centers in Shandong Province (Jinan) and Jiangxi (Nanchang) carried out the measurements of the reaction of the cardiorespiratory system and blood sampling for lactate measurement.

Variables measured

Gas exchange, HR, and blood lactate measurements.

Oxygen consumption ($V\dot{}O_2$), CO_2 production ($V\dot{}CO_2$), minute ventilation ($V\dot{}E$), and RER were determined on a breath-by-breath basis using an Oxycon mobile (Jaeger) metabolimeter. HR was recorded every 5 s with an HR monitor (S610 Polar Electro, Kempele, Finland).The blood lactate concentration ([La]b) was determined using a portable lactate analyzer (Biosen S. line lab +).

The content of the testing program (Vogler et al, 2010; Wanget al 2019) is presented in Table 1.

To assess the power of the aerobic energy supply, we analyzed the highest VO_2 values in the steady state period within ± 0.1 l / min (VO_{2max} / kg) with a duration of at least 20 s.

Statistical Analysis

In order to assess and analyze the data received the Statistical Package (SPSS 10.0) was used. Descriptive statistics suggested defining arithmetical average - $\overline{x}$, standard deviation - SD, as well as median - Me, maximal (Max) and minimal (Min) indices, 25% and 75% indices. Correlation analysis used. The data was verified in accordance with the normal probability law (applying the Shapiro Wilk criteria). If the data were normally distributed, then in order to define the statistical significance, Student t-Criteria was applied. In case the data were not normally distributed, non-parametric criteria of Wilkinson was applied to define the statistical significance. The error probability during the statistical analysis was set at the level of p=0.05 (significance level).

Table1. Characteristics of tests and indicators aimed at assessing the special work ability and functionality of kayakers, taking into account fatigue compensation

Test task parameters	Registered indicators
Modelling of conditions of realization of Anaerobic Alactic (AA) power- "test 10 s"	$\bar{W}$ 10 c, Watt
Recovery period - 3 minutes	
Modelling of conditions of realization of Anaerobic Power (ANP) - "test 30 s"	$\bar{W}$ 30 c, Watt; La test 30 s, mmol·$^{l-1}$ (blood sampling 3 and 7 minute recovery period); delta (Δ) lactate difference of lactate 3 and 7 minutes.
Recovery period - 10 minutes	
Modeling of conditions of realization of aerobic power - "step test". Duration of work on a step - 2 min, number of steps - individually, before decrease in EP of loading set on a step. EP of the first stage = EP of standard loading + 30 Watt; increase in EP load on the step + 30 Watt	$\bar{W}$ VO_2max, Watt VE/VO_2,c. u., V_E/VCO_2,c. u.; VO_2 max / kg, ml·min^{-1}·kg^{-1}; VO_2 max, l·хв$^{-1}$
Recovery period – 1 minute	
Modeling the conditions of fatigue - test "CP test 90 s"	$\bar{W}$ "CP test 90 s", Watt; VE/VO_2, VO_2 c. u., .; V_E/VCO_2;VO_2 c. u., VO_2 / kg, ml·min^{-1}·kg^{-1}; VO_2max, l·min^{-1} La, mmol·l^{-1} (blood sampling 3 and 7 minute recovery period); delta (Δ) lactate difference of lactate 3 and 7 minutes.

Results

Testing of special working capacity and functional readiness of kayakers was carried out. Table 2 shows the individual and statistical characteristics of the ergometric power of the kayakers ' work. The table shows that the average indicators of ergometric power and energy supply of work correspond to the level of training of skilled athletes. Several indicators (VO_{2max} – 6.0 l·min^{-1}, La test 30 s– 12.0 mmol·l^{-1}. La test CP – 16.0 mmol·l^{-1}) indicated the high potential of kayakers who corresponded to the world-class model.

Table 2. Individual data on ergometric power and functionality of kayakers, (n=20), p<0.05

№ athletes	$\bar{W}$ test 10 s	$\bar{W}$ test 30 s	La test 30 s	VO_2 max	VO_2 max/kg	$\bar{W}$ VO_2 max	$\bar{W}$ test CP 90 s	La test CP 90 s
1	461.0	392.0	10.3	4.1	50.2	187.0	212.0	15.8
2	541.0	432.0	9.1	4.7	50.0	210.0	270.0	15.8
3	405.0	410.0	9.5	6.0	64.9	227.0	229.0	15.,4
4	428.0	462.0	11.8	5.9	63.4	207.0	231.0	18.3
5	436.0	394.0	10.5	5.0	62.5	184.0	254.0	15.5
6	506.0	408.0	9.3	5.5	61.2	182.0	249.0	16.0
7	508.0	483.0	10.9	6.0	63.2	191.0	269.0	13.0
8	497.0	417.0	9.8	4.1	45.1	184.0	255.0	12.8
9	397.0	363.0	12.1	4.5	54.2	170.0	215.0	11.0
10	427.0	418.0	11.7	5.2	56.0	187.0	247.0	10.3
11	449.0	370.0	10.7	5.0	60.6	189.0	229.0	13.8
12	373.0	338.0	7.6	5.0	62.5	164.0	191.0	14.7
13	337.0	331.0	8.6	4.4	56.9	159.0	217.0	15.8
14	416.0	360.0	8.8	4.3	51.2	171.0	196.0	14.8
15	369.0	311.0	10.1	3.9	44.5	178.0	213.0	16.0
16	318.0	295.0	7.5	4.2	55.6	136.0	143.0	12.2
17	336.0	252.0	5.6	4.2	52.1	145.0	181.0	10.7
18	299.0	254.0	7.7	4.0	56.3	128.0	148.0	11.9
19	288.0	298.0	6.6	4.9	54.4	162.0	161.0	10.9
20	292.0	329.0	9.3	4.2	50.6	169.0	192.0	14.1
	404.2	365.9	9.4	4.8	55.8	176.5	215.1	13.9

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Table 2. Individual data on ergometric power and functionality of kayakers, (n=20), p<0.05

№ athletes	$\bar{W}$ test 10 s	$\bar{W}$ test 30 s	La test 30 s	VO_2 max	VO_2 max/kg	$\bar{W}$ VO_2 max	$\bar{W}$ test CP 90 s	La test CP 90 s
median	410.5	366.5	9.4	4.6	55.8	180.0	216.0	14.4
SD	76.8	64.6	1.7	0.7	6.1	24.2	37.8	2.2
min	288.0	252.0	5.6	3.9	44.5	128.0	143.0	10.3
max	541.0	483.0	12.1	6.0	64.9	227.0	270.0	18.3
25%	336.5	320.0	8.2	4.2	50.9	163.0	191.5	12.1
75%	455.0	413.5	10.6	5.1	61.9	188.0	248.0	15.8
CV	19.0	17.7	18.6	14.4	11.0	13.7	17.6	16.0

Legend: $\bar{W}$ test 10 s - average ergometric power of work in test 10 s; $\bar{W}$ test 30 s - average ergometric power of work in test 30 s; La test 30 s- lactate concentration after test 30 s; VO_2max -oxygen consumption; VO_2max / kg- relative oxygen consumption; $\bar{W}$ VO_2max- maximal aerobic power; $\bar{W}$ test CP 90 s - average ergometric power of work in test 90 s; La test CP90 s - lactate concentration after test 90 s

Table 3 shows a high degree of intercorrelation of indicators of ergometric power and functionality of kayakers. At the same time, attention is drawn to the fact that with a large number of reliable links, most indicators have a high level of individual differences.

The characteristics of the relationship between the kayakers' working productivity from the level of functional readiness are presented in Table 4. Noteworthy are the correlations between the indicators of ergometric power of work and physiological indicators of functional readiness.

Table 3. Correlation coefficients of indicators of functional capabilities and ergometric power of kayakers (n=20), p<0.05

Data	$\bar{W}$ test 10 s	$\bar{W}$ test 30 s	La test 30 s	VO_2 max	VO_2 max / kg	wVO_2 max	$\bar{W}$ test CP 90 s	La test CP 90 s
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	–	0.84	0.55	0.41	0.10	0.69	0.87	0.4
2	0.84	–	0.73	0.68	0.33	0.84	0.87	0.4
3	0.55	0.73	–	0.37	0.16	0.61	0.66	0.3
4	0.41	0.68	0.37	–	0.82	0.64	0.50	0.2
5	0.10	0.33	0.16	0.82	–	0.24	0.16	0.2
6	0.69	0.84	0.61	0.64	0.24	–	0.79	0.5
7	0.87	0.87	0.66	0.50	0.16	0.79	–	0.4
8	0.36	0.42	0.28	0.25	0.19	0.53	0.37	–

Table 4. Indicators of the relationship between productivity and functionality of kayakers

The basic component of special efficiency	Physiological characteristics associated with the basic component of correlation dependence
Anaerobic alactic working performance, test 10 s	Power of glycolytic reactions
Anaerobic lactic working performance, $\bar{W}$ test 30 s	Power of glycolytic reactions, maximum consumption o_2 (absolute indicators)
Anaerobic working performance,WVO_2max	Maximum consumption o_2 (absolute indicators), power and capacity of anaerobic lactic energy supply
Work performance during fatigue compensation, $\bar{W}$ test 10 s	Power of glycolytic reactions, maximum consumption o_2 (absolute values)

On the basis of the given data, as well as modeling, it is possible to form the structures of the training process, which are based on the registration of working capacity parameters in accordance with the individual level of reaction and the use of control results in natural conditions of the training process.

Discussion

Ergometry is most widely used in cyclic sports, where special ergometers have been developed and are successfully used in the practice of control and training work, which simulate the kinematic and dynamic structure of locomotion and allow real-time recording of work parameters.

This allowed to simulate test and training loads in accordance with the structure of competitive activities and the general patterns of implementation of functional support of special working capacity (Vilaça-Alves et al., 2016). These can be test loads aimed at implementing the integral structure of special working capacity in the process of modelling a competitive distance or its individual components - the initial segment, the middle and the second half of the distance (Wang et

al., 2019). In this case, we are talking about taking into account the specific components of the functional support of special working capacity - a high speed of deployment of reactions, a steady state and compensation for fatigue (Mishchenko & Suchanowski 2010).Depending on the duration and intensity of competitive activity (Nikonorov, 2015), functional readiness (Mishchenko & Suchanowski, 2010), individual reactivity of athletes to neurogenic, hypoxic and acidemic stimuli (conditions that accompany athletes in the process of performing competitive loads) differ in the structure of the reaction and parameters of athletes' performance (Warren, 1986; Miyamoto, Nakazono, & Yamakoshi, 1987; Mishchenko, Lysenko, & Vinogradov, 2007).

The body's response to physiological stimulus forms an individual structure of the functional support of special working capacity, which depends both on the individual capabilities of athletes and on the course of adaptation processes under the influence of training loads that simulate these states. Determination the parameters of such work is possible only on the basis of a comprehensive ergometric and physiological testing, which will make it possible to determine the parameters of work in accordance with the level of reaction and use the registered parameters in the process of standardizing the modes of training work (Withers, Van der Ploeg, & Finn, 1993). An important role is played by the accuracy of measuring the indices of special performance in accordance with the response of the cardiorespiratory system and the energy supply in the process of modeling a specific distance (Ward, Lamarra, & Whipp, 1996).

The proposed methodology allows to allocate the leading components of the functional support of special working capacity, to differentiate the conditions for their registration and to determine the parameters of training work in accordance with the individual body's response to the load. Standardization of measurement conditions allows to control changes in special working capacity during the training period, to check cumulative changes in functional capabilities after a certain period of the training cycle of athletes.

The technique allows to develop and apply in practice types of load, which allow the directed development of the power of anaerobic alactic and lactic energy supply, the power of aerobic energy supply, the possibilities of compensation of fatigue. Optimization of parameters of work and reaction of an organism according to "dose-effect" of influence will allow to stimulate necessary level of the body's reaction, as well as perform the required amount of training work in accordance with the requirements of the structure of the functional support of special working capacity, taking into account the group differences in athletes' readiness.

Obviously, in the process of developing training programs, it is necessary to take into account general and special factors that affect the formation of a specialized orientation. In the process of developing training programs, at the very beginning, it is necessary to determine the structure of the functional support of special working capacity in accordance with the structure of the competitive distance, to highlight its leading components and the conditions for their implementation. After that, develop test tasks in accordance with the conditions for the implementation of the components of the functional support of special operability. As a result of testing, register the indicators of ergometric power and physiological characteristics of the reaction. In the process of modeling training loads, use individual indicators of ergometric power of work in accordance with the recorded characteristics of work.

Conclusion

Ergometry is an effective tool for the development and implementation of the body's functional reserves. This modern method of control and management of training loads allows you to determine the parameters of training work in accordance with the individual level of the body's response to the load.

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SportMont

ORIGINAL SCIENTIFIC PAPER

The Characteristics of Physical Fitness Related to Athletic Performance of Male and Female Sport Dancers

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Abstract

The aim of this research was to define specific characteristics of physical fitness of dancers and couples of dancers when analyzing them in relation to their dancing efficiency indices. Quantitative and qualitative characteristics of functional power, fast kinetics and economy indicated high requirements for the high functionality of dancers-athletes. This can be seen from the indicators of the reaction power of the cardiorespiratory system and the energy supply of work. Differences of indicators: relative oxygen uptake (VO_2max); pulmonary ventilation (V_E); carbon dioxide production (VCO_2), anaerobic threshold (AT) for both partners were statistically significant ($p<0.05$). At the same time, high requirements have been set for the fast kinetics and economy of the reaction. It is shown that the quantitative characteristics of the fast kinetics: half-time reaction of oxygen uptake (T_{50} VO), pulmonary ventilation (T_{50} VE); carbon dioxide production ($T_{50}VCO_2$), heart rate (T50 HR) and cost-effectiveness characteristics: oxygen heart rate at maximal oxygen uptake (VO_2/HR at VO_2 max), oxygen heart rate at anaerobic threshold (VO_2/HR at AT); ventilatory equivalent for carbon dioxide at anaerobic threshold (VE/VCO_2 at AT); ventilatory equivalent for carbon dioxide at maximal oxygen uptake (V_E/VCO_2 at VO_2max); ventilatory equivalent for oxygen at anaerobic threshold (VE/VO2 at AT); ventilatory equivalent for oxygen at maximal oxygen uptake (V_E/VO_2 at VO_2 max); oxygen uptake percentage at anaerobic threshold from maximal oxygen uptake (%VO_2AT from VO_2max^{-1}) between partners do not differ significantly. This made it possible to analyze the integral functional readiness of the pair and compare the characteristics of sportsmen-dancers of high and low qualifications.

Keywords: *dancesport, aerobic power, efficiency, fast kinetics responses*

Introduction

It is a well-known fact that sport training in every sport has specific requirements towards athlete's body, determined by the contents of the tournament program. In dancesport, duration of a dancing program is 7 to 8 minutes with 2 to 3 minutes rest interval between different dance types. At the prestigious dancing tournaments athletes complete the dancing program from three to seven times. In every round of a competition, the duration of Waltz, Tango, Foxtrot, Quickstep, Samba, Cha-cha-cha, and Paso Doble must be not less than minute and a half for each, and not less than a minute for Viennese Waltz and Jive. Dance tempo is from 28-30 bars per minute to 58-60 bars per minute in Standard program and from 25-27 bars per minute to 60-62 bars per minute in Latin program. All the above factors combined define high specific physical fitness requirements for dancers.

In recent years, high levels of power supply response indices during dance sport have been recorded and in individual

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cases reached 60.9±6,0 ml·kg^{-1}·min^{-1} (VO_2 max) and 9.0±2.1 mmol·l^{-1}(La) (Bria et al., 2011; Beck, Wyon, & Redding, 2018).

Based on the provided data a notion about high strain of functions, and consequently, about possibly increasing role of fatigue buildup for specific performance of dancers was formed. Level and pattern of fatigue buildup are defined by high specific physical fitness. Its differences increase differences of partners' specific performance during competition. This may be evidenced by such indices of physical fitness as VO_2max and capability of its realization along with an increasing fatigue during dance, change in pulmonary ventilation response and HR at anaerobic threshold and more. As a result of differences in key physical fitness characteristics, range of individual differences related to fatigue buildup may increase. For instance, a mismatch was observed between lactate-acidose levels reached during a Standard program dance (8.5±2.3^{-1} – men, 8.3±3.9 mmol·l^{-1} – women) and aerobic power (VO2 max), providing for the compensation of increasing acidemic shifts (45.8±6.0ml·kg^{-1}·min^{-1} –men, 38.0±8.5 ml·kg^{-1}·min^{-1} – women) (Faina, Bria, Scarpellini, Gianfelici, & Felici, 2001). Fatigue was observed to have most significant influence in semifinal during the performance of the 4th and 5th dances of competition program. In the final, the fatigue appears and influences on the dancers' skills demonstration during the 2nd and 3rd dances (Dalla Vedova, Besi, Cacciari, Bria, & Faina, 2006; Rodrigues-Krause, Krause, & Reischak-Oliveira, 2015). However, existing data, in most cases, relates to stating the existence of high requirements towards energy supply of work performed and don't give a comprehensive description of specifics of such requirements towards functional capabilities of dancers. It is clear that it is hardly possible to limit their adequate assessment to defining maximum oxygen consumption and anaerobic threshold (Vissers et al., 2011; Beck, Redding, & Wyon, 2015). As stated, there is a necessity to single out other characteristics of functional capabilities specific for dancers. We were especially interested in analyzing differences between functional preparedness of male and female dancers. It is well known that these differences do influence the level of special efficiency and demonstration of dancers' skills (Lankford et al., 2014).

We preceded from the fact that physical fitness and dancers' ability to withstand fatigue are based on the increase in aerobic energy supply efficiency in the general energy balance of work considering its specific mode in dance sport. Interpretation of CRS response may be based on the evaluation of ability to quickly, adequately and fully respond to physical load typical for dancers during competitions (Lankford et al., 2014; Burzynska, Finc, Taylor, Knecht, & Kramer, 2017). Based on the above, criteria for specialized enhancement of physical fitness in both partners separately and a couple in general may be improved. Dedicated literature currently contains no such data. It could be based on studying the quantitative and qualitative characteristics of functional ability which deliver the high function deployment speed and long period of stable condition of functions. For that we will need to study the characteristics of fast kinetics and economy of dancers-athletes.

The aim of this study was to define high specific characteristics of dance physical fitness of individual dancers and couples when analyzing against dance performance indices taking into account possible differences of functional preparedness between partners. This can become a prerequisite for making physical and functional training more purpose oriented.

Methods

Subjects

The research included 24 dancers comprising of 12 couples: men of 22.8±5.0 and women of 21.3±4.2 years of age. The athletes formed a homogeneous national and international level in terms of their qualification. They all belonged to Ukraine's national dance sport team and were winners of prestigious international category A Tournaments. All of them had official tournament experience of 5.2-9.5 years. Training load within a week amounted to 12.5±1.1 hours.

Research organization

The research took place during a period of preparation preceding a competition following the voluntary written consent of athletes and approval by the local commission on bioethics of scientific research. All experiment participants took no medication, doping, or other stimulating substances.

Test exercises

We used two test exercises. The first exercise (standard test) consisted of a steady activity – running with standard load at 3.0 m·s^{-1} for 6 minutes with a 0° incline of a treadmill. The second exercise consisted of a gradually increasing load on a treadmill according to VO_2 max measuring protocol (MacDougall, Wenger, & Green, 1991). The whole exercise included 4-5 subsequent stages (intensity levels). Each stage lasted 2 minutes. Load level was increased by changing incline angle (in degrees) of a treadmill by 0.5° with a constant speed of 3.0 m·s^{-1}.

Measurements and equipment

Analysis of physical fitness characteristics was performed based on the assessment of power, kinetics and response efficiency indices in two tests.

First test

Fast kinetics of response (T50) were defined for VO_2, VCO_2, V_E and HR in a 6 min standard load test (in the process of transition from the state of rest while standing on a treadmill) using monoexponential dependence according to S. Ward (Whipp & Ward, 1992).

The second test was performed after 1 minute rest.

Second test

We measured VO_2 levels, CO_2 emission, pulmonary ventilation and heart-rate. VO_2 max and anaerobic threshold (AT) were defined. These indices were registered during gradually increasing load. They were oriented towards a characteristic of ability for the quick development of function (fast kinetics indices), effective functional maintenance of work (functional efficiency indices) and for the evaluation of those response indices of CRS that characterize functional capacity limits of the athletes (power indices). Evaluation was performed based on maximum VO_2 levels, CO_2, pulmonary ventilation and HR, as well as indexes of relation between the said responses at AT and VO_2 max (V_E/VO_2 at AT, V_E/VO_2 at VO_2 max, V_E/VCO_2 at AT, V_E/VCO_2 at VO_2max, VO_2/HR at VO_2max, %VO_2AT from VO_2 max).

We used a system for ergometric and physiological assessment of athletes' functional abilities Meta Max 3B (Cortex, Germany).

Statistical analysis

The statistical analysis used the Statistical Package for

the Social Sciences (SPSS 26.0). The following methods of the mathematical statistics are descriptive statistics, selective method, criterion of consent of Shapiro Wilk, non-parametric criteria of Mann-Whitney. To determine the statistical significance of the differences between samples were used parametric criteria (t-test) for those samples, which corresponded to the normal distribution, and non-parametric criteria for small samples (Wilcoxon test) in other cases. A significance level (that is, the probability of error) was assumed to be $p \leq 0.05$. The informativeness of the tests and indicators was recorded, evaluated under the standard conditions of measurement.

Results

During a gradually increasing load, we assessed the different aspects of physical fitness of male and female dancers comprising in the abovementioned 12 couples. Body mass and height of the men were 70.7±5.8 kg and 179.8±5,1 cm, respectively; of women — 51.5±4.3 kg and 164.9±3.8 cm. We evaluated power, fast kinetics and response efficiency indices.

It should be noted that there were significant individual differences in body length and weight both among men and women. Thus, we took athletes' body mass into account when choosing most of the indices for evaluating functional abilities (Table 1). Statistically significant differences of reaction power indices (VO_2max, V_E, VCO_2) for male and female partners needed to apply special evaluation criteria for these reaction indices for male and female partners apart (Bria et al., 2011).

Table 1. Maximum indices of oxygen uptake, CO_2 emission, and thresholds of pulmonary ventilation response and HR at the maximum load intensity, and at the level of load intensity corresponding to dancers' anaerobic threshold

Indices	Men (n=12)			Women (n=12)			Differences of indices between men and women	
	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	*t*	p
VO_2max, ml·kg^{-1}·min^{-1}	54.8	3.1	5.7	47.5	3.5	7.4	t=5,85	p=0.000007
V_E, ml·kg^{-1}·min^{-1}	1614.9	186.9	11.6	1247.5	132.9	10.7	t=8.18	p=0.000001
VCO_2max, ml·kg^{-1}·min^{-1}	57.9	2.7	4.7	50.3	2.5	5.0	t=8.02	p=0.000001
VO_2at AT, ml·kg^{-1}·min^{-1}	39.7	7.9	19.9	38.9	7.6	19.5	t=0.23	p=0.820795
$V_E$at AT, ml·kg^{-1}·min^{-1}	950.0	221.0	23.3	842.8	96.9	11.5	t=5.12	p=0.00004
VCO_2at AT, ml·kg^{-1}·min^{-1}	37.5	5.5	14.7	38.6	6.4	16.6	t=3.73	p=0.00152
HR max, beat·min-1	185.8	5.3	2.9	173.5	5.4	3.1	t=2.81	p=0.010105
HR at AT, beat·min^{-1}	165.2	7.4	4.5	163.8	5.9	165.2	t=0.35	p=0.728307

Legend: VO_2 max - relative oxygen uptake; V_E- minute ventilation; VCO_2max - maximum of carbon dioxide production; VO_2at AT - oxygen uptake at anaerobic threshold; V_E at AT- minute ventilation at anaerobic threshold; VCO_2at AT- carbon dioxide production at anaerobic threshold; HR max-maximal heart rate; HR at AT- heart rate at anaerobic threshold.

Analysis of indices representing maximum oxygen consumption level, CO_2 emission, anaerobic threshold (AT) and HR revealed that maximum CRS response indices were high.

The value of indices at the AT level were high in men and had a significant range of individual differences. Thus, no statistically significant differences in CO_2 emission and HR indices were recorded.

CRS response indices at the AT level relative to maximum indices in women were at the level of 81.9 % for VO_2, 67.6% for V_E, 76.7 % for VCO_2 and 94.4 % for HR at AT, the same indices in men were as follows: 72.4% for VO_2, 58.8% for V_E, 64.8% for VCO_2, and 88.9% for HR. For VO_2 and HR max differences were significant.

Further, we considered indices characterizing fast kinetics of aerobic energy supply responses and respiratory compensation of metabolic acidosis during high-intensity movement. For this, we considered initial kinetic indices and relative indices between response level, O2 consumption and CO2 emission levels. The latter are defined as characteristics of CRS response efficiency.

An analysis of fast kinetics of oxygen consumption, carbon dioxide emission, pulmonary ventilation and heart rate was made during a 6-minute test with a standard physical load. The analysis demonstrated that differences between male and female dancers were statistically insignificant (Table 2). A high level of individual differences in all indices was registered, as evaluated by CV.

There were no significant differences recorded in the indices of ventilation equivalent for O_2 and CO_2, O_2 consumption

Table 2. Indices of fast kinetics of oxygen uptake, carbon dioxide emission, pulmonary ventilation and heart rate of dancers

Indices	Men (n=12)			Women (n=12)			Differences of indices between men and women	
	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	t	p
T_{50} VO_2, s	28.3	5.6	19.8	29.3	4.3	14.7	t=0.45	p=0.629760
T_{50} V_E, s	26.9	6.3	23.4	27.6	4.0	14.5	t=0.31	p=0.759366
T_{50} CO_2, s	26.5	5.6	21.1	28.0	4.3	15.4	t=0.73	p=0.47.592
T_{50} HR, s	28.0	5.0	17.6	28.3	4.9	17.3	t=1.32	p=0.199847

Legend: T_{50} VO_2- half-time reaction of oxygen uptake; T_{50} V_E - half-time reaction of pulmonary ventilation; T_{50} CO_2 - half-time reaction of carbon dioxide production; T_{50} HR - half-time reaction of heart rate.

ration at AT load level to VO_2 max, O_2 consumption and HR of men and women (Table 3). Those indices mostly characterized efficiency of dancers' work when going through a gradually increasing test.

Differences in ventilation equivalent indices for O_2 and CO_2 at VO_2 max were statistically significant ($p<0.05$). The fact worth noticing is a high level of individual differences in ventilation equivalent for O_2 and CO_2, for both men and women, in the period of reaching maximum rate of work at the AT intensity level. This may be indicative of differences in the intensity of respiratory compensation of metabolic acidosis when reaching maximum response values, as well as at AT intensity level.

Analysis of the rapid kinetics and economy of couples with high and low skill levels showed a high level of requirements for the indicated reaction components, as well as significant differences ($p <0.05$) of the indicated reaction characteristics in athletes of high and low qualifications.

A number of physical fitness characteristics of dancers in couples with high and lower level of specific mastery is represented in Table 4. We compared a group of athletes that had high average score for performing 5 dances (Group 1) with a group having lower athletic mastery indices (Group 2). Groups of athletes (pairs of dancers) with higher athletic mastery levels had higher values of VO_2 max and VE max indices, as well as fast kinetics and response efficiency indices, corresponding physical fitness of athletes.

Table 3. Characteristic of relation between VO_2 and HR, O_2 uptake at anaerobic threshold load level, as well as pulmonary ventilation with VO_2 and VO_2 in men and women

Indices	Men (n=12)			Women (n=12)			Differences of indices between men and women	
	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	t	p
VO_2/HR at VO2 max, ml·min^{-1}·beat^{-1}	19.4	2.0	10.3	17.2	2.1	12.2	t=6.16	p=0.000003
VO_2/HR at AT, ml·min^{-1}·beat^{-1}	16.2	2.1	13.0	14.3	2.1	14.7	t=5.02	p=0.000049
VE/VCO_2 at AT	27.9	3.2	11. 5	24.7	2.8	11.3	t=0.61	p=0.549424
VE/VCO_2 at VO_2 max	25.3	3.3	13.0	21.8	3.8	17.4	t=1.02	p=0.549424
V_E/VO_2 at AT	23.9	2.7	11.3	21. 7	2.7	12.5	t=1.74	p=0.095084
V_E/VO_2 at VO_2 max	29.5	3.90	13.23	26.26	4.20	16.0	t=0.53	p=0.18952
%VO_2AT from VO_2max^{-1}	70.6	10.0	14.2	78.40	12.2	15.6	t=1.1	p=0.377802

Legend: VO_2/HR at VO_2 max- oxygen heart rate at maximal oxygen uptake; VO_2/HR at AT, ml·min^{-1}.beat^{-1}- oxygen heart rate at anaerobic threshold; V_E/VCO_2 at AT - ventilatory equivalent for carbon dioxide at anaerobic threshold; V_E/VCO_2 at $VO2_2$ max- ventilatory equivalent for carbon dioxide at maximal oxygen uptake; V_E/VO_2 at AT- ventilatory equivalent for oxygen at anaerobic threshold; V_E/VO_2 at VO_2 max- ventilatory equivalent for oxygen at maximal oxygen uptake; %VO_2AT from VO_2max^{-1}- oxygen uptake percentage at anaerobic threshold from maximal oxygen uptake.

Table 4. Basic physical fitness characteristics of pairs of dancers (n=24, 12 couples) having different athletic mastery levels

Indices	Couples with higher athletic mastery (first group, n=12)			Couples with lower athletic mastery (second group, n=12)			Differences of indices	
	$\bar{x}$	SD	CV	$\bar{x}$	SD	CV	t	p
T_{50} VO_2, s	24.1	2.1	8.71	31.1	2	6.43	t=6.02	p=0.00005
T_{50} V_E, s	23.0	1.9	8.26	32.4	3	9.26	t=7.21	p=0.000001
T_{50} CO_2, s	26.1	2.1	8.05	27.2	2.2	8.09	t=7.86	p=0.000001
T_{50} HR , s	21.1	2	9.48	28.8	2.3	7.99	t=6.37	p=0.000002
VO_2/HR at VO_2 max, ml·min^{-1} beat^{-1}	18,5	1,1	5,9	15,9	1,0	6,3	t=2.59	p==0.016533
VO_2 /HR at AT, ml·min^{-1}•beat^{-1}	15,8	1,1	7,0	12,9	1,0	7,8	t=3.15	p=0.004615
%VO_2AT from VO_2max	80.6	5,0	6.20	66.1	5,0	7.56	t=1.04	p=0.278801
V_E/VO_2at VO_2max	25.2	1,0	3.97	21.1	1.7	8.06	t=4.51	p=000173
V_E/VO_2at AT	27.7	2.1	7.58	21.6	1.9	8.80	t=3.97026	p=0.000644
V_E/VCO_2 at VO_2max	26.9	2.1	7.81	20.0	2.0	10.00	t=6.13	p0.000004
V_E/VCO_2 at AT	27.7	2.0	7.22	21.9	1.5	6.85	t=5.49	p=0.000016

Legend: T_{50} VO_2- half-time of oxygen uptake; T_{50} V_E - half-time of minute ventilation; T_{50} CO_2 - half-time of carbon dioxide production; T50 HR - half-time of heart rate; VO_2/HR at VO_2 max- oxygen heart rate at maximal oxygen uptake; VO_2/HR at AT, ml· min^{-1}.beat^{-1}- oxygen heart rate at anaerobic threshold; %VO_2AT from VO_2max^{-1}- oxygen uptake percentage at anaerobic threshold from maximal oxygen uptake; V_E/VO_2 at VO_2 max- ventilatory equivalent for oxygen at maximal oxygen uptake; V_E/VO_2 at AT- ventilatory equivalent for oxygen at anaerobic threshold; V_E/VCO_2 at VO_2 max- ventilatory equivalent for carbon dioxide at maximal oxygen uptake; V_E/VCO_2 at AT - ventilatory equivalent for carbon dioxide at anaerobic threshold.

Discussion

High body tension at dance sport events is commensurate with the body tension of the sports integrating the elements of both sports and art: figure skating, gymnastics, sport aerobics (Boudolos, 2005; Lankford et al., 2014; Marra et al., 2019). Parities with the sports above are convergent by nature and thus do not allow to define the significance of functional fitness nor outline the factors to substantially boost specific endurance in dancers and efficacy of competitive performance as a whole. This is because the content of competitive performance in dancing is unique and unprecedented among other sports. It`s common knowledge that the differences of competitive performance structure predetermine the differences of special endurance and, consequently, the ones of training process direction (MacDougall et al., 1991; Mishchenko & Monogarov, 1995; Korobeynikov et al., 2020). Therefore, means to apply methods of special endurance improvement from hard-coordinating kinds of sports to dance sport are limited.

At the basis of this research there lies an approach that has proven efficacy in sports practice including the kinds of sport combining sporting and art elements. A specific sequence of actions was used to study the core functional fitness in dancers, making it compliant with the sport`s requirements as the foundation for further content of training. Such an approach predetermines the development of highly specialized training means and programs along with general and specific functional training (Vissers et al., 2011; Watson et al., 2017; Yin et al., 2019). This approach does not only stipulate the comprehensive evaluation of physical fitness, but differentiation of its major components as well. Determination of the physical fitness components relation with major efficacy indexes of competitive program performance is one of the accepted means of such determination. One of the key tasks of implementing such an approach in research is to select a set of physical fitness indexes and comprehensive group of indexes reflecting specific physiologic properties of the performance energy supply. Three groups of indexes were outlined in this research, reflecting such physiologic CRS properties as power, fast kinetics and efficiency (Mishchenko & Monogarov, 1995).

Reaction limits indexes in dancers are indicative of high potential capabilities of the performance energy supply system (aerobic power) in the majority of the assessed athletes. At the same time, CRS response indexes were low at high tension levels of anaerobic limit in a vast number of dancers. The relatively low anaerobic limit in vast majority of athletes pointed out the necessity to assess other functional characteristics of athletes that boost the efficacy of aerobic energy supply. To this end, the indexes of fast kinetics and efficiency of responses were assessed. The comparative analysis results did not show significant differences of indexes in males and females despite the considerable individual differences between them. This is the indicative of considerable differences on the level of various components (power, fast kinetics and efficiency of responses) in dancers with a couple. This can have a significant impact on athletic skills. Therefore, the secondary endpoint is to define key characteristics of athletic skills and compare them with the components.

The analysis showed the importance of assessing the indicators of the cardiorespiratory system reaction and the work's energy supply of the athletes-dancers. The assessment of fast kinetics indicators and cost-effectiveness characteristics of work is of particular interest. The research has shown that these response characteristics underlie the dancer's working capacity. This is evidenced by a higher level of rapid kinetics indicators and economy of reactions among highly qualified dancers. The importance of assessing these characteristics is that the normative levels of the men's and ladies' reactions do not differ significantly. High integral manifestations of the indicated physical fitness components form the conditions of a stable state of both partner's functions during a long period of competitive activity. At the same time, there was formed an understanding that such differences can serve as a reason for a high tension of the functional provision of the special working capacity of one of the partners, the development of early fatigue and, as a consequence, a decrease in the demonstration of dance skills demonstration. There is an evidence to assume that the adjustment of a dancer's functional fitness to functional competitive performance significantly increases the quality of a dancer's training.

Conclusion

The data represented in the research indicates new opportunities of assessment and improvement of directed functional fitness with regard to specific functionality and endurance in a dance couple. The received data shows that a constant increase of competitive performance tension in dancesport corresponds to an increase in the values of factors of fatigue suppression and specific decrease in the process of dancing program performance.

Therefore, a significant performance improvement in dancesport stipulates the improvement of those aspects of functional abilities that are most influential to athletic excellence. This can be seen in the indicators of fast kinetics and the economy of the reaction. It is shown that the quantitative characteristics of the fast kinetics ($T_{50}VO_2$, V_E, VCO_2, HR) and cost-effectiveness characteristics (VO_2/HR, V_E/VCO_2, V_E/VO_2 at VO_2 max) between partners do not differ significantly. This made it possible to analyze the integral functional readiness of the pair and compare the characteristics of sportsmen-dancers of high and low qualifications. Analysis of the rapid kinetics and economy of couples with high and low skill levels showed a high level of requirements for the indicated reaction components, as well as significant differences ($p < 0.05$) of the indicated reaction characteristics in athletes of high and low qualifications.

In view of the aforesaid, a functional training program can be created specifically for this kind of sport based on the differences in the functional fitness of the couple – a current trend for further studies of dance training.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Correction of Endurance Training and Competitive Activities of Athletes by Determining the Blood Urea Content

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Abstract

The generalization of data from the modern literature on the studied problem, as well as the results of previous studies by Stankevych, Zemtsova & Tomilova (2018), allowed to justify experimentally the choice of blood urea to correct one of the metabolic processes in training athletes. As a result of the study of athletes found that at the starting mesocycle of the special-preparatory stage of the preparatory period, the rate of blood urea in both groups of athletes did not differ significantly and amounted to 4.05±0.082 mmol·l^{-1} and 3.68±0.084 mmol·l^{-1} in women and 3.97±0.091 mmol·l^{-1} and 4.68±0.045 mmol·l^{-1} in men, accordingly. This content of blood urea corresponds to the average group norms and indicates the balance of anabolism and catabolism of proteins, and therefore, may indicate the state of recovery of athletes at the beginning of the mesocycle. However, the increase in this indicator at the end of the mesocycle indicates that the amount of training loads differs in the duration of work. However, both in athletic walking and in middle-distance runners, reliability was noted regarding the state of rest ($p<0.01$). Knowledge of the peculiarities of the functioning of this part of the metabolism and the development of ways to increase the effectiveness of this mechanism in terms of intense muscle activity should be considered as one of the promising research areas to improve training and competitive activities, as well as speed up recovery in athletes.

Keywords: *sport, endurance, metabolism, blood, blood urea*

Introduction

The formation of urea is closely related to various metabolic pathways: amino acid catabolism, gluconeogenesis, polyamine synthesis, transport of substances across the mitochondrial membrane. Thus, according to research (Litvinov, 1988), these connections indicate the existence of a complex system that affects the synthesis of urea in the body.

To date, thanks to fundamental research by domestic and foreign authors, the mechanisms of urea formation under different types of physical activity (Hecksteden et al., 2016) have been elucidated. It is established that the basis of urea formation during muscular activity is a violation of biochemical homeostasis and, first of all, a violation of the balance of adenosine triphosphate (ATP) in working muscles, as well as increased protein catabolism.

It is known that proteins are not the main source of energy during physical activity. Although their oxidation is less than 10% of total energy production, the results of numerous studies suggest that muscle work may not affect the breakdown of proteins, and cause strengthening or weakening of this process, depending on the conditions of exercise, and in particular, such as their different duration and intensity (Zemtsova et al., 2016), accompanied by changes in the concentration of amino acids in blood plasma. Muscle-stimulated protein

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breakdown in the liver can also cause the release of significant amounts of amino acids.

The actual breakdown of proteins should be determined by the dynamics of the concentration of essential amino acids, because the body does not synthesize them and any change in their content can be associated only with changes in plasma concentrations or endogenous breakdown.

Thus, according to some authors (Erkomajshvili & Seluyanov, 1990) found a significant increase in the concentration of essential amino acids such as tyrosine and leucine in skeletal muscle, liver and blood plasma in an experiment on rats after performing muscle work to failure. Similar data were obtained by Dohm, Kasperek and Tapscott (1987), who also found a progressive increase in plasma tyrosine content with increasing duration of muscle work.

Thus, according to Dunkin, Phillips and Strength (2017), a specific indicator of the degradation of contractile proteins is 3-methylhistidine (3-MG), because it is a secondary product of the breakdown of actin and myosin. In particular, it turned out that during muscle activity its content decreased, and in the recovery period - increased. It was found that the excretion of 3-MP does not increase in the recovery period after minor muscle tension but increases after exercise as their duration and intensity increase. A similar trend is observed with respect to the concentration of urea in blood plasma.

It is also established that the contribution of amino acids to the total energy supply during prolonged physical activity can range from 3 to 18% (Zemtsova et al., 2020).

During exercise that requires endurance, the breakdown of proteins occurs mainly in the liver and muscles, with the process of catabolism prevails over the process of protein synthesis. Thus, according to Viru (1981), the performance of work on the treadmill for one hour was accompanied by inhibition of protein synthesis in the liver by 20%, and when performing exercise to failure, this figure decreased by 65%. Therefore, the degree of inhibition of protein synthesis in the liver and skeletal muscle is determined by both the intensity and duration of exercise.

With high-intensity muscle activity, when ATP resynthesis occurs mainly due to respiratory phosphorylation, the elimination of ammonia is significantly enhanced, its content in the blood and tissues decreases, and the formation of urea - increases. This is confirmed by the fact that the increase in the concentration of blood urea is directly proportional to the duration of work with high intensity (Khmelnitskaya & Smyrnova, 2011). However, according to some studies by Kropta et al., (2020) low motor activity of 30% of oxygen consumption (VO_2max) does not cause significant changes in urea in the athlete.

The process of urea formation deserves special attention because it is known that proteins are a very dynamic component of skeletal muscles that produce ammonia, both during short-term intense and prolonged exercise of submaximal aerobic capacity. Thus, the determination of the dynamics of blood urea is used in the practice of biochemical control to determine the functional state of athletes at all stages of training (preparatory, competitive, transitional) to assess the impact of stress on the athlete, tolerance of training loads, total and anaerobic regimens in the process of muscle activity and the speed of recovery processes after exercise (Osipenko, & Vdovenko, 2017; Stankevich, & Zemtsova, 2014).

Determination of urea content in the blood allows to assess the functional and energy capabilities of runners (middle distances) and representatives of athletic walking by the level of metabolic changes and the functional response of the body to training and competitive loads of different energy orientation. The results of the study allow to correct individual training process.

The purpose of the study was to analyze the dynamics of blood urea concentration as an indicator of recovery processes in endurance athletes.

Methods

The study involved 28 athletes (15 men and 13 women) aged 19 to 30 years, with sports experience of 6 - 15 years (middle distance runners and representatives of athletic walking) qualifications of Master of Sports (MS) and International Master of Sports (ICMS). Written consent was obtained from each study participant. Athletes were at the special preparatory stage of the preparatory period of the annual training cycle. The concentration of blood urea was determined using a high-speed biochemical variophotometer "DiaglobalGmbH" (Germany) using ready-made reagents. Athletes performed test physical activity - overcoming distances of 15 km and 30 km. The results of the study were processed using mathematical statistics using standard computer programs.

Data were expressed as mean ± standard error of mean. Shapiro-Wilk test was used to analyze the normality of distribution. Paired t-test or two sample t-test was used to evaluate the difference in urea content. P values less than 0.05 were considered significant.

The study was conducted in accordance with the basic bioethical norms of the Helsinki Declaration of the World Medical Association on ethical principles of scientific and medical research, as amended (2000, as amended in 2008), the Universal Declaration on Bioethics and Human Rights (1997), the Council of Europe Convention on Human Rights and Biomedicine (1997). The study was approved by the NU-UPES Biomedical Ethics commission, Kyiv, Ukraine (№2 16.12.2020). Written informed consent was obtained from each study participant.

Results

Biochemical assessment of the urgent and delayed training effect on the basis of determining a relatively small set of indicators provides information about the state of metabolic processes in the body, reveals the individual characteristics of metabolism in athletes.

Thus, to characterize the state of metabolism during rest after exercise, when there is a gradual normalization of metabolic processes and return to baseline, in the practice of sports is most used to determine the content of blood urea.

Determining the dynamics of urea concentration during intense muscular activity provides important information about the direction of metabolic processes occurring in the body during muscular activity, which, in turn, ensures compliance with all the rules of building a rational training process and justifies timely correction of training loads.

It is known that the body's response to exercise is expressed in three successive phases: exercise, recovery and supercompensation. Increased formation of urea during prolonged physical activity of high intensity and increase its content in the blood occurs in the late stages of physical activity.

To assess the special endurance of athletes who specialize in athletic walking, carried out a control test work - overcoming distances of 15 km and 30 km. They determined the content of blood urea at 2 hours, after 18 and 42 hours of recovery.

In addition, the content of blood urea of the studied athletes at rest at the beginning and end of the mesocycle of the preparatory period was determined.

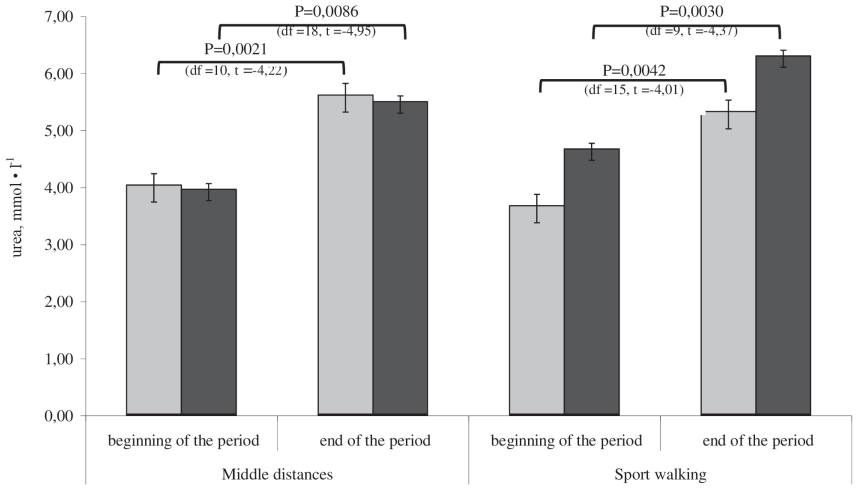
The studied endurance athletes (middle distance running and athletic walking) were at the special preparatory stage of the preparatory period.

The dynamics of the increase in blood urea of athletes has significant differences in the preparatory and competitive period. As a rule, the concentration of urea in the preparatory period is higher, which is due to the significant amount of training loads and low fitness of athletes.

For a more complete individual characterization of metabolic processes in the content of blood urea of athletes, we conducted a study as at the beginning, end of the mesocycle, as well as at different times of recovery after exercise.

As a result of the study of athletes (walking, middle distances) found (Figure 1) that at the beginning of the mesocycle of the preparatory period, the urea in both groups of athletes did not differ significantly and amounted to 4.05±0.082 mmol·l^{-1} and 3.68±0.084 mmol·l^{-1} in women and 3.97±0.091 mmol·l^{-1} and 4.68±0.045 mmol·l^{-1} in men, respectively. This blood urea content of both groups at the beginning of the mesocycle indicated a balance of anabolism and catabolism of proteins, and therefore may indicate the optimal state of the regenerative processes, the compliance of physical activity with the functional capabilities of the studied athletes.

However, the increase in this indicator at the end of the mesocycle (Figure 1) allows to guess that the amount of training loads was possibly different. Thus, in middle-distance runners (men), where the work is more intense, but much less over time, the increase in urea is much slower compared to representatives of athletic walking. However, both in athletic walking and in middle-distance runners, a significant difference was observed compared with the state of rest ($p<0.01$).

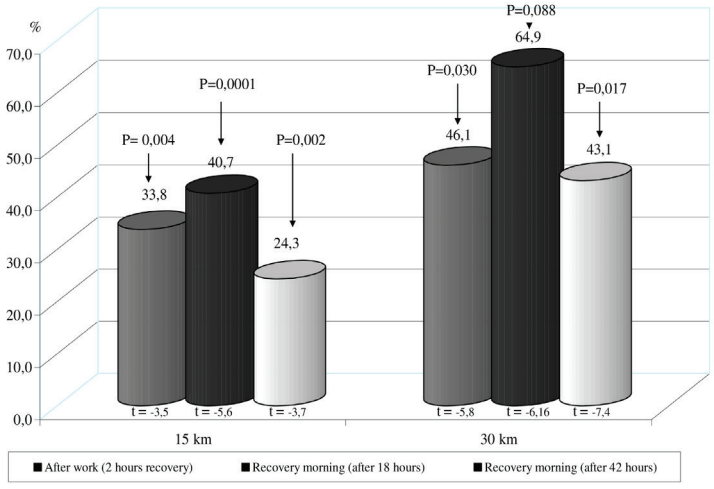


Legend: p - as calculated by paired t test

FIGURE 1. The content of blood urea in athletes trained for endurance at the beginning and end of the special training stage of the training period

Thus, significant amounts of training loads of the preparatory period enhance the breakdown of body proteins, which leads to the mobilization of protein resources of the body and there is an increased release of free amino acids from lymphoid and muscle tissues. These amino acids are reanimated in the liver in the necessary directions and are used for the synthesis of enzymes, which leads to an increase in energy resources and accelerate the development of structural changes in the body of athletes whose work is aimed at endurance.

Determination of blood urea after "shock" microcycles,



Legend: p - comparing with the state of rest (as calculated by t test)

FIGURE 2. Increment in the level of blood urea of representatives of walking after control-training loads comparing with a state of rest, in percent (15 km, 30 km)

which are characterized by significant volume and intensity at the special preparatory stage of the preparatory period, is an indicator of tolerability of individual training, microcycles and individual response of athletes to specific training loads of a particular microcycle.

To more fully characterize the state of recovery of athletes, we conducted a study of urea content at different times (in 2 hours, 18 hours and 42 hours) after control training, which consisted of overcoming distances of 15 km and 30 km (Figure 2). Thus, after the control and training load (15 km), the largest increase in blood urea was observed after 18 h of recovery and amounted to 40.7% relative to rest, and after 42 h there was a slight under-recovery, which amounted to 24.3% relative to rest.

After overcoming the control and training load (30 km), the content of blood urea increased significantly after two hours, which was 46.1% of rest, and at 18 hours of recovery, this figure was maximum and amounted to 64.9% of rest, after 42 hours, there was a gradual recovery of protein metabolism in athletes. This response to the load in the training period allows you to assess the response to specific training loads, their tolerability and get an idea of the functional state of the athlete in this period of training.

Discussion

Analysis of literature scientific data, as well as the results of our own research indicate that urea, as one of the end products of protein metabolism, really plays a significant role in the body's adaptation to intense muscular activity Dohm et al. (1987). At the heart of its biological effects are the features of the structure of the molecule, which determine its chemical properties, which are realized in the body in complex intersystem relationships.

In our opinion, the results of our study of the urea content in the blood of athletes at the beginning and end of the mesocycle of the special preparatory stage of the preparatory period of middle-distance runners and representatives of athletic walking deserve some attention.

So from the interpretation of the data to determine the level of blood urea during muscle activity deserves the fact that the concentration of this indicator may in some way reflect both the characteristics of energy supply processes and the amount of training work performed for one mesocycle.

The magnitude of the urea clearance itself varies depending on the volume and intensity of performed work: as a rule, it increases in the postpartum period. In studies by Viru (1981), strenuous muscle work delays the increase in the intensity of renal excretion of urea. Thus, during long-term work at the beginning of the recovery period (during the first six hours), its active accumulation in the blood continues, reaching the highest concentration. Inhibition of the functioning of the adrenal cortex, which is accompanied by changes in water-salt metabolism, causes a delay in blood urea.

Upon reaching the limit values of urea concentration, there was a lack of arginase activation, which plays an important role in the formation of urea Dunkin etc. (2017).

In studies by Stankevich and Zemtsova (2014), short-term recovery periods between frequent training loads were characterized by the maintenance of high-intensity protein catabolism and, accordingly, the level of blood urea. A significant increase in protein synthesis, according to Erkomajshvili and Seluyanov (1990) occurred only on rest days between microcycles, and the level of blood urea returns to its original state. It is known that the restoration of normal levels of blood urea occurred after a load of high power faster than after a long load of moderate power Dohm et al. (1987).

In the phase of supercompensation, along with various biological processes, the content of glycogen and protein in skeletal muscle increases, as a result of which the functional capabilities of the organism increase. This is the most important process of transition from urgent to long-term adaptation. The severity and duration of the supercompensation phase depends on the magnitude of the preload. At the same time, if during the period of incomplete processes of anabolism significant loads are used, then, on the contrary, the opposite state may appear - fatigue, overtraining. Since urea is an integral indicator of the course of recovery processes, the assessment of the dynamics of its concentration in the blood is one of the main indicators used in the practice of sports training. In most cases, to interpret the data obtained during biochemical control of blood urea, it is customary to focus on known types of reactions according to Erkomajshvili and Seluyanov (1990):

Type 1 is characterized by a direct correlation between the dynamics of urea and exercise, which indicates a balance of catabolic and anabolic processes, and also indicates that the loads used in the training process correspond to the range of functional capabilities of the body.

Type 2 manifests itself in a paradoxical decrease in urea, which is regarded as incomplete recovery processes, when conditions are created for inhibiting the formation of urea in connection with the active use of amino acids in the synthesis of skeletal muscle proteins.

Type 3 is characterized by the absence of any relationship between changes in the magnitude of the load and the urea content. At the same time increase of its level above individual norm within several days is noted. This type of reaction is observed after performing high-intensity long-term loads of a "stressful" nature and indicates a mismatch between the functional capabilities of the body and the training effects used, which serves as a signal to possible overstrain of functions and the body as a whole.

At a combination of inadequate increase or sharp decrease in concentration of urea in blood serum disturbance there can be a heart rhythm disturbance, decrease in the content of hemoglobin of blood below 120 $g \cdot l^{-1}$ at men and 100 $g \cdot l^{-1}$ at women, decrease in level of iron in blood and decrease in special working capacity (threshold speed and power), there is a failure of adaptation, which requires the use of a set of restorative and therapeutic measures.

The dynamics of recovery after significant training loads (overcoming distances of 15 km and 30 km) in the content of blood urea of athletes allowed to assess the state of training and readiness to perform such control and competitive loads. Training loads of microcycles caused a significant increase in the content of blood urea not after 2 hours, but in a later recovery period. However, the dynamics of the urea content was characteristic of the first type of reaction of urea to the load and by the beginning of the next microcycle the urea content decreased to baseline values. Based on the obtained data, we can conclude that the processes of recovery of metabolism in these athletes have been completed, do not require correction and correspond to the state of readiness for training.

Conclusions

The obtained data indicate that for effective control over the process of adaptation to physical activity in the process of

training and control-competitive activities of middle-distance runners and representatives of athletic walking can be used to determine the content of blood urea.

Determining the content of blood urea after exercise makes it possible to assess the contribution of proteins to energy supply of muscular activity, and control of the dynamics of urea in the morning the next day after a set of training loads indicates the balance of anabolic and catabolic processes in the athlete. The definition of these indicators allows you to correct the training process quickly in order to increase its effectiveness.

Comprehensive use of this method makes it possible to control the processes of urgent and cumulative adaptation, to influence its course at the stage of specialized training of athletes and other sports with a similar nature of sports activities and energy supply.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Psychological Components of a Football Coach Personality

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Abstract

The article analyses and summarizes the views on the coach's personality in sports that are available in modern scientific and methodological literature and in the Internet resources. Attention is drawn to the fact that although the points of view differ, it is possible to single out those properties of a coach's personality that, according to scientists, determine the achievement of success in sports activities: gnostic, design, constructive, communicative and organizational properties. The results of own research include the motivational component of the coach's personality; organizational and communication skills as components of their pedagogical mastery; professionally important personality traits of coaches that determine the individual style of their activities; data from the analysis of the degree of formation of professional burnout and the current state of coaches. The obtained data are compared and explained according to the professional categories of coaches (A and B), who participated in the research.The formation and improvement of the personal qualities necessary for the successful professional activity of a football coach are very important and should be under the constant control of the individual; changes of admissible personal indicators of professionally significant properties in trainers are related to the level of their professional skill, depend on level of emotional burnout and deviation from autogenous norm (according to an indicator of vegetative coefficient); revealed mainly low and intermediate level of ability to empathize in the surveyed coaches, regardless of category, age and experience, suggests that they have insufficient training of pedagogical skills.

Keywords: *personality's characteristics, coach, motivational components, empathy, organizational, communication skills, individual style, professionalism*

Introduction

Today, any changes that occur in the society, necessarily affect one way or another various spheres of human life. The question is, if a person lives in close interaction with the environment, then does the composition of his personality change over time and significantly changes the functioning of society?

It is natural to predict that such changes could not but affect the field of sports. We can assume that under the influence of various factors, the personality of the football coach has undergone certain changes. So, having achieved some success in coaching, each specialist must remember that the "ideal image" of the coach is not permanent and depends on many components (qualification, age, gender, characteristics of the relationship, etc.) (Petrovskaya & Malinovsky, 2018). So it exist the differences of opinion of practicing coaches, students, as future sports professionals, and young athletes (Ushkho, 2007). The purpose of this study is to study the psychological characteristics of the personality of a modern football coach, as a guarantee of success of his professional activity.

Methods

A questionnaire "Motives of work" (Melnik, Shemet, & Silich, 2014) was used to determine the characteristics of the motivational sphere of coaches. The following motives were

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determined: the actual work, the social significance of work, self-affirmation through work, professional skills. We used the tests "Communicative and organizational tendencies" (Rogov, 1999), "Self-assessment of empathic abilities" (Melnik et al., 2014) to determine business, reflexive, communicative and empathetic qualities.

The level of formation of the properties: attention, mnemonic, motor and sensory, imagination, mental, emotional, volitional, linguistic and communicative properties was determined by adapted "Professionally significant personality traits" test. The predominance of one or another individual style of pedagogical activity in a coach was investigated with the help of appropriate methods adapted by Melnik et al. (2014).

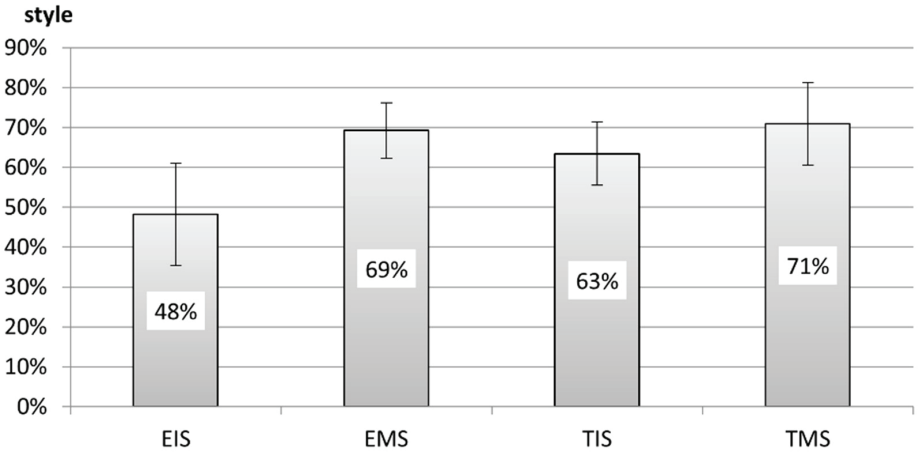
The level of coach's emotional burnout was studied using test by Boyko (Raigorodsky, 2011). The most necessary determining component of human behavior in any activity is its functional state which depends on the regulation of the brain component (Alexandrov, 2001). In this sense, the vegetative coefficient according to K. Shiposh (Timofeev, & Filimonenko, 1990) was chosen as a psychodiagnostic parameter that allows to determine the features of the actual psychophysiological state of the coach (Timofeev & Filimonenko, 1990). Researches used the following methods of mathematical statistics: basic descriptive statistics, such as means, standard deviations; frequency tables and histograms. Spearman rank correlation coefficient ρ was calculated to determine the relationship between psychophysiological parameters since their estimates were obtained on an ordinal scale. Statistica 10.0 (StatSoft) was used as statistical software.

The study involved 20 football coaches, aged 33 - 69 years, with coaching experience from 4 to 50 years. According to the level of professional training, coaches belong to "A" and "B" categories.

Coaches of "A" and "B" categories had A and B diploma according to UEFA Coaching Convention, Article 16, 17. Research protocol was approved by National University of Ukraine on Physical Education and Sport No 2 of December, 16, 2020. All the participants signed the informed consent form as required by research Ethics Committee.

Results

The study of the predominance within experienced coaches of a particular individual style of teaching (IST) gives us reason to conclude that their activities have both positive and negative achievements in the process of mastering the coaching profession. The IST estimation was calculated by processing the results of 33 questions (Melnik et al., 2014). For each match with the key, 1 point was awarded (answer "Yes"). To determine the dominant style, a pronounced the percentage of a particular style was used. The number of points scored, must be divided by the total number of questions (33) included in the scale. The obtained results testify to the predominance in the IST within the tested coaches of two of the four individual styles – emotional-methodical (69%) and thinking-methodical (71%) (Figure 1). Unfortunately, the vast majority of surveyed coaches were characterized by reflective and methodological style, which indicated the consolidation of some conservatism in the choice and application of methods, tools and training. This leads to a limited arsenal of methods used by such coaches, mainly authoritarian style of leadership of athletes, and the coach himself mainly imposes on athletes a reproductive (minimum efficiency) way of doing things.



Legend: EIS-emotional and improvisational; EMS-emotional and methodical; TIS–thinking and improvisational; TMS-thinking and methodical

FIGURE 1. Individual style of pedagogical activity of football coaches (n=20)

Taking into account the many different social influences, under which coaches are daily, due to the specifics of the profession, the resulted data give reason to note that the experience of traumatic situations in coaches of "A" category lead to a feeling of hopelessness (correlation coefficient ρ=0.68, p<0.05), causes inadequate selective emotional response (ρ=0.68), reduces the desire to engage in professional activities (ρ=0.67) and leads to emotional alienation from everything around the person (ρ=-0.69). This increases the emotional tension, which forces the coach to expand the boundaries of economical use of emotions (ρ=0.82), to move away from the negative effects of the environment (ρ=0.95). Motivational factors of the coach's activity are and depreciate under the influence of emotional burnout, when the social significance of work, the motive of self-affirmation and professional skill displaces the motive aimed at simple, uncomplicated performance of the activity process (ρ=0.72), and then there is a decrease interest in the process of activity in general (ρ=0.65).

Category "B" includes coaches with less professional skills and perhaps that is why emotional burnout causes much greater changes in their personality, when self-dissatisfaction leads to increased anxiety and depression (ρ=0.68), emotional defi-

cit (ρ=0.82), there is a personal detachment (ρ=0.90), which usually causes psychosomatic and psychic-vegetative disorders in the organism (ρ=0.96). It is interesting, for the coaches of this category, the process of burnout, namely emotional and moral disorientation is much more closely correlated with the motives of work. That is why we can observe the reducing the motive of social significance of work (ρ=-0.81), the increasing the desire for self-affirmation (ρ=0.94) and the motive to improve professional skills (ρ=0.63) p<0.05 at the increasing level of emotional and moral disorientation within them.

Our research shows that the level of empathy in coaches is not high enough, regardless of the category, i.e. the factor of professional success (Figure 2). The low level of development of the ability to empathize was recorded in the vast majority of coaches - 65%, the intermediate level - in 35%. A high level of development of this personality characteristic is not revealed.

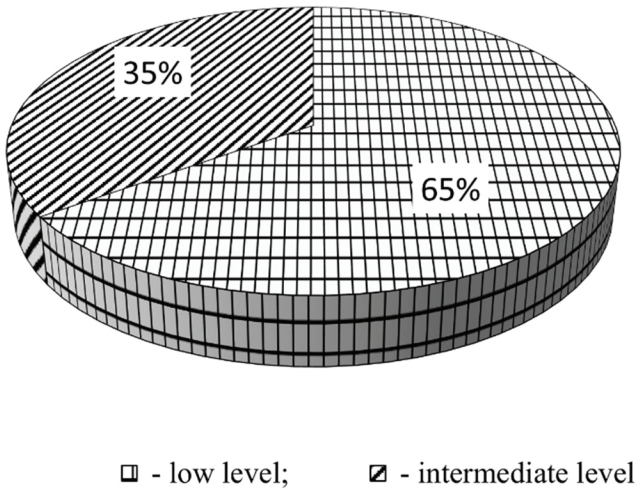


FIGURE 2. Level of empathy development of football coaches (n=20)

It was determined that the indicators of the vegetative coefficient, as evidence of successful psychological adaptation of coaches to professional activities, correlate with the ability to long-term attention (ρ=0.56), observation (ρ=0.58), mnemonic (ρ=0.64), motor (ρ=0.57), mental (ρ=0.49) and communicative (ρ=0.45) abilities. In this sense, the relationship between empathic abilities and vegetative coefficient (ρ=0.47) p<0.05 was also found.

The biggest changes in negative psychological adaptation are professionally significant properties of coaches of B category, namely: the ability to long-term attention (ρ=0.75), observation (ρ =0.64), mnemonic (ρ=0.67), mental (ρ=0.70), communicative (ρ=0.67) and imaginative (imagination) (ρ=0.68) p<0.05 abilities.

Organizational skills in this category of coaches are closely interrelated with communicative (ρ=0.65; p<0.05), which logically follows from their professional tasks: the ability is available, understandable for each age category and skill level of athletes, language to explain current tasks, is an indicator of the pedagogical skills of the coach.

Discussion

In sports, the coach is the main person who definitely influences not only the process of sports improvement, but also the process of athlete's personal growth, when the available personal qualities of the coach determine the degree and speed of mastering the necessary knowledge and skills of his students – athletes. In this regard, emphasizing the role of the coach's personality in the lives of his students, Yakovlev and Babushkin (2016) notes that in the formation of the athlete's personality, exercise and motor skills is not the main thing. That is why novice athletes often come to the sports section "to a certain coach".

The publications of the famous football coach Martens (2014) have significantly expanded the understanding of the peculiarities of the coach's professional activity. The author emphasizes that in order to work successfully with athletes, the coach must know what kind of person he is, what he can offer the athlete. It is noted that athletes, especially those who have long worked with this coach since childhood, usually not only learn from him, but copy his qualities, behavior, words, etc., which psychologists explain by the action of one of the important but unconscious laws of personality formation – the law of imitation. For better self-knowledge, the author suggests that coaches apply a four-component system of self-assessment – that is, to analyze information about themselves, namely: known to themselves and others; known to themselves but hidden from others; unknown to themselves but visible to others; unknown to themselves and others. Such a deep personal analysis of the self-concept will allow you to know your own essence, understand your interests and level of competence, which will inevitably lead to the realization of the need to eliminate ineffective patterns of behavior, changing them to more perfect and modern (Nikolaenko & Voronova, 2014).

However, coaching inevitably differs significantly from the activities of the athlete and to think that for success a simple transfer of knowledge, skills and abilities acquired in the process of sports improvement is a big mistake. Studies show that the level of achievement of coaches as outstanding athletes in the past is not a significant factor in the effectiveness of their activities as a coach, but only important mainly in organizational terms, at the beginning of the coaching career of a famous athlete, due to inertial continuation of the press, sponsors, etc. to pay attention to him as a famous person (Morozov, 2002). If such a novice coach continues to not pay attention to the study of features and factors of coaching efficiency, then due to the reproductive structure of the training process and

lack of professional knowledge he will inevitably have problems not only with the process, but also in relationships with athletes. In this regard, it is pointed out that "sometimes unjustifiably fast status growth of a former highly qualified athlete in the coaching field often turns into self-confidence, reliance only on personal experience and, as a consequence, stagnation in professional aspirations and scientific information requests" (Morozov, 2002). Given the above, Melnyk et al. (2014) note that to choose the profession of coach "on demand", without regard to vocation, personality qualities and abilities is the mistake.

At the initial stages of formation of professional skill, direct practical activity, namely personal characteristics determine largely the level and nature of burnout of the coaching profession.

Under researching the specifics of the professional activity of the coach, it is necessary to take into account the fact that professional burnout can be manifested at different levels of organization of the individual and at different manifestations of his behavior (Voronova & Kovalchuk, 2016). That is why we considered the level of formation of professional burnout separately for coaches of professional training levels of "A" and "B" categories.

Sports psychologists and sports professionals call empathy, the presence of which in a person affects the understanding of another person, their empathy and sympathy for her among the obligatory personal qualities that distinguish a successful coach as a teacher and professional athletes (Ilyin, 2012; Markov, 1999). It is noted that the level of empathy depends on the ability to imagine different perceptions of different people of the same event, which gives a person the opportunity to recognize the right of others to the existence of different views, opinions, etc. (Neretin, 2017). Sklyar (2005) studied the level of empathy in students seeking to become a coach and established in them, regardless of their sports specialization, a low level of formation of this personal quality, which in the author's opinion is due to specific perceptual and motivational orientations and personal characteristics, including the level of significant partial empathic qualities of future sports professionals.

Thus, our data show that for high-quality professionally successful management of coach's training, especially beginner, it is necessary to develop and improve empathic abilities, and this, according to available data, is possible provided that empathy is a priority of the coach's personality; constant monitoring of personal characteristics and professional-empathetic qualities; introduction of specially developed psychological and acmeological training sessions in the process of future coach's training (Sklyar, 2005).

Factors that influence the change of indicators of professionally significant properties necessary for a coach to carry out effective activity deserve special consideration and comprehensive analysis (Melnik et al., 2014). Correlation analysis shows the existing statistically significant relationships between the formed professionally significant properties of coaches with the vegetative coefficient according to K. Shiposh (Timofeev & Filimonenko, 1990).

The research data are consistent with the study of Yanshin (2001), which concludes that the deviation from the norm of psychological adaptation leads to increased internal tension and anxiety, doubts and insecurities, fears, reduced dynamic energy, with difficulty switching attention, i.e. with those undesirable manifestations that may occur in the early stages of a coach's professional career.

The professional suitability of a coach for activity is a measure of the conformity of a person's qualities as a subject of activity to the actual requirements for him, his ability to perform the relevant job functions at present. Professional suitability is determined by a set of formed and interconnected qualities of the subject of activity (personal, psychological, physiological, etc.), which ensure the effectiveness of professional tasks. Having systematized the data on the professional activity of the coach as a teacher, the activity structure of which requires many different special knowledge, skills and abilities, Kuzmina (1990) singled out five directions of pedagogical activity, which indicate the complexity and versatility of knowledge that must be mastered by a person who has decided to make his main profession the profession of coach – it is gnostic, design, constructive, communicative and organizational directions.

The data in the scientific literature show that the professional skills of a coach in sports are significantly manifested in his creative activity, which indicates the transformation of a coach into a specialist who already has his own individual style of coaching to train athletes (Nemtinov, 2014; Yakovlev & Babushkin, 2016; Tulebaeva & Zhanserikova, 2016). Analyzing the factors influencing the effectiveness of the coach, Frolova and Morozov (1981) and Bushueva (2007) indicate that both the methodological aspects of the organization of the training process and the personal characteristics of the coach play a significant role, emphasizing the exceptional influence of the latter on the coach's professional efficiency.

Melnik et al. (2014) summarized a significant number of studies on the personality of the coach and concluded that the business, reflective, empathetic and communicative qualities of the coach's personality were the most important professionally significant qualities. Thus the most essential requirements are shown to neuropsychic qualities in comparison with physical and volitional qualities. The study of this issue show that the personal qualities of the coach not only determine his professionalism, but also significantly affect his skills, the formation of individual style of activity, relationships with athletes and the microclimate in the team.

Melnik et al. (2014) propose a conditional division of coaches into "personal" and "national team coaches". The "personal" category of coaches includes the most working coaches who:

- work with athletes from the time of their introduction in this sport and to the level of the highest professional skills;
- are "lucky" to occasionally educate an athlete of the highest level from the recruited contingent, where a gifted, promising athlete happened to be;
- coaches who are indispensable because they train children, adolescents, young people in the initial stages of long-term training, and then pass their athletes to more experienced or talented colleagues (Melnik et al., 2014).

Therefore, scientists take into account, first of all, the most effective implementation of the coach's psychological personalities which are necessary in the coach's activities at the studying the individual style of activity,. All the above determined the feasibility of identifying three main symptom complexes that are important for the formation of individual style of activity of each coach: individual characteristics of the personality; change of their frequency and intensity in the process

of formation; creation of new relationships between existing individual personality features (Merlin, 1986).

Polozov and Polozova (2009) note that for effective management of training in team sports, a coach needs personal qualities of a leader who can bring to athletes the benefits of a coaching innovation, constant enrichment with new knowledge and practical experience, intuition in choosing strategies and tactics of teamwork, analytical thinking, the ability to use effectively the best qualities of each player of the team and eliminate unnecessary ones.

At the same time, Gorbunov (2019) warns coaches that even the presence of the necessary personality characteristics and a significant stock of accumulated knowledge do not automatically lead to success in coaching, because they must be systematized and generalized into a certain system. The author notes that in the modern scientific literature it was formed the idea about a system of such personality features of a successful coach as a high-level professional: criticality of their activities, independence and flexibility of mind, good memory, application of logic in reasoning, search for better forms of training and constant creative ideas, firmness and independence of thought, realistic views. However, even meeting most of these requirements, the coach in real life is very difficult to achieve this perfection, as "the coaches with personal characteristics far from the standards of ordinary ideas sustain and succeed" (Gorbunov, 2019).

As already mentioned, an integral part of the coach's activity is his pedagogical skills, which necessarily include such components of the coach's professionalism as communicative and organizational ones as noted in most available scientific data (Markova, 1996; Melnik et al., 2014). In addition, studies aimed at determining personal qualities that would characterize the pedagogical component of the "ideal" coach in general showed that athletes distinguish as such only 4 groups: business, reflexive, communicative and empathetic qualities. Therefore, when choosing the appropriate research methods, we focused on the tests "Communicative and organizational tendencies" (Rogov, 1999), "Self-assessment of empathic abilities" (Eliseev, 2008).

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Cognitive Characteristics of Skilled Badminton Players

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Abstract

Study of the cognitive characteristics of qualified badminton players. 34 qualified badminton players, 12 men and 22 women were test subjects. Testing was carried out individually. Analysis of scientific and methodological literature and world experience shows that the study of psychophysiological characteristics provides additional information about an athlete's functional state during training and competitive activities. It is known that sports results largely depend on the individual typological characteristics of a person, as well as on the extent to which these features are used to realize the entire spectrum of the athlete's capabilities. Activation of higher nervous processes is present in almost all components of sports activity and provides a quick reaction, perception and processing of information, the speed of mastering technical elements and quick switching from one type of activity to another. The study of the cognitive characteristics of badminton players was organized using the hardware-software computer complex "Multipsychometer-05". In our research, the first part of Raven's advanced progressive matrices was applied. It is an express version of the test, consisting of 12 tasks and covers the entire range of possibilities diagnosed by the full test. The main informative indicator of the test is performance – the total number of correctly completed tasks for the entire time of the test (the total number of correct answers). The test execution speed, accuracy, efficiency are also determined. The analysis of Raven's progressive matrices showed that qualified badminton players have an average level of productivity, speed and accuracy, a level below the average of test performance. The study of cognitive abilities, taking into account sexual dimorphism, showed that, in terms of speed and quality indicators of cognitive tests, women demonstrate significantly better values in relation to men. General cognitive abilities can be used as diagnostic and prognostic criteria in the selection process for qualified badminton players.

Keywords: *psychophysiological characteristics, Raven's matrices, cognitive abilities, badminton players*

Introduction

Badminton is considered one of the three most hard sports game in relation to physical loadings and is the fastest one among the so-called "racquet sports". According to its characteristics, badminton refers to a game complex coordination sport, it is characterized by the following features: speed of movement, speed of thinking, speed of execution of techniques (Bekiari, Perkos, & Gerodimos, 2015).

Badminton is characterized by high speeds, variety and rapid changes in attacking and defensive actions, the intensity of tactical combat and extreme emotional stress. During the game, a badminton player must assess adequately the playing moment, as soon as possible determine the further development of game events, choose the best option and implement it. Decision making on the further development of a game situation is based on the perception and processing of a huge amount of information, both from the outside and from working muscles (Korobeynikov et al., 2019).

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The study of psychophysiological characteristics provides additional information about the athlete's functional state during training and competitive activities. After all, it is known that sports results largely depend on the individual typological characteristics of a person, as well as on the extent to which these features are used to implement the entire spectrum of the athlete's capabilities (Cabello, Padial, Lees, & Rivas, 2004; Lyzohub, Chernenko, & Palabiyik, 2019).

Experts point out that the assessment of athletes by psychophysiological qualities is more predictable than determining the level of development of physical qualities, because psychophysiological qualities are genetically determined and less dynamic in ontogenesis than physical qualities (Lyzohub et al., 2019; Korobeynikov et al., 2019).

The modern system of complex control in sports consists of various components, and in our opinion, psychophysiological research is one of the most important (Iermakov et al., 2016; Kozina et al., 2017). When deciding which the athlete's psychophysiological characteristics should be taken into account as qualitatively important, it is necessary to proceed from the principle of the unity of personality and activity. Therefore, those psychophysiological characteristics that correspond to the requirements of a particular sport and affect the achievement of high sports results are considered important (Fahimi, & Vaez-Mousavi, 2011; Subarjah, Gilang, Sandey, & Amanda, 2019).

The analysis of references showed that neurodynamic functions can be attributed to the main psychophysiological characteristics that affect the success of game activity. They are congenital, unchanged, change little in ontogenesis and play an important role in determining the signs of human behavior and psyche (Makarenko & Lyzohub, 2007; Korobeynikov et al., 2020; Chernenko et al., 2020).

The analysis of the psychophysiological state of badminton players forms an idea of the objective state of the players. The general functional state of the organism is an idea of the functional system that controls a specific type of activity and characterizes the level of functioning of individual systems of the organism (sensory, intellectual, motor) or the athlete's organism as a whole (Tyshchenko et al, 2020).

During the study of any psychophysiological state, it is necessary to study all levels and make conclusions about the human condition based on a set of indicators characterizing each of the levels.

Numerous criteria for the elements of a functional system that affect the result of activity determine the psychophysiological mechanisms of human activity (Isaychev et al., 2012). Therefore, it is important to assess the methods of perception and processing of information at the decision-making level (Wu et al., 2013). Many authors have substantiated and proven that the properties of nervous processes are genetically determined (Korobeynikov et al., 2006; Kozina et al., 2018).

This theory is of decisive importance in the further development of the conceptual foundations of studies of the psychophysiological properties of behavior and remains the basis for substantiating the biological foundations of individual behavior. However, there is no idea about the nature of the manifestation of cognitive functions in qualified badminton players.

The purpose to study the cognitive characteristics of qualified badminton players.

Methods

Subjects

34 qualified badminton players: 12 boys and 22 girls (aged 14-16) were examined. All athletes had badminton training experience from 4 to6 years and level of qualification of candidates for master of sports. Testing procedures were carried out individually.

Testing Procedures

The study of the cognitive characteristics of badminton players was organized using the hardware-software computer complex "Multipsychometer-05". In our research, the first part of Raven's advanced progressive matrices was applied. It is an express version of the test, consisting of 12 tasks and covering the entire range of possibilities diagnosed by the full test. Raven's test is known as measurements of the general nonverbal intelligence. The success of this test is interpreted as an indicator of the ability to learn. The test contains 60 tasks, distributed over five series. The test includes five series (12 tasks), each next task in the series is more complex than the previous one. The test result is the total number of correctly solved problems.

The main informative indicator of the test is performance – the total number of correctly completed tasks for the entire time of the test (the total number of correct answers). The speed of the test execution, accuracy and efficiency are also determined.

Statistical analysis

Statistical processing of the research results was carried out on a PC using special software (MS EXCEL, STATISTICA 6.0). The main statistical characteristics of the studied indicators have been determined in the research. The median, lower quartile, upper quartile, and coefficient of variation were calculated. The statistical significance of the differences between the indicators was assessed using the Wilcoxon test.

Ethical clearance on this research was provided by Commission on Biomedical Ethics of the National University of Ukraine on Physical Education and Sport (on 12/16/2020, minutes No. 2), in accordance with the ethical standards of the Helsinki Declaration.

Results

Table 1 presents the results of testing the general cognitive abilities of badminton players. Badminton players have an average level according to the main informative indicator

Table 1. The level of general cognitive abilities of qualified badminton players in mixed gender group (n=34)

Test	Characteristic	Statistical parameters			
		Median	Lower quartile	Upper quartile	CV (%)
Raven's Advanced Progressive Matrices	Productivity, beeps	9.00	6.00	10.00	25.95
	Speed, beep per minute	4.12	3.43	6.07	58.57
	Accuracy, conventional unit	0.75	0.50	0.83	26.77
	Efficiency, %	53.57	21.42	67.46	52.79

(productivity) (Me = 9), the range of values is from medium to high, the group is heterogeneous (CV = 25.95%).

The test execution speed in the sample corresponds to the average level (Me = 4.12 beeps per minute), the scatter of the indicators ranges from the average to the high level, the group is heterogeneous (CV = 25.95%).

The quality (accuracy) of the test is at an average level (Me = 0.75), the range of values is from low to medium, the group is heterogeneous (CV = 26.77%).

Badminton players have a level below the average in terms of efficiency (Me = 53.57%), the range of values is between low and medium levels, the group is heterogeneous.

If we compare the general cognitive abilities of men and women who play badminton at a high level (Table 2), then the analysis of the Raven's Progressive Matrices test showed that women demonstrate significantly the best values in terms of the main informative indicator of productivity, with the best indicators of the spread (lower and upper quartiles).

Table 2. The level of general cognitive abilities of qualified badminton players accounting for gender differences

Test	Characteristic	Statistical parameters			
		Men (n=12)		Women (n=22)	
		Median	Lower quartile; upper quartile	Median	Lower quartile; upper quartile
Raven's Advanced Progressive Matrices	Productivity, beeps	8.00	6.00; 9.00	10.00*	7.00; 10.00
	Speed, beep per minute	3.95	3.13; 5.35	4.35	3.47; 6.53
	Accuracy, conventional unit	0.67	0.50; 0.75	0.83*	0.58; 0.91
	Efficiency, %	42.06	21.42; 53.57	67.46*	30.55; 82.93

Legend. * - the difference is statistically significant in relation to men at the level p=0.05

The speed of the test in men and women is at an average level and does not have a statistically significant difference, although the tendency for better results remains in women, both in the median and in the lower and upper quartiles.

The results of Table 2 indicate that, women have significantly better values in terms of the quality (accuracy) of the performance of cognitive abilities testing, both in terms of the median and the range of indicators. Summarizing the results of the study of the cognitive characteristics of badminton players, we can conclude that athletes who play badminton at a high level have an average level of general cognitive abilities, and women show significant differences in speed and quality indicators of cognitive tests.

Discussion

In modern sports science, much attention is paid to the development of methodological approaches that allow assessing the functional state of the athlete's nervous system (Bekiari et al., 2015; Kozina et al., 2017).

In team sports, efficiency and performance depend on high speed qualities, an unexpected alternation of attacking and defensive actions, an abundance of tactical decisions and extreme emotional stress (Ivaskevych et al., 2020; Petrovska et al., 2020).

Considering that the effectiveness of qualified badminton players depends on the athlete's ability to perceive, analyze and process information, the study of psychophysiological functions in order to monitor the athlete's functional state and correct the training process is very important (Kostiukevych et al., 2020).

The study of psychophysiological characteristics provides additional information about the functional state of an athlete during training and competitive activities. After all, it is known that sports results depend largely on the individual typological characteristics of a person, as well as on the extent to which these features are used to implement the entire spectrum of an athlete's capabilities (Klymovych et al., 2020).

Modern elite sports can be classified as extreme conditions of life, requiring constant physical, mental and emotional efforts. It is under such conditions that the innate properties of the nervous system are clearly manifested (Makarenko & Lyzohub, 2007; Korobeynikov et al., 2020).

The manifestations of higher nervous processes are present in almost all components of sports activity and provide a quick response, quick perception and processing of information, the speed of mastering technical elements and a quick switch from one type of activity to another (Lyzohub et al., 2019; Chernenko et al., 2020).

Badminton is characterized by high speeds, variety and rapid changes in attacking and defensive actions, the intensity of tactical combat and extreme emotional stress. During the game, a badminton player must adequately assess the playing moment, as soon as possible determine the further development of game events, choose the best option and implement it. The basis for making a decision on the further development of a game situation is the perception and processing of a huge amount of information, both from the outside and from working muscles (Romanenko et al., 2020).

Like any game activity, badminton game goes in the form of solving tactical problems related to the perception of moving objects (shuttlecock, contestant), the assessment of movement parameters, provided for the development of the game situation and the adoption of operational decisions. In the process of training, specialized psychomotor functions reach a particularly high level, which determine the effectiveness of preventive responses to a moving object, as well as the speed of perception and processing of information. The success of motor activity is provided by a high level of processes of perception, analysis, comparison and generalization based on visual-motor coordination, fine differentiation of muscle-motor sensations, spatial and temporal perception of various movements (Tyshchenko et al., 2020; Petrovska et al., 2020).

At the same time, cognitive abilities are considered as individual stable features that determine the originality of the strategy of perception and processing of information, problem solving, learning and other types of cognitive activity.

The analysis showed that qualified badminton players have an average level of productivity, speed and accuracy of per-

ception and processing of non-verbal information. In terms of speed and quality indicators of cognitive tests, female badminton players demonstrate significantly better values in relation to men. General cognitive abilities can be used as diagnostic and prognostic criteria in the selection process for qualified badminton players.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Body Composition and Heart Rhythm Variability in Elite Wrestlers

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Abstract

The aim of the research was to study the body composition and heart rhythm variability in elite wrestlers. In the study we used: Omron BF511 body composition monitor, we obtained and analyzed data on the body composition of 8 highly qualified athletes, members of the Ukrainian national team in Greco-Roman wrestling in 5 weight categories. 67 kg - 1 person, 72 kg - 1 person, 77 kg - 3 people, 87 kg - 2 people and 97 kg - 1 person. Vegetative regulation was assessed according to the indicators of statistical and spectral analysis of heart rhythm variability. For this purpose, we used a portable electrocardiograph with finger electrodes for an integral assessment of the functional state of the cardiovascular system "Fazagraf". The parameters of autonomic regulation and the results of spectral analysis in athletes were recorded. As a result of the study, it was found that the indicators of the body composition of the studied athletes have differences, but most of them correspond to the norm according to the Omron Healthcare rating scales. It was revealed that the hemodynamic supply of the body in highly qualified athletes occurs at a higher tension of the mechanisms of regulation of cardiac activity. Studies have shown that a high percentage of muscle mass is consistent with the activation of parasympathetic influences on the sinus node of the heart at rest state, which reflects the result of adaptive restructuring of the body during the training process.

Keywords: *elite athletes, wrestling, body composition, heart rhythm*

Introduction

Modern elite sport presupposes high competition among participants in sports competitions, coaches, functionaries and many other professionals who provide the training process (Slacanac, Baic, & Starcevic, 2017; McDonald, Deitch, & Bush, 2019; Kostiukevych et al., 2019). In this connection, in order to ensure an objective understanding of changes in the parameters of athletes' readiness, and to build a competitive system for training athletes of national teams, a scientific approach to the training process is relevant and does not raise doubts about its need.

In its implementation, it involves the study of various aspects of the sport preparation process and the search for ways to optimize it using the obtained research data (Keshavarz, Bayati, Farzad, Dakhili, & Agha-Alinejad, 2017; Chernenko et al., 2020). Along with the traditionally studied problems of physical, technical, tactical and other types of training, the problem of studying the component composition of the body of athletes in the precompetitive mesocycle of the preparatory period is urgent to assess the potential for correction of body weight due to fat tissue, as well as to determine changes in body composition caused by correction of its weight and, as a consequence of the effect on heart rhythm variability (Yukhymenko et al., 2019). This indicates the need for research and study of this problem.

The heart rhythm variability is a very relevant and infor-

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mative direction in the analysis of the adaptive reactions of the body of athletes. However, there is little understanding of the relationship between body composition and heart rhythm variability in elite athletes.

The aim of the research was to study the body composition and heart rhythm variability in elite wrestlers.

Methods

As a result of the studies using the Omron BF511 body composition monitor, we obtained and analyzed data on the body composition of bioimpedansometry (Kalantari et al., 2017) of 8 elite athletes, members of the Ukrainian National Greco-Roman wrestling team from 5 weight categories. 67 kg - 1 person, 72 kg - 1 person, 77 kg - 3 persons, 87 kg - 2 persons and 97 kg - 1 person.

Before the start of the study, each of the experimental athletes filled out a questionnaire that contains questions regarding consent or disagreement with the use of the step research for scientific purposes. The written consents were obtained from all athletes to conduct research in accordance with the recommendations of the ethical standards of the Helsinki Declaration. Ethical clearance on this research was provided by Commission on Biomedical Ethics of the National University of Ukraine on Physical Education and Sport (on 12/16/2020, minutes №. 2).

The functional state of the athletes was studied according to the characteristics of the vegetative regulation of the heart rhythm. Vegetative regulation was assessed according to the indicators of statistical and spectral analysis of heart rhythm variability. For this purpose, a portable electrocardiograph with finger electrodes was used for the integral assessment of the functional state of the cardiovascular system "Fazagraf" (Korobeynikov et al., 2018). The parameters of vegetative regulation and the results of spectral analysis in athletes were recorded.

Statistical analysis was performed using the software package STATISTICA 8.0. The main statistical characteristics of the studied indicators were determined in the work. Our sample was tested according to the normal distribution of the Gaussian function. However, the analysis revealed the absence of a normal distribution of the studied sample. That is why the nonparametric statistics with determine the median, lower quartile and upper quartile were used.

Results

As a result of the analysis, we can note the following, all the subjects 2 weeks before the expected start at important competitions had "working" weight indicators, exceeding the level of the body weight category by 1.3 - 5.4 kg. At the same time, among those athletes who were planning to go to the competition, the difference between the mass of the weight category and their own body mass was 1.3-3.5 kg, which indicates a possible control over their body mass by the athletes. The percentage of skeletal muscle mass is in range of 40.2-46.5%, which corresponds to "high" and "very high" levels of muscle mass according to the Omron Healthcare scale. By that, there was no clear relationship between the weight category and the percentage of skeletal muscle mass in the subjects. However, it should be noted that this indicator in 4 athletes, considered to be leaders in the team, was in the range of 44.7 - 46.5%, and for others - 40.2 - 42.9%, which refers the first to the group with a "very high" level of muscle mass, and the second - to the group with a "high" level of muscle mass.

The next investigated indicator - the percentage of body fat, was considered in accordance with the Omron Healthcare scale developed on the basis of studying the data presented in the publication (John et al., 2018), as well as the publication data (Zemková et al., 2017). Based on the results obtained, we can state that the percentage of fat in the two subjects was at a "low" level and is 7.2% and 7.9%, respectively. These values were the smallest of the entire sample, which is also consistent with the smallest difference in these athletes between the current level of body mass and the competitive level corresponding to the weight category of the athlete. In five athletes, the percentage of body fat ranged from 9.4% to 16.7%, which corresponded to the norm for men 18-39 years old according to the normalized scale (John et al., 2018), and one athlete had 21.1% body fat as a result of which was assigned to the group with a "high" level of fat.

Along with the percentage of body fat, the visceral fat indicator was studied, which shows the area of fat on the surface of internal organs. One unit of this indicator indicates an area of 10 sq.cm, and according to Omron Healthcare indicators, values from 1 to 9 cu (conventional units) are considered the norm. As a result of measuring this indicator, all the athletes under study were assigned to the group with a "normal" level, and the lowest values were recorded in athletes planning to go to competitions (5 and 6 cu, respectively). The highest values are 9 cu were recorded in two athletes, with one of them having the highest percentage - 21.1% body fat and the lowest percentage of muscle mass - 40.2%.

The resting metabolic rate tended to increase with increasing body weight in wrestlers, as shown in Table 1.

Table 1. Resting metabolic rate of elite wrestlers of different weight categories (in kcal) (n=8)

Body weight of wrestlers	Kcal
70.5	1679
73.3	1970
81.5	1833
81.9	1815
82	1830
88.5	2344
91.1	1928
100.2	2595

Although in two athletes weighing 73.3 kg and 88.5 kg, these indicators turned out to be higher than in athletes performing in a heavier weight category, which may indicate a more intensive course of their metabolic processes.

The functional state of the athletes was studied according to the characteristics of the autonomic regulation of the heart rhythm. Table 2 shows the values of the indicators of autonomic regulation of heart rhythm in Greco-Roman wrestlers.

Table 2. The value of autonomic regulation of heart rhythm in Greco-Roman wrestlers (median, lower and upper quartile)

Indicators	Value
Heart rate (HR), beat/min	76.81; 75.44; 95.38
Duration of RR cardio intervals (RRNN), мс	784.5; 700; 848
Standard deviation of cardio intervals (SDNN), мс	92; 52; 107
Average deviation of cardio intervals (RMSSD), мс	60.795; 40.68; 88.645
Number of consecutive cardio intervals pairs that differ by more than 50 ms (pNN50), мс	24.95; 11.575; 32.67
Ccoefficient of variation (CV), %	10.4515; 7.479; 13.62
HRV triangular index	13.1; 9.9085; 17.335
Stress index, cu	49.73; 30.045; 99.205

The results of the analysis of temporal indicators at rest state showed the following. The heart rhythm frequency (HRF) in the group is within the fluctuation range (Table 2). The average value of RR intervals in the group was slightly higher compared with conditional norm. The Standard Deviation of NN (RR) intervals (SDNN) in wrestlers indicates a more pronounced activity of the sympathetic division of the autonomic nervous system. For wrestlers, a decrease in the activity of the parasympathetic division of the autonomic nervous system is characteristic, as indicated by a lower Root Mean Square of the Successive Differences (RMSSD) value (Table 2). At the same time, a significant number of works, for example (Korobeynikov et al., 2016; Bakayev & Bolotin, 2019) note an increase in parasympathetic influences on the sinus node of the heart in athletes with a high level of fitness in a state of relative rest. Increased parasympathetic tone in wrestlers is associated with an increase in stroke blood volume and a decrease in blood pressure due to a prolonged diastole period (Korobeynikov et al., 2016; Bakayev & Bolotin, 2019).

Heart rhythm variability among wrestlers is reduced by almost 2 times compared to the norm. This is indicated by the proportion of NN50 divided by the total number of NN (R-R) intervals (pNN50) value (Table 2). Also, a peculiar centralization of heart rhythm control was revealed in elite wrestlers (Table 2). The results obtained on the analysis of heart rhythm variability indicators reflect a decrease in parasympathetic influences on the sinus node of the heart when the sympatho-vagus balance is shifted towards the prevalence of sympathetic influences. Thus, an increased tension of the mechanisms of regulation of the heart rhythm is observed. With an increase in the tension of the system of autonomous regulation of the heart rhythm in wrestlers, the humoral and sympathetic regulation channels are activated. This circumstance indicates an increase in the activation of the neurohumoral centers of the autonomic nervous system in wrestlers during the training process (Lucini et al., 2014). As a result of the activation of adaptive reactions, an increase in the tension of the heart rhythm regulation system is observed, aimed at ensuring a high level of central and peripheral blood circulation.

For a more detailed analysis of the mechanisms of heart rhythm variability, the concept of Baevsky et al. (2007) was applied (Table 3).

It was revealed that the presence of high values of the mode amplitude of RR intervals (AMO%) indicator (Table 3) in elite wrestlers indicates the activation of the sympathetic link of the autonomic nervous system.

Table 3. The value of the statistical characteristics of heart rhythm variability among Greco-Roman wrestlers (median, lower and upper quartile)

Indicators	Value
Histogram mode of cardio intervals (Mo), мс.	775; 675; 850
Amplitude of histogram mode of cardio intervals (AMo), %	36.06; 23.17; 45.85
Variation range of cardio intervals (MxDMn), мс.	398.45; 290; 578.15

Table 4 shows the values of the spectral characteristics of heart rhythm variability in Greco-Roman wrestlers (median, lower and upper quartile).

Table 4. Values of spectral characteristics of heart rhythm variability among Greco-Roman wrestlers (median, lower and upper quartile)

Indicators	Value
Low frequency (LFn), %	51,4; 44,55; 66,3
High frequency (HFn), %	18,7; 15,8; 44,8
Ratio (LF/ HF)	3,06; 2,145; 5,745

Similar changes were revealed in the spectral indicators of heart rhythm variability. According to the low frequency spectrum of RR intervals (LFn) indicator (Table 4), elite wrestlers activate the sympathetic link of the autonomous regulation of the heart rhythm. Athletes have significantly higher high frequency spectrum of RR intervals (HF) contribution (Table 4). An increase in the influence of the sympathetic division of the autonomic nervous system is also indicated by the LF / HF ratio (Table 4).

Discussion

As a result of the study, it was stated that the indicators of the body composition of the highly qualified wrestlers have some differences, but most of them correspond to the norm (according to the Omron Healthcare rating scales). Also, a distinctive feature of the studied athletes is a high and very high percentage of skeletal muscle mass (in the range from 40.2 - 42.9% to 44.7 - 46.5%). At the same time, the highest values of this indicator were found among the leaders of the National Team. The studied variable indicator of the percentage of body fat was low and normal (in the range of 8-19.9%). At the same time, one athlete with a body weight of 81.5 kg showed the highest percentage of fat (high level, 21.1%). This athlete had the highest value of visceral fat (9 conventional units), although this indicator was in him within the upper limit of the norm.

Thus, the highest of the studied indicators of body composition have been demonstrated by athletes, preparing for responsible competitions and being the leaders of the National Team.

Comparison of the obtained results of the study with data by the authors (Zemková et al., 2017) confirms the data of our studies on the percentage of adipose tissue in the body of highly qualified wrestlers at the normal level in the range from 8 to 19.9%. At the same time, the authors' data (Zemková et al., 2017) disagree with ours on the dependence of this indicator on the athlete's body weight, since the studies cited by the authors use averaged data, which does not reflect the individual characteristics of highly qualified wrestlers.

Our research has shown that most wrestlers try to have a very low percentage of body fat as they adjust their body weight before each bout (Vardar, Tezel, Oztürk, & Kaya, 2007). Optimal body composition is one of the main concerns of elite wrestlers. Wrestlers and coaches see body fat percentage as a factor that needs to be controlled. It is believed that the lower percentages of fat mass are to be preferred.

According to the study of heart rhythm variability, it was found that the total power of the spectrum (TP) increases due to an increase in the power of the energy spectrum of the parasympathetic link of autonomic nervous regulation (high-frequency spectrum HF) and a decrease in the power of the low-frequency spectrum (LF). In elite wrestlers being at rest state, it is possible to activate maximum parasympathetic rhythm regulation with inhibition of sympathetic influences (Korobeynikov et al., 2016). Consequently, the hemodynamic supply of the organism of highly qualified athletes occurs under higher tension of the mechanisms of cardiac activity regulation.

The distinctive features of the heart rhythm in elite wrestlers were: decreased heart rhythm variability (low RMSSD, pNN50 values) with a predominance of sympathetic activity in the sympatho-vagus balance (high AMO values, %), as well as a significant decrease in the spectrum power in all frequency ranges. The elite wrestlers have a higher level of tension in the regulation of the heart rhythm in comparison with the wrestlers with low qualifications. With an increase of tension in the autonomous regulation system of the heart rhythm in elite wrestlers, humoral and sympathetic links of regulation have been activated. Thus, the spectral analysis of cardiointervals revealed a more perfect system of autonomic regulation in elite wrestlers with a simultaneous lower percentage of body fat.

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ORIGINAL SCIENTIFIC PAPER

Dynamics of Changes in Physical Capacity of Patients with Severe Chronic Obstructive Pulmonary Disease during Physical Therapy

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Abstract

The purpose of the study was the assessment of the proposed physical therapy on physical capacity of patients having severe chronic obstructive pulmonary disease (COPD). One hundred and twenty-four (124) patients having severe COPD were examined. All patients underwent standard clinical, laboratory and functional examination. Physical capacity of patients was assessed by the 6-minutes walking distance (6MWD). Application of physical therapy with patients having COPD resulted in a statistically significant greater dynamics of growth of the distance traveled at 6 MWD with both men - by 104.66-9.24 m (at standard treatment - by 57.07-8.99 m; p <0.001), and women - by 81.17-8.35 m (at standard treatment - by 44.97-6.67 m; p<0.001). Compared to standard treatment, patients of the main group increased their physical capacity (both men and women) 1.8 times, and the achieved state of their physical abilities (511.2-9.38 m; 100.9-1, 96% of the appropriate value (AV)) significantly exceeded the one at standard treatment (481.5-10.59 m; 94.57-1.99% of AV; p<0.01). Physical therapy, which is used with patients having severe COPD, results in an increase in their physical abilities, which significantly improve compared to standard treatment.

Keywords: *physical therapy, chronic obstructive pulmonary disease, physical capacity, 6-minutes walking distance*

Introduction

Chronic obstructive pulmonary disease (COPD) is an extremely topical medical and economic problem due to its high prevalence, severity, high risk of death and high costs of patients' treatment and rehabilitation (Havrysiuk, Yachnyk, & Berenda, 2004; Mohammed, Da Silva, Van Oosterwijck, & Calders, 2017; Kruis, Boland, & Assendelft, 2014). COPD is one of the leading causes of morbidity and mortality worldwide in medical, social and economic terms. Patients suffer from COPD for years; die prematurely from it or its complications. Prolonged exposure to risk factors, aging of population around the world leads to an accelerated increase in the incidence of COPD. This disease affects 8 to 22% of adults aged 40 years and older (Ali, Bolton, & McKeever, 2017; Kim, Lee, & Park, 2016; Kon, Dilaver, & Mittal, 2014; Rodriguez, Arbillaga, & Barberan-Garcia, 2016). According to unofficial statistics, the incidence of COPD in Ukraine is 7%, i. e. it affects about 3,000,000 people (Gashynova, 2015; Linnik, Nedospasova, & Tarasenko, 2017).

An analysis of scientific and methodological, special and medical references related to treatment and physical therapy of patients having COPD has revealed that there is a need to improve approaches to physical therapy, which has significant theoretical, practical and social significance for patients' health protection and improvement.

The aim of the research was to analyze the efficiency of

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influence of the proposed physical therapy on physical activity in patients with severe chronic obstructive pulmonary disease (COPD).

Methods

The research was carried out on the basis of the department of rehabilitation treatment by traditional and alternative methods, and the pulmonology department of the Rivne Regional Clinical Hospital. As patients were admitted to inpatient treatment, results were accumulated. Within the research, available COPD 3 (severe) of patients was the selection criterion. The doctor determined severity of the disease according to the normative document of the Ministry of Healthcare of Ukraine: patients with values of volume of forced expiratory for the first second (VFE1) from 30 to 50% of the appropriate value (AV) according to spirography were classified as the ones having 3rd-degree severity.

One hundred and twenty-four (124) patients with severe COPD were examined; average age was 59.19±0.74 years, of which men - 64 (51.61%) and women - 60 (48.39%). Patients were randomly (using a table of random numbers) assigned to control (men - 32, women - 30 persons) and treatment (men - 32, women - 30 persons) groups, proportionally, as being admitted. Under supervision of doctors, all patients were examined at the beginning and at the end of the research.

All patients underwent standard clinical, laboratory and functional examination.

Physical capacity was assessed via a 6-minutes walking distance (6MWD). 6MWD was administered 30 minutes before or 2 hours after having a meal. During the test, the distance traveled by the patient in 6 minutes at a moderate pace was measured. The obtained distance was compared with the appropriate value, which was calculated by the formula: 6 MWD (men) = (7.57 x height, cm) - (5.02 x age) - (1.76 x weight, kg) - 309; 6 MWD (women) = (2.11 x height, cm) - (5.78 x age) - (2.29 x weight, kg) + 667. The final test result was presented as percentage of the appropriate value (AV). Additionally, respiratory and circulatory parameters that are directly related to physical capacity of patients were analyzed: respiratory rate (RR), heart rate (HR), blood pressure (BP) - systolic (BPs) and diastolic (BPd).

Patients were treated according to the Ministry of Healthcare of Ukraine. The control group of patients underwent rehabilitation in accordance with the recommendations of the regulatory protocol of the Ministry of Healthcare of Ukraine, and the treatment group - according to the proposed method. Duration of physical therapy averaged 30 days and consisted of inpatient and outpatient stages.

This study complies with the ethics committee of National University of Ukraine on Physical Education and Sport Approval date: 16.12.2020 Approval number: Protocol №2.

All patients were informed about the progress of the study and gave written consent to participate.

Statistical description of selections was carried out by determining the mean (M) and its error (m). The type of parameter distribution in the variation series was determined by the Shapiro-Wilk test. Significance of differences between selections as determined by using non-parametric methods for dependent and independent selections (Wilcoxon T-test, Mann-Whitney U-test). The level of significance with an indication of probability of erroneous assessment (p) was the criterion of authenticity. Estimation of the mean difference was considered significant at $p<0.05$. Excel XP and STATISTICA 6.0 software (StatSoft, USA) was used for calculations.

Results

The main clinical signs of pathology of patients with severe COPD were complaints on significant shortness of breath, persistent cough and sputum discharge; physical examination revealed impaired breathing, moderate or significant wheezing. Disorders of external respiration, according to spirometry, were significant (in the control group VFE1 was 40.81±1.59% of AV, in the treatment group - 42.06±1.56% of AV).

Drug therapy, which was prescribed in accordance with the regulatory document, according to the severity of the disease, was carried out along with physical therapy. Patients of the control group underwent physical therapy in accordance with the recommendations of the regulatory document of the Ministry of Healthcare of Ukraine (Annex 9), according to which, at severe COPD (reduced motor skills, light motor training), therapeutic gymnastics lasting 35-40 minutes was used in 30-35 exercises at an average pace and terrenkur 1.9-2.7 km long with the speed of 80-110 steps/min.

In the treatment group, physical therapy was based on the same principles and was carried out according to the proposed method. It consisted of patient assessment, patient training, weight correction measures, physical training programs, psychological support. The main aim of physical therapy was to reduce intensity of shortness of breath, improve respiratory function, increase tolerance to physical workload, reduce anxiety and depression associated with COPD, which should reduce the number and duration of hospitalizations, improve quality of life. The elaborated program of physical therapy for each patient envisaged taking into account age peculiarities, clinical picture of the disease and mechanism of its development, existing side-effects and cautions, specific physiological and psychopathological disorders, functional state and level of physical fitness, clear definition of the purpose and mechanism of influence of each exercise on the patient's body. At all stages of rehabilitation, patients were trained to develop realization to follow the recommendations of the doctor and physical therapist. Patient's refusal to smoke, learning proper nutrition, active lifestyle, proper breathing was important. For each patient the program of physical therapy was developed for a long term (Grygus, & Maistruk, 2017; Maistruk, 2017; Grygus, Maistruk, & Zukow, 2017; Maistruk, 2016; Maistruk, 2015).

The examined patients with severe COPD showed reduced output level of physical capacity, as evidenced by the data in Tables 1 and 2. At the beginning of rehabilitation, the examined control group generally traveled the distance of 430.5±11.36 m, which was 83.44±2.08% of AV, the treatment group - 421.7±10.28 m (82.65±2.15% of AV). These results indicated that the course of the disease of 3 degrees of severity significantly affected physical abilities of patients, reducing them. Men suffered from this course of the disease more. Their output level of physical abilities in the control group was 79.13±1.92% of AV, in the treatment group - 75.12±2.64% of AV, while with women, these indicators were 88.03±2.85% of AV ($p=0.0432$) and 88.92±2.48% of AV ($p=0.001$) respectively.

The obtained data on the output level of physical capacity at a distance of 6 MWD did not coincide with those provided by foreign authors. Thus, (Riario-Sforza et al., 2009). indicated

3 degrees of COPD; the distance traveled by patients during performance of 6 MWD ranged from 327 to 416 m, while (Mariiyn, Danilack, Weston, & Garshick, 2012) - 354 m. We consider this discrepancy is due to different methodological approaches to the implementation of 6 MWD.

Both standard treatment and physical therapy improved physical abilities of all patients, as evidenced by the data in Tables 1 and 2.

Table 1. Value of 6 MWD with patients having severe COPD (males and females) of both groups before and after rehabilitation (distance covered in meters, M±т)

Group	Period of examination	Overall in the group	Men	Women
Control	Before rehabilitation	430.5±11.36	443.6±18.24	416.6±13.01
	After rehabilitation	481.5±10.59*	500.6±17.80*	463.0±9.90*
	t values	9.04	6.35	6.76
	p values	0.00	0.00	0.00
Treatment	Before rehabilitation	421.7±10.28	435.4±15.66	421.2±12.21
	After rehabilitation	511.2±9.38*""	540.1±14.14	503.1±13.76*»
	t values	14.7	11.3	9.94
	p values	0.00	0.00	0.00

Legend: *-Statistically significant differences between values before and after rehabilitation (p<0.001); ш – compared to control group (*-p<0.05," - p<0.01).

Table 2. Value of 6 MWD with patients having severe COPD (males and females) of both groups before and after rehabilitation (% of appropriate value, M±т)

Group	Period of examination	Overall in the group	Men	Women
Control	Before rehabilitation	83.44±2.08	79.13±1.92	88.03±2.85
	After rehabilitation	94.57±1.99*	91.52±2.91*	97.82±2.61*
	t values	9.2	6.78	6.27
	p values	0.00	0.00	0.00
Treatment	Before rehabilitation	82.65±2.15	75.12±2.64	88.92±2.48
	After rehabilitation	100.9±1.96*	93.12±2.21*	106.3±2.55*»
	t values	9.84	8.12	7.43
	p values	0.00	0.00	0.00

The proposed physical therapy used by us resulted in the formation of better physical abilities of patients compared to standard treatment. Thus, in general, in the treatment group the traveled distance (511.2±9.38 m; 100.9±1.96% of AV) was statistically much greater than in the control group (481.5±10.59 m) <0.01); 94.57±1.99% of AV). This also applies to women of the treatment group who traveled bigger distance after physical rehabilitation - 503.1±13.76 m (106.3±2.55% of AV) than the ones of the control group - 463.0±9.90 m (97.82±2.61% of AV), which was statistically significant (p<0.05).

The dynamics of 6 MWD given in Table 3 indicates a better effect of the proposed physical therapy on patients' physical abilities. The difference between the values after and before rehabilitation with men of the treatment group was 104.66±9.24 m, which was significantly higher than in the control group - 57.07±8.99 m (p<0.001). The same dynamics of 6 MWD was revealed with women (in the treatment group - 81.17±8.35 m, in the control group - 44.97±6.67 m (p<0.001)). That is, application of physical therapy made it possible to significantly increase physical abilities of patients compared to standard treatment: with men - 1.8 times, with women - 1.8 times, overall - 1.7 times.

Table 3. Dynamics (difference between values after and before rehabilitation) of 6 MWD of patients having severe COPD (males and females) of both groups by the results of rehabilitation (distance covered in meters, M±т)

Group	Overall in the group	Men	Women
Control	51.31±5.68	57.07±8.99	44.97±6.67
Treatment	89.18±6.32*	104.66±9.24*	81.17±8.35*
t values	6.72	8.24	7.36
p values	0.00	0.00	0.00

Application of standard treatment along with physical therapy has resulted in the improvement of other indicators of functional state of patients with severe COPD. Patients of both control and treatment groups showed significantly decreased respiration rate and heart rate, decreased blood pressure, as shown in Tables 4 and 5. Differences between the achieved values of these indicators with patients of control and treatment groups have not been revealed.

According to data of medical supervision, clinical con-

Table 4. Values of routine cardio-respiratory indices of patients having severe COPD (males and females) before and after rehabilitation (M±τ)

Index	Control group		t	p	Treatment group		t	p
	before	after			before	after		
RR, number in 1 min	19.00±0.52	15.31±0.45**	6.24	0.00	19.53±0.53	14.97±0.46**	8.44	0.00
HR, number in1min	84.44±2.03	76.63±1.31**	6.46	0.00	83.94±2.34	74.91±1.40**	8.76	0.00
BP_s, mm. of mercury	133.3±3.65	125.6±1.82*	7.2	0.00	136.7±3.59	127.4±1.54*	9.26	0.00
BP_d, mm. of mercury	82.03±1.97	80.00±0.98	6.86	0.00	84.22±1.80	79.77±0.91*	7.46	0.00

Table 5. Values of routine cardio-respiratory indices of patients having severe COPD (males and females) before and after rehabilitation (M±τ)

Index	Control group		t	p	Treatment group		t	p
	before	after			before	after		
RR, number in 1 min	17.47±0.32	15.53±0.54**	6.44	*0.00*	17.89±0.44	14.13±0.35**	9.38	*0.00*
HR, number in1min	81.87±1.42	74.13±1.23**	7.12	*0.00*	82.54±1.31	73.34±1.36**	10.58	*0.00*
BP_s, mm. of mercury	134.5±2.83	126.8±0.94*	6.46	*0.00*	135.8±2.96	126.1±0.88*	9.82	*0.00*
BP_d, mm. of mercury	86.33±1.12	81.67±1.60*	7.18	*0.00*	85.74±1.31	81.05±1.54*	8.68	*0.00*

dition of the patients improved: decreased cough, improved sputum discharge, decreased shortness of breath; wheezing in the lungs decreased or disappeared. Standard treatment along with physical therapy applied resulted in an increase in functional capabilities of patients, which manifested itself in the increased physical capacity, reduced tension in the cardio-respiratory system at the end of the research, as evidenced by data given by us.

Discussion

Rehabilitation plays the leading role in complex treatment of patients with COPD. Pulmonary rehabilitation implemented in daily treatment of patients allows to reduce illness manifestations, optimize patient's functional status, and lower the cost of treatment via stabilization or reduction of illness manifestations (Cindy, Mackney, Jenkins, & Hill, 2012; Grygus, Maistruk, & Zukow, 2017; Mohammed, Da Silva, Van Oosterwijck, & Calders, 2017; Rodriguez, Arbillaga, & Barberan-Garcia, 2016)

Analysis showed a better dynamics of indices of cardiovascular system's functional state of patients with severe COPD from treatment group, which proves efficiency of the developed technology of physical therapy. Application of physical therapy technologies for patients with COPD results in significant increase of their motor and functional capacity. It is expressed by a statistically significantly greater dynamics of growth of the distance traveled at 6 MWD with both men - by 104.66 ± 9.24 m (at standard treatment - by 57.07 ± 8.99 m; p<0.001), and women - by 81.17 ± 8.35 m (at standard treatment - 44.97 ± 6.67 m; p<0.001). When using the proposed physical therapy programs, physical abilities of patients, compared with standard treatment, increased with both men and women by 1.8 times, and the achieved state of physical abilities of all patients of the treatment group (511.2 ± 9.38 m; 100, 9 ± 1.96% of AV) significantly exceeded the one at standard treatment (481.5 ± 10.59 m (p <0.01); 94.57 ± 1.99% of AV).

The research proved therapeutic orientation of physical exercises, proved its necessary inclusion into systematic physical therapy of patients with COPD when composing long-term programs as a basic link of physical therapy.

Implementation of conceptual physical therapy of patients with COPD promoted reduction of COPD clinical symptoms, which allowed to stay active, not be limited at usual physical workload or exercises.

Due to application of the proposed concept of physical therapy of patients with COPD, general level of physical health, physical capacity, life quality could be improved, functional state of cardiorespiratory system could be restored.

Application of physical rehabilitation of patients with COPD allows to obtain positive changes that cannot be obtained with medical therapy only. Due to its application it is possible to control symptoms of the illness, patients' functional state improves, tolerance to physical workload increases, every-day physical activity increases, life quality improves, which is primarily expressed in reduced anxiety and depression related to COPD.

Physical rehabilitation should be recommended to patients with COPD in order to help control the symptoms, improve life quality, and increase physical activity.

Perspectives of further research lie in the analysis of efficiency of influence of the proposed method of physical therapy on the function of external respiration of patients with COPD.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Physical Rehabilitation of Patients with Cerebral Blood Flow Acute Disorders in the Late Recovery Period

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Abstract

The purpose of this article is to substantiate, develop and evaluate the effectiveness of a physical rehabilitation comprehensive program using functional training method for patients with cerebral blood flow acute disorders in the late recovery period. The rehabilitation program focuses on improving the quality of life indicators according to the International Classification of Functioning, treating movement disorders and returning patients to their previous functional level. The ascertaining experiment involved 73 patients. The primary diagnosis was the consequences of cerebral blood flow acute disorders lasting for at least 6 months and not more than 9 months after a stroke. The physical rehabilitation comprehensive program was implemented amongst the patients of the experimental group (n=35) and the control group (n=38), the latter attending a standard physical rehabilitation course in a medical institution. The statistical analysis revealed a great number of correlations at a significant level, which is explained by the connection between body structures and functions, activity and participation. The study proves the effectiveness of the proposed program as compared to the traditional approaches. It ascertains that using specialized methods based on functional training in post-stroke rehabilitation programs is the way to increase functional capacity and improve the adaptation of stroke patients.

Keywords: *physical therapy, stroke, functional training, activity, participation*

Introduction

In Ukraine there are currently a number of projects on physical rehabilitation of stroke patients in the acute and early rehabilitation periods, for example, the Ukrainian Anti-Stroke Association, which clearly outlines protocols for providing rehabilitation assistance to stroke patients (Holik, 2011). However, despite some advances in the rehabilitation of stroke patients in the acute period, the problem of functional movement disorders rehabilitation in the late period remains poorly developed (Krupinski, Secades, & Shiraliyeva, 2013; Cifu, 2016). Standard programs based on traditional means and methods, including massages, combinations of therapeutic physical training, and physiotherapy are mostly used in the late period (Bohdanovska & Kalenova, 2017). Therefore, there are no programs for comprehensive recovery of physical, neuropsychiatric and linguistic spheres of stroke patients in the late period (Bilianskyi, Skobolyak, & Rokoshevska, 2018).

The strategy for solving this problem consists of reducing physical disabilities, increasing acquisition of new skills and abilities that maximize patient's activity, changing the environment to minimize social restraints (Braunet et al., 2013; Breceda & Dromerick, 2013). Using methodological approaches of

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the International Classification of Functioning (ICF) allows conducting a comprehensive analysis of the existing physical disabilities (Rokoshevska & Kruk, 2016; Dmytruk & Rokoshevska, 2017). Up-to-date rehabilitation interventions should be aimed at enhancing neuroplasticity processes to restore lost movement and cognitive functions (Cifu, 2016). The functional training method involves restoring and compensating for lost physical characteristics by training motor skills that are necessary to improve or return to normal social life (Kitago & Krakauer, 2013; Winstein et al., 2016).

Thus, it would be appropriate to develop and test new differentiated programs of physical rehabilitation of patients with cerebral blood flow acute disorders in the late recovery period based on the current approach of the ICF aimed at participation level.

Methods

Participants

The study involved 73 patients, eligible to take part therein, i.e. having clear consciousness with a level of wakefulness sufficient to withhold and execute instructions during exercises; having no severe somatic pathologies, acute systemic diseases, uncontrolled sinus tachycardia with a heart rate of more than 120 beats per minute, musculoskeletal disorders, which complicate exercising, lack of sensory aphasia and cognitive disorders that prevent active involvement of patients in rehabilitation activities.

All persons were informed about the content of the tests, measurement procedures and signed an informed consent form. The research was approved by the Institutional Ethics Committee (number 1/2017) and was carried out in compliance with the international principles of the Helsinki Declaration of the World Medical Association (World medical association Declaration of Helsinki, 2013), and following the Law of Ukraine "Fundamentals of Ukrainian Legislation on Healthcare" (Law of Ukraine, 1992) on ethical norms and rules for conducting medical research involving human.

Procedure

The study, conducted at the premises of the neurorehabilitation department of Kyiv City Clinical Hospital No. 8, was as follows:

Patients with the consequences of cerebral blood flow acute disorders lasting for more than 6 months after a stroke, who were at the neurorehabilitation department of the hospital, underwent an objective rehabilitation examination.

Prior to starting rehabilitation activities, a rehabilitation survey was conducted, which used ICF methodological approaches to solve the problems at the level of body functions and structures, activity and participation.

The patients were divided into 2 groups: the experimental group (EG), n=35 and the control group (CG), n=38. For the patients of the EG, a 27-week program was developed based on ICF methodological approach. The CG used the standard 27-week program of the institution which consisted of massages, a sequence of therapeutic exercises and ergocycling.

EG program included three periods of four weeks each with five weeks intervals between them.

The frequency of the classes per week was 5, 2 classes per day; each class lasted 45-60 minutes.

For detecting selective and optimal effects on improving patient's life quality, major disorders of body functions and systems were identified. The type of these disorders determined rehabilitation interventions by means of selecting physical exercises to perform various functional tasks that help patients to restore or compensate for the skills necessary for a normal life and active participation in public activities.

In each of the three rehabilitation periods, tasks were addressed at the level of disorders of structures and functions, activity and participation, but the correlation of the tasks was directly proportional to the patients' initial state. In the first period, patients had significant disorders at the function and structure level that influenced positive outcomes of attaining independence at the activity and participation level, and accordingly, more time was given to the exercises aimed at improving function and structures.

Closer to the end of the rehabilitation course, patient's movement tasks were aimed at achieving functional independence at the participation level.

The program was based on individual exercises with the patient to ensure independent, efficient and long-term movement in space, restore upper limb and hand functioning. Restoration of physical activity was closely related to restoration of the necessary components of mental activity, which is crucial for a productive life.

Each period of the physical rehabilitation program included tasks and exercises aimed to improve functional independence, but the distribution by ICF domain was different.

In the first rehabilitation period correlation of the exercises to solve problems at different levels was as follows: problems at the level of structures and functions – 50%, at the level of activity – 30%, at the level of participation – 20%. The problems at the level of structures and functions needed more time because of low functionality and rough disruptions of the structures that made it impossible to fully complete the tasks at the level of activity and participation. This period included: medical history analysis, examination, determination of the nature and degree of motor function disorder, determination of mental status, restoration of movement amplitude, exercises to increase strength, exercises to restore support capacity and swing phase of the step, improving functional status, exercises to improve postural control and balance, exercises to restore the amplitude, increase strength and improve functioning of the upper limb and hand.

Strength exercises were performed every other day during all three periods of rehabilitation to restore walking pattern. In the case of plantarflexion contractures were used: therapeutic exercises from the standing starting position on flat surfaces and stairs. Selection of an orthosis with fixation of the foot in the neutral position + 5°. To increase the strength of dorsal flexors: getting up from surfaces of different heights; motor tasks for step over the objects of different heights; walking while pushing various objects using the affected foot with a load, on an inclined plane, stairs, backward and sideways; ball exercises. In case of proprioception dysfunction: exercises from the starting position standing, the affected leg ahead, transfer of weight to the affected leg with a change of position in the knee joint, on an unstable surface; movements in the affected limb blindfolded; rising of the toes at different angles and with different degrees of support. To correct the position of the pelvis in the single-support phase of walking, exercises were done from the starting position standing, leaning the affected side against the wall - abduction of the opposite limb. To increase the functioning of the hand and arm, actively worked on: stability of the postural muscles of the torso; per-

forming active physical exercises from different starting positions; the activity of the muscles of the torso, shoulder joint, and rotational cuff muscles; normalization of the position of the scapula; improving the reaching and griping of objects of different shapes and sizes in different planes; improving sensory perception in the affected limb.

The main motor tasks of the restoration of the hand were: training of the wrist extension with abduction and extension of the thumb; increase the grip amplitude; achieve the necessary sensory connection with the object managing vision control levels; simultaneous use of both hands.

In the second rehabilitation period correlation of the exercises to solve problems at different levels was as follows: problems at the level of structure and function – 20%, at the level of activity – 50%, at the level of participation – 30%. Patient's functionality made it possible to perform more activity-level tasks and increase participation. This period included: exercises to restore the amplitude and increase strength, improve vestibular responses, increase cardiorespiratory endurance, motor tasks to improve self-care and daily activities, improve cognitive abilities. Increased endurance was achieved by walking 10 - 15 minutes at a target heart rate of 55 -65% of maximum. Improved the ability to reach a certain object using exercises with changing speed, visualization of the target, sliding on the surface when approaching the object; exercises for reaching the subject and hitting it. All exercises were performed with motivation to move and individually selected goal-oriented tasks.

In the third period of rehabilitation correlation of the exercises to solve problems at different levels was as follows: 20% – at the level of structure and function, 30% – at the level of activity, 50% – at the level of participation. Functional condition and activity level made it possible to perform tasks at the level of participation. The third period included: exercises to improve and maintain the range of motion, increase strength, restore the previous level of cardiorespiratory endurance, motor tasks to improve self-care skills, exercises for coordination, balance, agility. Providing independent long-term movement in space, modeling of life situations, adaptation to environmental conditions and independent stay in it.

Within the breaks between the periods of the rehabilitation course, conducted at the inpatient unit, patients of the EG were given individual tasks and exercises that had to be performed at home. Such home tasks were aligned with the goals of the patient and his/her family.

Physical rehabilitation effectiveness was measured with the help of clinical tests at the initial, intermediate and final stages of the study. Within the physical rehabilitation course, indicators of lower and upper limb muscle strength, spasticity level, equilibration level and risk of falling, self-maintenance degree and dependence on outside help, fatigue level, walking pace and duration and cognitive condition level were monitored.

Physical rehabilitation comprehensive course was followed by the assessment of its effectiveness: data on changes in the functional state, intensity of motor and sensorimotor disorders were collected.

Research methods and their use have been selected depending on the task of study and methodological approach of the ICF. The spasticity rate was determined using the Ashworth Spasticity Scale. The Barthel Index was used to assess independence in the everyday life. The disability rate (functional dependence) was determined using the modified Rankin scale. Postural abilities were assessed using the Berg balance scale and the Tinnety Test. Mobility was assessed using the Rivermead Mobility Index and the Fugl Meyer Stroke Sensory Motor Scale. Muscle strength was determined using a modified Motor Verticalization Control Test. The walking rate was assessed by the 6-minute walk test (6MWT). The intensity of physical activity was determined according to the Borg individual load perception scale. The level of mental status - according to the SAGE test.

Statistical analysis

All statistical analyses were conducted using SPSS 21.0 program (Chicago, IL, USA). Mean ± standard deviation (M±SD), median (Me), upper and lower quartiles (25%; 75%) were measured. Correspondence between the type of quantitative indicators distribution and the normal distribution law was analyzed with the help of Shapiro-Wilk's test. To measure the significance of the difference, Student's t-test (for dependent groups) was used provided there was a normal distribution of study results. Wilcoxon test (for dependent groups) and Mann-Whitney U test (for independent groups) were used provided the indicators had a distribution other than normal. Statistical significance defined at $p<0.05$.

Results

According to the results of the ascertaining experiment, the patients had similar indicators with a slight, more marked and considerable increase in muscle tone on Ashworth Spasticity Scale. Muscle strength indicators measured by Motor Verticalization Control were 11.44±0.23 points, which comprised only 49.7% of the maximum; Me (25%; 75%) indicators were 12.0 (10.0; 13.0) points.

Berg balance test revealed a high level of falling among all patients. Total Berg balance test score was 28.84±7.23 points, Me (25%; 75%) indicators comprised 30.0 (23.0; 35.0) points. Mean value comprised 51.5% of the maximum. Among the results obtained, the minimum score comprised 12 points and the maximum score comprised 42 points. Besides, none of the patients had a score higher than 45 points and, accordingly, all patients had a high level of falling.

Mid-test results on the Rankin scale comprised 1.83±0.62 and 2.13±0.74 points in EG and CG, Me (25%; 75%) indicators were 2 (2; 2) and 2 (2; 3) respectively. At this stage, no statistical difference was observed between the groups ($p=0.086$, $Z=-1.719$), though a significant improvement was observed in both groups as compared to the pre-tests ($p<0.01$).

The Rivermead Mobility Index comprised 44% of the maximum score. The highest proportion of patients received 7 (21.9%), 6 (20.5%) and 12 (16.4%) points.

The assessment of hand and wrist motor functioning on the Fugl-Meyer scale revealed an average score of 10.1±3.88 points, which comprised 41.96% of the maximum. The average Barthel Index comprised 67.95±12.04 points. 41.1% of the patients had a considerable degree of dependence, the rest – a moderate one. The Tinetti Test assessing balance and risk of falling also showed low results.

The average distance of 6-MWT patients was 100.22±58, 14 m when Borg scale of perceived exertion comprised 4.82±1.37 points. More than half of the sample (56.2%) had normal cognitive functions on the SAGE scale.

Thus, the results obtained at the first stage of the preliminary studies reveal significant limitations in each of the domains of the ICF, which requires physical rehabilitation.

The data obtained upon completion of the rehabilitation course indicate positive dynamics of the studied indicators. Decreased spasticity level was observed in both groups. On Ashworth Spasticity Scale mean value difference in the groups was 0.4 points and was significant (p=0.000, t=-3.785). Muscle strength increase was higher in EG, as indicated by the total score increase of Motor Verticalization Control. It was more significant among EG patients – 43% of the maximum, which influenced statistical difference between the groups.

A difference (p=0.000, t=6.860) was also observed in the total score of Berg balance test. Mean values in the EG comprised 44.9±5.79 points and in the CG – 35.2±6.27 points. There was a decrease in disability level in EG. On the Rankin scale the average score was significantly (p=0.007, t=-2.763) better in EG and comprised 1.11±0.62 points.

Patients' overall mobility improved in the Rivermead Mobility Index as well: at the end of the rehabilitation course, it comprised 11.97±1.42 among EG patients and 9.47±1.81 points among CG patients. The difference between the groups was significant (p=0.000, t=6.574) (Table 1).

Table 1. Dynamics of the Rivermead Mobility Index in the Experimental Group and Control Group of the patients, M±SD

Rivermead Mobility Index	EG	CG	t	p
Pre-test	6.23±1.83	6.95±1.74	-1.716	0.091
Mid-test	9.17±1.74	8.29±1.81	2.119	0.038
Post-test	11.97±1.42	9.47±1.81	6.574	0.000

Legend: EG - Experimental Group; CG - Control Group

According to Barthel Index EG had significantly better (p=0.000, t=5.234) results, with a 10 point superiority between mean values and better distribution of activity indicators in daily life.

The total score of the Tinetti Test assessing balance and risk of falling comprised 35.8% of the maximum among EG patients, and 15.8% – among CG patients (p=0.000, t=6.918).

Despite statistical improvements in the final results of walking tests (as well as 6-MWT) and Borg scale scores, statistical analysis revealed better results of CG patients.

After completion of the course most EG and CG patients had normal cognitive functions according to SAGE scale – 91.4% and 84.2% respectively. However, the difference indicated the superiority of EG results (p=0.012, Z=-2.505).

At the end of the rehabilitation course, there was an increase in functioning and improved motor control of an upper extremity. The dynamic of indicators of hand and wrist motor functioning on the Fugl-Meyer scale was statistically significant, as well as the difference of this index between the groups (p=0.010, t=2.653) (Table 2).

Table 2. Dynamic of mean values of the Fugl-Meyer total score ("wrist" and "hand" blocks) in the Experimental Group and Control Group of the patients, M±SD

Fugl-Meyer total score	EG	CG	t	p
Pre-test	9.29±3.37	10.79±4.22	-1.688	0.096
Mid-test	13.20±3.76	12.45±4.38	0.789	0.433
Post-test	16.91±3.85	14.29±4.60	2.653	0.010

Discussion

The data obtained confirm that using physical rehabilitation rationally (in particular controlled physical activity) increases functionality and improves the life quality of the patients with the consequences of cerebral blood flow acute disorders (Hesse et al., 1995; Visintin, Barbeau, Korner-Bitensky, & Mayo, 1998; Bohdanovska & Kalenova, 2018), who also offer training vertical posture by on-load walking on a treadmill. Thus, according to the results of 6-MWT after the rehabilitation course, EG patients' average result was 178 m. CG patients' average result was only 107 m. EG patients were able to cover longer distances in less time, which significantly influenced their mobility and ability to walk in the streets of a city that raised their independence and improved life quality.

Study results substantially supplement the data (Holik, 2011; Rokoshevska & Kruk, 2016) that research methods and their application time were determined by the research objectives and methodological approach according to the ICF. The ascertaining experiment was conducted to obtain baseline indicators of neurological damage degree at the level of functions and structures, activity and participation. The selected research methods contributed to a detailed and comprehensive analysis of sensorimotor disorders of the patients with the consequences of cerebral blood flow acute disorders in the late recovery period.

Study results substantially supplement the data (Lazarieva, 2015; Bohdanovska & Kalenova, 2017) that the proposed method of functional training contributes to the restoration of sensorimotor functions, improvement of motor functions and increase of the adaptation and compensatory potential of the CNS of the patients with cerebral blood flow acute disorders in the late recovery period.

Thus, the introduced physical rehabilitation program, featuring a comprehensive approach aimed to increase upper extremity functionality and restore optimal statics and balance for the patients with the consequences of cerebral blood flow acute disorders in the late recovery period, can increase functionality more efficiently and improve patient's life quality.

Our physical rehabilitation program for patients with post-stroke disorders in their late recovery period is based on modern methodological approaches of the ICF which helps to restore functionality, increase maximum activity, and participation. The results offered can be used to create 3 to 12-month rehabilitation programs for patients with post-stroke disorders who are in rehabilitation departments, centers, and at home during recovery.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Assessment of the Relationship between Therapeutic Alliance and Pulmonary Function Recovery in Cardiac Surgery Patients Undergoing Physical Therapy

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Abstract

Objective of the study was to assess the relationship between the indicators of therapeutic alliance and pulmonary function recovery in patients undergoing physical therapy after cardiac surgery (CS). 80 patients, who were submitted to CS (performed by median sternotomy on cardiopulmonary bypass) and standardized physical therapy program thereafter. Therapeutic alliance was assessed with the help of Working Alliance Inventory (SF Hatcher Client form) questionnaire. The questions were split into three domains: "goal items", "task items" and "bond items". The questionnaire was filled in on the 7th postoperative day (POD). Pulmonary function test was done before the surgery and on the 7th POD. The results of assessment confirmed a rather high level of therapeutic alliance between cardiac surgery patients and their physical therapists. Lung volumes and flow rates were worse after surgery. According to the analysis of correlation relationships between "task items" indicators and FVC, FIVC, FIV1 reduction rates, patients with less reduction of these volumeshad better "task items" results. According to the analysis of correlation relationships between a number of pulmonary function test indicators on the 7th POD and "goal items", "task items", totalquestionnaire score,patients with higher postoperative pulmonary function values had better therapeutic alliance. The obtained correlation relationships were significant, but weak or very weak. The results confirmed the relationships between postoperative pulmonary function values, their dynamic and therapeutic alliance.

Keywords: *working alliance, communication, rehabilitation, therapeutic exercises*

Introduction

The patient-therapist relationship has been traditionally regarded as an important determinant of treatment outcomes and considered essential in therapeutic process (Hall, Ferreira, Maher, Latimer, & Ferreira, 2010; Greenberg & Webster, 1982; Bordin, 1979).

Taking into account that physical therapy (PT) is a "person-person" type of work, the study of the relationship between the parties of interaction, their impact on the performance, as well as the comparison of the scores given by both parties of interaction is an important part of studying aphysical therapy process.One of the features of the patient-therapist interactionis therapeutic alliance. Studying therapeutic alliance between the therapist and the patient started with the

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spheres of psychotherapy (Horvath & Symonds, 1991; Martin, Garske, & Davis, 2000) and medical care (Stewart, 1995).

The amount of evidence proving the effect of therapeutic alliance on the possibility of achieving better results andhigher level of satisfaction with physical therapy has been growing (Taccolini Manzoni, Bastos de Oliveira, Nunes Cabral, & Aquaroni Ricci, 2018; Lawford, Bennell, Campbell, Kasza, & Hinman, 2019). There is also evidence that the level of therapeutic alliance influences primary outcomes of function, pain, disability, and global perceived effect in the physical therapy of patients with chronic low back pain (Ferreira et al., 2013). However, according to the results of a systematic review, current studies do not confirm strong relationships between therapeutic alliance and pain relief in patients with chronic low back pain (Taccolini Manzoni et al., 2018). According to another systematic review, therapeutic alliance has a positive effect on physical therapy outcomes; however, additional research is needed to determine the strength of this relationship (Hall et al., 2010).

Most of the researchon therapeutic alliance addresses its impact on physical therapy outcomes in patients with musculoskeletal disorders. Physical therapy of cardiac and cardiac surgery patients remains an important healthcare sphere owing to the prevalence of cardiac pathology, its complications and comorbidity (Vitomskiy et al., 2018; Junior et al., 2019; Vitomskyi, 2020). We have not found any research on the specificities of therapeutic alliance formation in cardiac surgery patients undergoing inpatient physical therapy. It has only been reported that sound therapeutic relationships between patients and staff may play an important role in facilitating the achievement of a wide-range of salutary outcomes during cardiac rehabilitation (Burns & Evon, 2007). Therefore, therapeutic alliance and its impact on physical therapy outcomes in cardiac surgery patients are unexplored.

Purpose: to assess the relationship between the indicators of therapeutic alliance and pulmonary function recovery in patients undergoing physical therapy after cardiac surgery.

Methods

Participants

The study involved 80 patients of both genders, who were admitted to CS. Age Me (25%; 75%) indicators comprised 64 (55.25; 70) years. All procedures were performed by median sternotomy on cardiopulmonary bypass with cardioplegic arrest. The exclusion criteria were: patients with unstable angina pectoris at the moment of selection or during the program, congestive decompensated heart failure, lack of intellectual capacity, complex ventricular and uncontrolled arrhythmia, uncontrolled high blood pressure, cerebrovascular accident. The study protocol was approved by the institutional review board and the local medical ethics committee of GI «Scientific and Practical Medical Center for Pediatric Cardiology and Cardiac Surgery of the Ministry of Health of Ukraine». All patients gave written informed consents.

Interventions

The patients received standardized PT (early mobilization; therapeutic exercises; respiratory PT). Before surgery, the patients were briefly consulted by a physical therapist on the aims and content of PT and activation algorithm after surgery. The postoperative protocol of PT called for the following practice of patient's early mobilization: sitting on the bed with the legs dangling on the 1 POD; standing (getting up with the help and under the control of a physical therapist, holding on a medical movable walker; agreed with an anesthesiologist) and on-the-spot walking if feasible on the 1-2 POD; on-the-spot walking, walking within the ward on the 2 POD; walking in the hospital corridor on the 3 POD; walking up and down the stairs on the 4-5 POD. All patients performed therapeutic exercises with a physical therapist and therapeutic walking under the control of a physical therapist. Sessions (about 20 minutes each) with a physical therapist were conducted 2 times a day on the 1 and 2 PODs, 1-2 times on the 3 POD, 1 time starting from the 4 POD. In case of a necessity (patient's condition, the need for motivation), the physical therapist could increase the number and the length of the sessions.

Outcome Measures

Demographic variables, clinical history were recorded on entry to the trial. All patients were submitted to the pulmonary function test (PFT) before surgery and on the 7 postoperative day (POD). The patients performed at least 3 PFT attempts using Spirodoc MIR spirograph and Winspiro PRO software. Individual rates were calculated automatically according to Knudson/ERS algorithms.

Therapeutic alliance was assessed with the help of Working Alliance Inventory (WAI) questionnaire, SF Hatcher Client form in particular (for a patient), which consisted of 12 questions (Hatcher & Gillaspy, 2006). The scoreswere calculated on a 5-point scale: 5 – always; 4 – very often; 3 – fairly often; 2 – sometimes, 1 – seldom. Besides, the questions were split into three groups/domains: "goal items", "task items" and "bond items". Each of these domains was scored from 4 (minimum) to 20 points (maximum); the total questionnaire score ranged from 12 (minimum) to 60 (maximum) points. The questionnaire was filled in on the 7 POD.

Statistical analysis

The materials of the research were processed in Statistical Package for the Social Sciences 21 program of statistical analysis. Mathematical processing of numerical data was fulfilled with the help of variation statistics. The analysis of quantitative indicators distribution's correspondence to the law of normal distribution was checked by Shapiro-Wilk test. Mean value and standard deviation (M±SD) were calculated for the results of indicators that corresponded to the law of normal distribution. Median value (Me) and upper and lower quartiles (25%; 75%) were calculated for the indicators with a non-normal distribution (results of WAI); besides M±SD was indicated for better analysis. Student's t-test (for dependent groups) was used to measure the significance of the difference, provided there was a normal distribution of study results (PFT results). Spearman's rank correlation coefficient was also usedto study the relationships between the indicators.

Results

The study involved 51 males and 29 females. The average body weight and height indicators comprised 82.54±14.58 kg and 168.29±9.11 cm, respectively, at the time of hospitalization. Body mass index was 28.72 (26.20; 31.95) kg/m2. Left ventricular ejection fraction was 54 (48.3; 59.5)%. The duration of operation and anesthesia was 370 (300; 438.8) min. and 435 (360; 508.8) min., respectively. Artificial lung ventilation lasted 7 (6; 10.75) hours. 5% of the examined patients had stage 1

hypertension, 38.8% and 36.3 had stage 2 and stage 3 hypertension, respectively. NYHA functional classes were the following: I – 15%; II – 30%; III – 55%. 44 patients (55%) had coronary artery bypass grafting; 30 (37.5%) – mitral valve intervention; 33 (41.3%) – aortic valve intervention; 17 (21.3%) – tricuspid valve intervention; 1 patient (1.3%) – aortic intervention.

The specificities of pulmonary function indicators dynamic are presented in Table 1.

Table 1. Indicators of the pulmonary function test (Mean±SD)

Indicators	Before surgery	On the 7th postoperative day	p	t
VC, % predicted	101.80±15.96	73.86±16.47	0.000	16.144
FVC, % predicted	98.91±16.72	71.70±17.62	0.000	14.901
FEV_1, % predicted	99.39±18.49	72.44±19.28	0.000	12.982
FEV_1/ VC, % predicted	99.08±10.70	100.96±10.32	0.048	-2.019
FEV_1/ FVC, % predicted	103.46±10.81	106.04±11.98	0.027	-2.258
PEF, % predicted	96.40±18.34	77.98±19.88	0.000	8.217
FEF_{25-75}, % predicted	93.63±34.72	71.67±31.92	0.000	7.055
FIVC, % predicted	93.66±18.20	67.47±17.99	0.000	13.478
FIV_1, % predicted	112.03±23.13	81.84±23.54	0.000	13.653
PIF, % predicted	67.25±21.42	55.01±17.66	0.000	6.026

Note. VC – vital capacity; FVC forced vital capacity; FEV_1 forced expiratory volume in one second; FEV1/ VC Tiffeneau index; FEV_1/FVC Tiffeneau-Pinelli index; PEF peak expiratory flow; FEF_{25-75} forced expiratory flow at 25–75% of forced vital capacity; FIVC forced inspiratory vital capacity; FIV_1 forced inspiratory volume in one second; PIF peak inspiratory flow.

Consider the results from the analysis of therapeutic alliance indicators based on the questionnaires filled in by cardiac surgery patients. Me (25%; 75%) indicators in the first questionnaire item (patient's understanding of how he/she might be able to change as a result of the sessions) were 4(3; 5) points, indicators comprised 4.61±5.68 points. Me (25%; 75%) indicators in the second item (the frequency of receiving new ways of looking at the patient's problems as a result of the sessions) were 4(3; 5) points, M±SD indicators comprised 3.71±1.05 points. Me (25%; 75%) indicators in the third item (the patient believes that the physical therapist likes him/her) were 3(2; 4) points, M±SD indicators comprised 3.03±1.23 points. The fourth questionnaire item, which evaluates collaboration between the physical therapist and the patient in setting goals for the therapy, had 4(3; 5) points with M±SD indicators being 3.86±1.14 points. Me (25%; 75%) indicators in the fifth item (mutual respect between the patient and the physical therapist) were 5(4; 5) points, M±SD indicators comprised 4.59±0.76 points. The sixth questionnaire item (joint work of the physical therapist and the patient towards mutually agreed upon goals) was scored by the patients at the level of 5(4; 5) points, with M±SD indicators being 4.41±0.87 points. The seventh questionnaire item (patient's feeling that the physical therapist appreciates him/her) had slightly lower scores: Me (25%; 75%) indicators comprised 4(3; 5) points, with M±SD indicators being 4.06±1.08 points. The eighth questionnaire item (agreement of the physical therapist and the patient on what is important for the latter to work on) had Me (25%; 75%) indicators at the level of 5(4; 5) points; mean value was 4.49±0.81 points. The ninth item (the patient feels the physical therapist cares about him/her even when the patient does things that the physical therapist does not approve of) had Me (25%; 75%) indicators at the level of 4(3; 5) points, with M±SD indicators being 4.13±1.04 points. Me (25%; 75%) indicators in the tenth item (patient's feeling that physical therapy sessions will help to accomplish the changes that he/she wants) comprised 4(4; 5) points, and in the eleventh item (the level of establishing a good understanding of the changes that would be good for the patient) – 4(3.25; 5) points. Mean values in these items comprised 4.15±0.93 and 4.14±0.95 points, respectively. The twelfth questionnaire item (the frequency of patient'sfeeling that the way of working with his/her problem is correct) had indicators at the level of 5(4; 5) points, with M±SD indicators being 4.48±0.76 points.

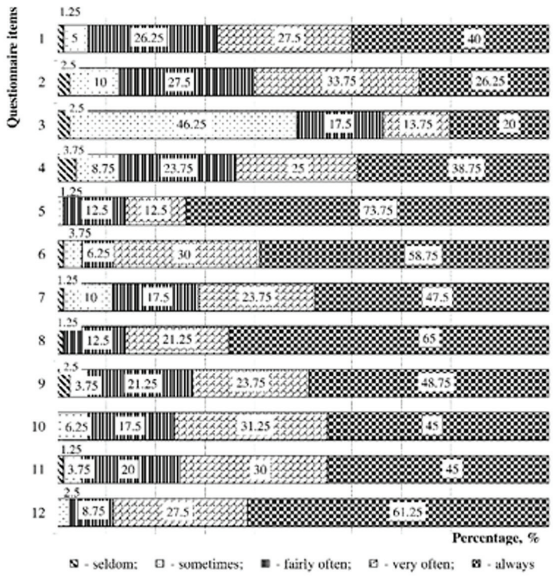
The presented analysis (Figure 1) confirms that most patients chose high score answers, i.e. "very often" and "often". The majority of patients chose the answer "sometimes" only in the third item. Me (25%; 75%) indicators among cardiac surgery patients comprised 17 (15; 20) points for "goal items", 16 (15; 19) points for "task items", and 16 (13; 18) points for "bond items". M±SD indicators of these three domains comprised 16.90±2.85, 16.95±6.14 and 15.80±3.06 points, respectively.

It should be noted that the scores were calculated on a 5-point scale, which started with 1 point, not 0. This should be taken into account when analyzing and interpreting the results, particularly when comparing the obtained scoreswith the maximum possible scores. With this in mind, we calculated the percentage of the theoretical maximum for three domains: "goal items" – 80.63%; "task items" – 80.94%; "bond items" – 73.75%.

The total questionnaire score was 50.5 (44; 55) points; M±SD indicators were 49.64±9.14 points, which comprised 77.7% of the maximum, taking into account the specificities of the assessment.

Correlation analysis of domain scores, total score of therapeutic alliance and indicators of decreased pulmonary function (Δ) revealed only three reliable relationships: between "task items" and ΔFVC (ρ=-0.265; p=0.017), ΔFIVC (ρ=-0.242; p=0.031), ΔFIV1 (ρ=-0.263; p=0.018). These relationships confirmed that better therapeutic alliance in "task items" domain corresponded to a less decrease of these three indicators of pulmonary function.

None of therapeutic alliance indicators correlated with the initial results of pulmonary function assessment. At the same time, the analysis revealed a number of correlation relation-



Note. Questionnaire items 1 – «As a result of these sessions I am clearer as to how I might be able to change»; 2 – «What I am doing in therapy gives me new ways of looking at my problem»; 3 – «I believe PT likes me»; 4 – «PT and I collaborate on setting goals for my therapy»; 5 – «PT and I respect each other»; 6 – «PT and I are working towards mutually agreed upon goals»; 7 – «I feel that PT appreciates me»; 8 – «PT and I agree on what is important for me to work on»; 9 – «I feel PT cares about me even when I do things that he/she does not approve of»; 10 – «I feel that the things I do in therapy will help me to accomplish the changes that I want»; 11 «PT and I have established a good understanding of the kind of changes that would be good for me»; 12 – «I believe the way we are working with my problem is correct»; PT – physical therapist.

FIGURE 1. Distribution of patients' responses regarding therapeutic alliance formation in the questionnaire items

ships between PFT indicators on the 7 POD and some indicators of therapeutic alliance. For example, "goal items" domain had a relationship with FIVC (ρ=0.236; p=0.035); "task items" domain – with VC (ρ=0.331; p=0.001), FVC (ρ=0.357; p=0.001), FEV1 (ρ=0.290; p=0.009), FIVC (ρ=0.374; p=0.001), FIV1 (ρ=0.360; p=0.001); total questionnaire score – with VC (ρ=0.239; p=0.032), FVC (ρ=0.261; p=0.019), FEV1 (ρ=0.228; p=0.042), FIVC (ρ=0.294; p=0.008), FIV1 ρ=0.242; p=0.031). These relationships confirmed that better therapeutic alliance corresponded to better postoperative pulmonary function values.

Discussion

The results of assessment confirmed a rather high level of therapeutic alliance between cardiac surgery patients and their physical therapists, despite significant specificities in the modalities of the physical therapy program and the length of interaction period. In particular, the modalities (intensive care unit and recovery room, recent complex medical intervention) and the period of program implementation are emotionally and physically difficult for the patient. On the other hand, the patient needs help to restore mobility and independence in self-care at this time, as well to increase functioning level, which provides a solid basis for therapeutic alliance formation.

On the other hand, subjective assessment of the difficulties of postoperative recovery process and physical therapy procedures may vary. Therefore, some patients may find physical therapy procedure or the tasks to be performed (sitting down, standing up, walking) somewhat difficult.

The third questionnaire item had the lowest score, since the answer "sometimes" here was chosen by 46.25% of respondents, whereas "fairly often", "very often" and "always" options were chosen by lessrespondents than in other questionnaire items. The fifth questionnaire item, on the contrary, had the most answers with maximal 5 points. Interestingly, that the third and fifth items refer to the "bond items" domain.

The assessment of correlation relationships between the indicators of therapeutic alliance and pulmonary function revealed three very weak relationships: between "task items" score and FVC, FIVC and FIV1 dynamics. At the same time, the obtained correlation relationships between PFT indicators on the7POD and some indicators of therapeutic alliance confirmed better therapeutic alliance in patients with better postoperative pulmonary function values.

When commenting on the obtained results physical therapists noted that some patients recovered longer after surgery: they had much more complaints of malaise, weakness, pain, lack of stamina, breathing difficulties within the whole period of hospital stay, and not only during the first postoperative days, when most patients recover almost completely (mobility, self-care) after surgery and anesthesia. Besides, physical therapists noted that it wasmore difficult to work with, connect to and conduct a quality physical therapy program with such patients because of their complaints and subjective conditions. On the other hand, there are very diligent patients with good preoperative PFT values. However, the reduction of their PFT results can reach 40-50%, which can reduce the strength of correlation between therapeutic alliance and pulmonary function dynamic.

This may form the basis for the established relationships and their strength.

As to the influence of patient's attitude to the disease on therapeutic alliance formation, there are evidence, which confirm lower indicators of therapeutic alliance in patients with an irrational attitude to the disease (Fedorenko, Vitomskyi, Lazarieva, & Vitomska, 2019).

Another reason for a very low strength of the revealed correlation relationships may be the fact that pulmonary function recovery does not depend on interventions of the physical therapist, and therefore theoretically it does not depend on-patient's diligence and compliance. There is evidence proving that additional respiratory muscle training does not improve PFT values (Dull & Dull, 1983; Jenkins, Soutar, Loukota, Johnson, & Moxham, 1989, 1990; Overendet al., 2001). At the same time, the evidence to support the advantages of one breathing technique over another is currently absent (Lomi & Westerdahl 2013). In this case, the revealed correlation relationships will confirm the fact that patients with better pulmonary function recovery have better therapeutic alliance formation.

Previous studies have shown that therapists' distancing behavior was strongly correlated with short- and long-term decreases in their clients' physical and cognitive functioning. Distancing was expressed through a pattern of not smiling and looking away from the client. In contrast, facial expressiveness, as revealed through smiling, frowning, and nodding, was associated with short- and long-term improvements in functioning (Ambady, Koo, Rosenthal, &Winograd, 2002).It was also indicated that therapists who spent more time with their patients had a better relationship with them (Sluijs, Zee, & Kok, 1993). However, there is evidence that a special training course for physical therapists, which enhanced biopsychosocial attitudes and beliefs, as well as increased such knowledge and skills did not change the way patients perceived their physical therapists (Overmeer, Boersma, Main, & Linton, 2009).

The results of assessment confirmed a rather high level of therapeutic alliance between cardiac surgery patients and their physical therapists. All PFT values on the 7 POD differed from the preoperative ones. Volume indicators were particularly subject to reduction. According to the analysis of correlation relationships between "task items" indicators and FVC, FIVC, FIV1 reduction rates, patients with less reduction of these volumes had better "task items" results. According to the analysis of correlation relationships between a number of PFT values on the 7 POD and "goal items", "task items", total questionnaire score, patients with higher postoperative pulmonary function values had better therapeutic alliance.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Formation of the Knowledge and Skills to Apply Non-Parametric Methods of Data Analysis in Future Specialists of Physical Education and Sports

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Abstract

Application of information technologies in the process of research in the field of physical education and sport, sports medicine allows to effectively use mathematical and statistical methods in scientific research and teaching. We have highlighted the main stages of practical training aimed at the formation of practical skills in the use of non-parametric methods for estimating and analyzing statistical hypotheses in sports-pedagogical and biomedical research among the students in the field of physical education and sports. It was noted that the role of qualitative statistical processing of research results is growing. It is important to form the skills the use of the methods of mathematical statistics of future specialists in various fields. The article presents a systematic process for the formation practical skills and abilities to use non-parametric procedures for statistical analysis of sports pedagogical data on the example of the Mann-Whitney U-test. There are the following stages of the training: announcement of the theme, goals, tasks; actualization of core knowledge; formation of theoretical skills. Article contains stages the presentation of the algorithm for the comparative analysis of independent sample data that does not follow the normal distribution law. It is shown calculation of a working example of the Mann-Whitney U-test using MS Excel in group using a interactive whiteboard with a detailed explanation of the steps; individual solving of the practical tasks; knowledge check.

Keywords: *formation, research, statistics, analysis, criterion, law, distribution*

Introduction

The scientific basis for obtaining reliable experimental results is the mathematical-statistical processing of empirical data, and the application of information technologies in the process of research in the field of medicine and sports opens up significant prospects for the application of mathematical-statistical methods to a wide range of researchers (Byshevets, Synihovets, & Oliynyk, 2011; Byshevets, 2017).

Analyzing the results of sport-pedagogical and biomedical experiments, the researcher often faces the task of testing statistical hypotheses (Shynkaruk, 2012; Stroganov et al., 2020; Tukaiev et al., 2020; Tretiak et al., 2020). The Student t-test is especially popular among scientists. However, as it is well known, the use of parametric criteria needs the fulfillment of a number of conditions. Researchers should pay attention to the condition of normal distribution of each of the compared samples.

Unfortunately, as Leonov (2007) points out, the Student's t-test is often used without justification, which negates the perfect experimental work and gives rise to doubts about the correctness of the declared conclusions.

The ordinal variables data does not follow the normal distribution law while analyzing sports-pedagogical and biomedi-

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cal data, especially when it comes to small sample sizes. In such cases, scientists use non-parametric methods for estimating and analyzing statistical hypotheses. They are computational procedures that do not use the distribution parameters, but use the results of ranking or calculating the values of the test feature (Lupan, 2010; Lang, 2016). At the same time, while retaining most of the information on the distribution, the use of non-parametric statistical methods eliminates the need to know what the distribution is, and there is no need for equality of variances (Glantz, 1998).

The Mann-Whitney U-test is used in order to identify the difference between the levels of the studied features of two independent samples. It helps to reveal the differences between the samples by estimating the width of the total area for both samples (Mann, 1948).

Purpose is to identify the stages of practical training aimed at developing practical skills in the use of non-parametric methods for estimating and analyzing statistical hypotheses in sports-pedagogical and biomedical research among students in the field of physical education and sports.

Methods

Used methods include the analysis of scientific and methodical literature, Internet data and mathematical statistics methods, including data processing.

Results

In the course of the study, we distinguished the stages of formation readiness to use non-parametric criteria in sports-pedagogical and biomedical research on the example of using the Mann Whitney U-test for students of physical education and sports training.

We give an example of practical training aimed at the formation of theory and practical abilities realize a comparative analysis of independent sample data that are not followed the normal distribution law, using MS Excel.

After informing the topic and goals, we define the tasks must be solved during the practical training.

1. To establish the purpose and accuracy of the Mann-Whitney U-test.

2. To learn to compare sample data using the Mann-Whitney U-test.

At the first stage, there is an actualization of students' basic knowledge. During this stage, they are surveyed, where the question is chosen in such a way as to reveal the final knowledge on the themes "Normal law of distribution and its application", "Testing statistical hypotheses", "Statistical criteria". This stage is intended to prepare students for a new theme in such a way that the formation of new theoretical knowledge takes place based on previously learned and deepened them.

At the second stage, we provide students with basic information and concepts. The purpose of this stage is the formation of theoretical knowledge of students about the features of the U-criterion and the conditions for its use.

The Mann-Whitney U-test is a non-parametric alternative to the Student's t-test for independent samples, which is commonly used to process the data obtained in the field of physical education and sports. The advantage of this criterion is that its use does not require assumptions about the normal distribution and the same variances.

The method is based on determining whether a sufficiently small area of values between two variational series that intersect. The smaller the value of the criterion, the more likely it is that the differences between the parameter values in the samples are significant.

At this stage, we stress the features of the U-criterion and the conditions for its use.

The Mann-Whitney U-test is a non-parametric test, therefore, unlike Student's t-test; it does not require a normal distribution of compared populations.

It is necessary that the data be measured at least in an ordinal scale.

The U-criterion is suitable for comparing small samples: in each of the samples, there must be at least 3 trait features.

It is allowed that one of the samples had only two features, but another one must have at least five features.

The condition for applying the Mann-Whitney U-test is the absence of matching features in the compared groups (all numbers are different) or the minimum number of such matches.

Also at this stage, we form a hypothesis in the following way: null hypothesis H0 {Character level in sample 2 is not lower than the characteristic level in sample 1}, and alternative to it is H1 {Character level in sample 2 is lower than the characteristic level in sample 1}

At the third stage, we inform the algorithm for the implementation of the comparative analysis of independent sample data that are not followed the normal distribution law, using MS Excel with a detailed explanation and group discussion of each step.

1. We make the initial data in the MS Excel table and make it in a convenient form.

2. We make a logical assumption about the presence of cause-and-effect relations between the studied features X and Y and make hypotheses: H_0 {the distribution of the sign of choice 1 corresponds to the distribution of the sign of choice 2}; H_1 {the distribution of the sign of choice 1 does not correspond to the distribution of the sign of choice 2}.

3. Perform data ranking, treat as one array.

4. We calculate the U-criterion according to the formula:

$$U = n_1 \cdot n_2 + \frac{n_x \cdot (n_x + 1)}{2} - T_x,$$

where n1, n2 – number of elements in samples, nx – the number of elements of a larger rank sums; – larger of two rank sums.

5. As criterion statistics, we use the value of U, the critical region of which is determined using the special Mann-Whitney distribution. That is, the critical value of the U-criterion is found using the statistical table, where the significance level α is taken 0.05, and for ni - the sample sizes i=1, 2.

6. We compare the calculated and critical value of U. We conclude: if U is critical exceeds U empirical, then the statistically significant differences between the studied groups based on feature, that is being studied, are not confirmed (Lupan, 2014).

Important! The number at the intersection of the sample size and the smallest sample is the critical value of the Mann-Whitney U-test.

The next fourth stage, aimed at developing students' practical skills and abilities to apply non-parametric the Mann-Whitney U-test for processing the results of sports-pedagogical and biomedical research, involves the instructions of an example solving a task. At this stage, there is a working example of solving the task and interpreting the obtained results. During this stage, the clarification of individual concepts and a group discussion of the result.

The stage of formation of practical skills is very important, so it is necessary to ask students to consider a practically oriented task, and also it is reasonable to present a step-by-step realization of the method of analysis. Students should also be encouraged to participate in a collective discussion on the relevance of using nonparametric methods of data analysis in physical culture and sports. Also in the demonstration process the steps of problem solving are clarified, the difficulties encountered by the students are identified.

So, we offer the students a professionally oriented task for consideration.

Example. There are indicators of task performance of the two study groups. Prove that the task performance of second-year students exceeds the task performance of first-year students.

The demonstration of the steps for solving the task is carried out using an interactive whiteboards.

Step 1. Run MS Excel, form a table and enter the output data into it.

Step 2. We form hypotheses: H_0 {task performance of first-year students is notlower than task performance of second-year students}; H_1 {task performance of first-year students is lower than task performance of second-year students}.

Give the significance level $\alpha = 0.05$ ($p<0.05$).

Step 3. We compile a common ranked series using the standard function RANK.AVG, where a smaller value is assigned a lower rank. In addition, in case of coincidence of values, the arithmetic mean of consecutive values of ranks is assigned to each of them.

Create cells n1 and n2, in which using the standard function COUNT we calculate the number of elements in each sample.

Create cells Rx sum and Ry sum, in which, using the standard SUM function, we calculate the sum of the ranks of each sample.

Calculate T_x. To do this, using the function IF, compare the values of ΣR_x and ΣR_y and choose larger of them.

Calculate nx. To do this, using the function IF, compare the values of ΣR_x and ΣR_y and choose number of elements larger of a rank sums. In the process of this step, we focus on the fact that when introducing formulas it is convenient to rely on the following considerations (Figure 1).

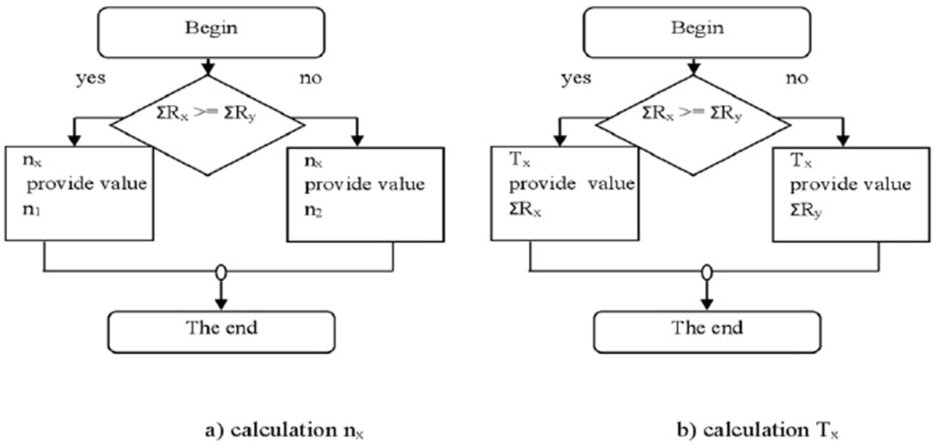

FIGURE 1. Algorithm for calculating the number of elements of a larger sample of n_x and the larger of the two rank sums T_x.

Step 4. Calculate the U-test by the specified formula.

Step 5. According to the table of critical values, we calculate U critical with sample sizes n1=20 i n2=16 at the significance level α=0.05. We got.

Step 6. We make the following conclusions: comparing the critical and empirical value of U, we are convinced that $U_{emp}>U_{kr}$. Consequently, it is no statistically significant differences between the task performance of the students of the first

C	D	E	F	G	H
Age		R_x	R_y		
I	II				
838	701	27	11		
643	645	5	6		
583	702	2	12		
709	803	14	24		
538	800	1	22,5		
714	710	16	15		
778	680	20	7	p	0,05
903	820	33	25		
741	681	18	8	n_1	20
1020	700	34,5	10	n_2	16
1040	730	36	17		
1020	620	34,5	3	ΣR_x	419
799	800	21	22,5	ΣR_y	247
685	901	9	32		
626	703	4	13	n_x	20
830	742	26	19	T_x	419
848		28			
854		30		U	111
882		31		$U_{cr}(0,05;20;16)$	98
852		29		result	H0

=RANK.AVG(D3;$C$3:$D$22;1)
=COUNT(C3:C22)
=SUM(E3:E22)
=IF(H11>H12;H11;H12)
=IF(H14>H15;H14;H15)
=H11*H12+H17*(H17+1)/2-H18
=IF(H20>H21;"H0";"H1")

FIGURE 1. The implementation of the calculation of the criterion of Mann-Whitney in MS Excel

year students and second year students (p=0.164> 0.05). The results of the task are shown in the figure (Figure 2).

During the implementation of the fifth stage of practical training, students are offered individual tasks, including test questions and practice-oriented tasks. Students aim this stage at identifying the level of mastery of practical work.

The purpose of the last stage is the operational control of the students' achievement. At this stage, an assessment of the results of passing tests on test questions is carried out; the result of solving the task is checked.

Discussion

Currently, the increasing role of statistical data processing requires the formation of students' skills and abilities to apply the methods of mathematical statistics. Now, to improve the system of training future specialists in physical education and sport, issues related to the formation of theoretical knowledge and practical skills to apply certain methods of data analysis are covered. In particular, an algorithm for analyzing personal data in sports pedagogical research was proposed (Denysova et al., 2012; Byshevets et al., 2019; Denysova et al., 2020), ways to automate the calculation of analysis results were proposed (Synihovets, 2011) and a methodology of preparing students of higher educational institutions for physical education to use the method of expert assessments was presented (Byshevets, 2018; Byshevets et al., 2019).

However, according to scientists (Leonov, 2007), the statistical processing of experimental data remains the weakest point of research in the field of medicine, biology, ecology, due to insufficient equipment of statistical knowledge and insignificant experience enrolled in these areas. Own experience suggests that students of the field of physical education and sports, unfortunately, face significant difficulties in studying the disciplines related to the statistical training of future specialists. Indeed, in many cases, the level of mathematical training of students often does not provide opportunities to master educational material, designed for a solid knowledge base (Byshevets, 2017; Kyslenko et al., 2020). Therefore, there is an urgent need to show the most accessible methods and techniques for automating the process of solving professionally oriented tasks using computer systems and programs for data analysis. It should be noted that the use of application programs and data analysis packages makes available statistical processing of empirical data of any complexity. Moreover, it is known that a positive experience encourages students to further research and practical developments in this direction.

At the same time, we agree with Toropova (2017), teachers should pay more attention not only to the formation of statistical knowledge and skills at students of non-core higher educational institutions, but also to focus on training students to use this knowledge to statistically process the research results doing course project, diploma project. This approach allows students in practice to realize the role and place of statistical data processing of experimental studies and to acquire the skills obtained through systematic recapitulation.

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At the same time, scientists note the need to apply distance-learning technologies when studying a course aimed at developing skills for statistical data processing of students who are at individual form of teaching (Krivtsova, 2016; Denysova et al., 2018; Imas et al., 2018). From our point of view, such an approach is appropriate for students of higher educational institutions in the field of physical education, since a significant part of the students are active athletes who are not able to attend classes regularly. Hence, the development of a distance course aimed at developing practical skills and abilities to carry out statistical data processing is a priority for improving the system of training future specialists in physical education and sports.

Conclusions

The role of statistical analysis of research results in various fields of knowledge is increasing, which has led to great interest at scientists to improve the statistical training of future specialists.

Statistical data processing causes difficulties both for students of non-core higher educational institutions and for researchers in physical culture and sports, medicine, biology, and ecology. This situation leads to errors that occur during the analysis of empirical data.

The most promising direction to optimize the educational process, aimed at the formation of theoretical knowledge, skills and abilities of statistical processing of empirical data is the use of modern information technologies at all stages of training. This opens up the possibility for students to carry out a qualitative analysis of research results without taking into account prior mathematical grounding. At the same time, the positive experience of solving professionally oriented tasks contributes to increasing the motivation of future specialists in physical education and sports to use learned methods in research practice.

A lot of active athletes are students in the field of physical culture and sport, as a result, they have to study at the individual form of teaching. Therefore, it is important to apply distance-learning technologies, including in the formation of student's statistical knowledge and skills.

The Mann-Whitney U-test is a non-parametric analogue of Student's t-test. However, unlike the latter, its use does not require that the compared samples follow the normal distribution law and there is no need for equality of the variances.

As a result of the study, a systematic process has been developed for students to form practical skills in using non-parametric procedures for statistical analysis of sports pedagogical data using the Mann-Whitney U-test. There are the following stages: announcement of the theme, goals, tasks; actualization of core knowledge; formation of theoretical skills; the presentation of the algorithm for the comparative analysis of independent sample data that does not follow the normal distribution law; implementation of the calculation of the Mann-Whitney U-test using MS Excel; independent solving of practical tasks; knowledge check.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Influence of PNF Therapy on the Active Range of Motion in Proximal Humerus Gunshot Injury Patients

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Abstract

The use of Proprioceptive Neuromuscular Facilitation (PNF), namely relaxation techniques, rhythmic initiation, a combination of isotonics, stabilizing and dynamic reversing, rhythmic stabilization and motor patterns, allows to improve motor function and to achieve active participations of patients with musculoskeletal injuries in the process. Therefore, the purpose of the study was to evaluate the effect of proprioceptive neuro-muscle facilitation techniques on index goniometry in individuals with gunshot lesions of the proximal humerus. The study involved 56 middle-aged men, who were randomized to two levels by group size. Investigation group (n=28) received proprioceptive neuromuscular facilitation, control group (n=28) received standard kinesiotherapy program and massage. Goniometry was performed on all participants for physical therapy on 28, 56 and 84 days of the treatment. Limits of movement amplitude were fixed in all three planes, which respond to the nature of the arthrogenic contracture. The total dynamics of increase in the amplitude of active movements in the shoulder complex in participants under the influence of proprioceptive neuromuscular facilitation, noted higher (p=0.038; t=6.94) than in control group which underwent kinesiotherapy and massage. Therefore, positive changes were observed under the influence of PNF in the active amplitude of movement in men with gunshot lesions of the proximal humerus; this in turn allowed to break the circle of pain and improve the functionality of the upper extremity.

Keywords: *proprioceptive neuromuscular facilitation, goniometry, proximal humerus, gunshot injury*

Introduction

Thousands of military personnel were injured during Joint Forces Operation in Ukraine. To date, despite attempts to peacefully resolve the situation in eastern Ukraine, the conflict has not been resolved, shelling continues, and military personnel are injured, which in turn requires rehabilitation practices to restore the health of those with gunshot wounds.

Noting the high degree of complexity of gunshot lesions, one of the consequences is a critical decrease in the amplitude of movements in the shoulder complex (SC), which necessitates the development of a system of measures to normalize the amplitude indices in patients who have received gunshot injury in extreme conditions. Reduced motor activity directly decrease the activity of daily living and the ability to perform the professional duties of militaries.

The use of proprioceptive neuromuscular facilitation (PNF) techniques can restore effective motor functions by reducing pain, increasing the patient's ability to reduce muscle and increasing patient strength, increasing the amplitude of active and passive movements, improving control of motor

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function, increasing endurance patient and fatigue prevention, improving patient's ability to move and maintain stability (Shimura & Kasai, 2002; Adler, Beckers, & Buck, 2014).

PNF-therapy is a dynamic concept that is was used to improve the motor function of its use in the practice of physical therapy (PT) of people with the effects of gunshot lesions (GL) will break the circle of pain, improve the amplitude of movement and achieve active participation of patients in therapy (Lee, 2015; Schmidt, Lee, Winstein, Wulf, & Zelaznik, 2018).

PNF-therapy is aimed at eliminating pathological clinical manifestations, improving functionality and includes the following techniques aimed at improving the amplitude of joint movements:

1. Soft mobilization of the shoulder joint (relaxation techniques, rhythmic initiation). Relaxation techniques include contract relax and hold relax. Restraint technique involves isometric contraction of the muscles being resisted, followed by relaxation. When applying the contraction-relaxation technique, the isotonic contraction of the resisting muscles is performed, followed by the relaxation and movement in the extended amplitude. Rhythmic initiation involves rhythmic motion over a certain amplitude, from passive movement to active resistance with added resistance (Voight, Hoogenboom, & Cook, 2008; Page et al., 2016).

2. Technique isotonic combination is characterized by concentric, eccentric and stabilizing contractions of one muscle group (agonists) without relaxation.

3. Stabilizing reverse and dynamic reverse. The stabilizing reverse technique incorporates alternating isotonic contractions with resistance to movement and enhances muscle strength, improves stability and balance. The dynamic reverse technique is used to increase the active amplitude of movement, strength and endurance of the muscles, to improve coordination by performing active movements with changing directions without interruption or relaxation.

4. Rhythmic stabilization is characterized by alternating isometric contraction with a resistance to movement, with no movement (Adler, Beckers, & Buck, 2014).

5. Motor patterns for improving the amplitude of motion in the SC: flexion - abduction - external rotation; flexion - abduction - external rotation with flexion in the elbow joint; flexion - adduction - external rotation (Yuktasir & Kaya, 2009; Ha, Han, & Sung, 2018).

Thus, the purpose of the study was to evaluate the effect of PNF techniques on goniometry in individuals with inflammatory lesions of the proximal humerus (PH).

Methods

The study involved 56 middle-aged men with GL of the PH. The exclusion criteria adopted were: chronic non-infectious illness, polytrauma (such as humerus injuries and head trauma), severe mental disorders, unconsolidated fractures, ossifying myositis. Inclusion criterion men with a diagnosis of "gunshot fracture (GF) of the PH". According to the classification of GF patients who participated in the study had the following characteristics of obtaining a GF: by type of fracture - blind; by type of wounding projectile - bullets; by the nature of the lesion - incomplete, perforated; by localization - humerus; at the level of fractures of long tubular bones - proximal; by degree of damage - open fracture, wound more than 1 cm in length without extensive soft tissue damage, which does not require secondary surgical treatment, with minor bone damage; with concomitant injuries - without damage to large blood vessels and nerves (Burianov, Komarov, Lykhodii, Kvasha, & Zadnichenko, 2015).

All subjects who participated in the study signed an informed consent form. The research was approved by the Institutional Ethics Committee (protocol number 2/2017) and was carried out in compliance with the international principles of the Helsinki Declaration of the World Medical Association (World medical association Declaration of Helsinki, 2013), and in accordance with the Law of Ukraine "Fundamentals of Ukrainian Legislation on Healthcare" (Law of Ukraine, 1992) on ethical norms and rules for conducting medical research involving human. Prior to the clinical trial the protocol was submitted before for consideration, comments, recommendations and the results were successfully approved the ethics committees for health.

Patients were divided into two groups using the simple randomization method, which provided random distribution of patients to the investigation group (IG) and control group (CG). The general characteristics of both groups revealed their representativeness and homogeneity, which made it possible to objectively compare the results of restoration of indicators of active range of motion in these groups. The baseline of the studied parameters in patients of the two groups were not significantly different ($p=0.044$; $t=8.01$).

The IG (n=28) of patients after PNF-therapy PH lesions; CG (n=28) of patients who underwent restorative complex according to the method of a medical care, which included kinesiotherapy (KT) and massage. The study of the results, their comparison with the baseline data and the evaluation were conducted four times: before the course of therapy, on the 28th, 56th, and 84th day of the therapy.

Movement amplitude was assessed using the goniometer. The following movements were assessed: flexion, extension, abduction, adduction, external and internal rotation in the SC.

To obtain the objective results of goniometry, the following rules were followed: the patient should remove his clothing, before starting the goniometry, the initial position should be taken, precise anatomical guidelines were was used to install the goniometry, and several passive joint movements should be performed before the evaluation, take measurements only in the morning, do not take measurements after considerable physical activity.

The evaluation process took place in the following sequence: the axis of the goniometry corresponded to the axis of the shoulder joint, the moving arm of the goniometry was located parallel to the moving distal segment of the body (humerus), the fixed shoulder did not change its position during evaluation. Quantitative of the volume of amplitude of movements in the SC is based on the gradation from 0 to 180° (O'Sullivan, Schmitz, & Fulk, 2014).

All statistical analyses were conducted using Statistic 6.0 (StatSoft, USA) and data were expressed in mean ± standard deviation (M±SD). The significance of the differences, in normally distributed data was assessed by the Student's t-test for independent groups.

Results

Analysis and evaluation of the effectiveness of PNF-therapy techniques for individuals with GL of the PH, was performed with regard to the changes in the volume of active movements in the SC (Table 1).

Table 1. Dynamics of changes in the amplitude of active movements in the shoulder complex during physical therapy (M±SD)

Movements in the SC	n=56	IG (n=28)			CG (n=28)			p/t 56-day; p/t 84-day
	Before treatment	28-day	56-day	84-day	28-day	56-day	84-day	
Flexion 0-180^0	100±4.2	117±2.7	147±24*	168±1.9*	117±2.5	136±2.4	146±1.9	0.02/5.5; 0.023/4.8
Extension 0-60^0	35±3.4	40±1.4	49±1.3	57±1.0*	43±1.4	48±1.4	52±1.3	0.082; 0.043/8.2
Abduction 0-180^0	97±2.8	113±2.8	139±2.4*	160±1.9*	110±2.4	125±2.4	143±2.3	0.037/7.0; 0.041/7.3
External rotation 0-90^0	42±1.7	53±1.1	68±0.8*	80±0.6*	48±0.6	57±0.6	71±0.5	0.026/8.6; 0.04/7.7
Internal rotation 0-90^0	53±2.1	66±0.6	75±0.6*	84±0.5*	67±0.1	72±0.1	81±0.1	0.041/6.2; 0.038/7.0

Note. *Significant difference between investigation group (IG) and control group (CG) at 56, 84 days which is reflected in p/t values

Dynamics of increase in the amplitude of active movements in the SC in patients of the main group under the influence of PNF-therapy techniques, noted higher than in participants of the CG who received KT and massage.

An increase in the indicators of active flexion (AF) in the SC at all stages of the assessment of the amplitude of movements. However, significantly better values were observed in patients of IG on day 56 - 147±2.4° (p=0.02; t=5.5), and in the final examination - 168±1.9° (p=0.023; t=4.8) in contrast to patients in CG, the average values of which on day 56 they reached only 136±2.4°, and on day 84 - 146±1.9°. Thus, the average rates of AF in the SC in the IG increased by 68 degrees, and in CG patients by only 46 degrees. Significant differences in extension parameters in the SC were recorded only during the final examination in patients of IG 57±1.0° (p=0.043; t=8.2), and in patients of CG 52±1.3°. Thus, the average rates of active extension in patients of IG increased by 22 degrees, and in patients of CG by 17 degrees. The indicators of abduction in the IG at day 56 were 139±2.4° (p=0.037; t=7.0), at day 84 - 160±1.9° (p=0.041; t=7.3) and show significant differences from the indicators of patients in the CG at day 56 - 125±2.4° and day 84 - 143±2.3° days of PT. The results of the final assessment of abduction in the SC in patients of the IG showed an increase of 63 degrees, and in patients of the CG by 46 degrees. The indicators of external rotation (ER) significantly improved in the IG on day 56 - 68±0.8° (p=0.026; t=8.6) and day 84 - 80±0.6° (p=0.04; t=7.7), and in patients of the CG on day 56 - 57±0.6° and day 84 - 71±0.5°, which reflects the increase in the active amplitude of ER in the SC in patients of the IG by 38 degrees, and in patients of the CG by 29 degrees. Appropriate significant improvements were recorded in patients of the IG when assessing the internal rotation (IR) on day 56 of the course of PT 75±0.6° (p=0.041; t=6.2) and day 84 - 84±0.5° (p=0.038; t=7.0), in contrast to patients in the CG whose values on day 56 reached only 72±0.1°, and day 84 - 81±0.1°. Thus, the average rates of AF in the SC in the IG increased by 31 degrees, and in CG patients by only 28 degrees.

Thus, in percentage the rate of AF before the course of PT was 55.5% of normal, and after the course in patients IG group 93.3%, and in patients CG 81.1% of normal flexion in the SC. Before the course of PT, the rate of active extension was determined to be 58.3%, and after the course in patients of IG 95.0%, and in patients of CG 86.6% of normal. The rate of abduction before the course was 53.8%, and after the course IG 88.8%, in patients CG 79.4% according to the norm. Evaluation of ER before the course showed 46.6%, IR - 58.8%, and after the course of PT in patients IG the rate of ER reached 88.8% and IR - 93.3%, and in patients CG ER was 78.8%, and IR - 90% of normal.

The determined percentages of active movements in the SC show limitations in all three planes in the range of 46-58% of the norm, and this, in turn, emphasizes the arthrogenic reason for the restriction of active movements.

Discussion

This study aimed to test the effect of PNF-therapy on index goniometry in individuals with GL of the proximal shoulder. The main conclusion was that the use of PNF-therapy in the process of PT of persons who received GL of the PH under extreme conditions allows to more effectively restore the amplitude of movements in the SC compared to standard KT and massage.

The study was conducted on days 28, 56 and 84 is justified by the available data, which confirm that visible improvements in functional indicators of the musculoskeletal system occur within four weeks (Shumway-Cook & Woollacott, 2016).

A significant decrease in the active amplitude (AA) of movement in the SC at the beginning of the study showed no significant difference in index goniometry at day 28 of PT between IG and CG. But there was some positive dynamics. Significant improvements in the AA of the movement in the IG were observed during the 56 and 84 days with some positive dynamics in participants CG. Therefore, it can be argued that both approaches can give a positive result in increasing the AA of motion in the SC, but four weeks of time will not be enough. This conclusion can be explained by the severity of the GL in comparison with the traumatic injury of this segment of the upper extremity. It is necessary to take into account the complexity of lesions of structures in the case of GL, the severity of the consequences, the duration of the restorative process, in contradistinction to traumatic injuries of the humerus.

Noting the high degree of complexity of GF of the proximal shoulder, it is necessary to pay special attention to the prevention and elimination of complications. Dysfunction is manifested in the form of contractures, decreased muscle strength, functional and morphological changes in the periarticular ligaments and articular cartilage, impaired blood microcirculation of the damaged limb (Burianov et al., 2015).

To build the process of PT and determine adequate tools and techniques, it is important to adequately differentiate the localization of contracture. According to the localization of the contracture, there are the main types of contractures: myogenic - occurs due to damage to muscle tissue; arthrogenic - joint damage; dermatogenic - due to scarring of the skin; desmogenic - scarring of ligaments, fascia, aponeurosis; tendogenous - due to tendon fusion, neurogenic - disorders of the nervous system (Konermann & Gruber, 1998).

Impaired range of motion in the joints leads to limitations in the functioning of people with GL include the following activities: body care, putting on and taking off clothes, doing housework, caring for household items, paid work, sports and hobbies. This, in turn, adds to the biopsychosocial context of the PT process and purposefully corresponds to the International Classification of Functioning, Disability and Health (ICFDH) model. The ICFDH seeks to achieve greater coherence between different aspects of health and disease: biological, personal and social (McDougall, Wright, & Rosenbaum, 2010).

The ICFDH covers all aspects of human health and some components of health-related well-being, describing them in terms of health domains and health-related domains.

Limitations of life are characterized as the consequences or results of complex relationships between changes in the health of the individual, personal factors and external factors that represent the conditions in which the individual lives. As a result of these relationships, different environmental factors can cause different effects on one individual with a certain change in health.

If the main task of PT is to eliminate the consequences of illness or injury, the ultimate goal of PT is the maximum destruction of the patient's limitations, maintaining or restoring his ability to work, improving the quality of life.

And according to the biomechanical model of the practice of increasing function - the active amplitude of movements, a person automatically uses them to restore other functional skills and abilities. General functional limitations in patients with GL of the PH: difficulties with daily activity (inability to reach something above the head, inconvenience when dressing, difficulties in carrying out hygienic procedures); difficulties with professional activities (inability to keep the weight of the weapon, difficulties with motor control and with the implementation of purposeful movements, inability to adhere to the military regime of the day due to low endurance, inability to perform throwing movements).

However, one component of PNF-therapy for motor learning and neuro-muscular reorganization is internal feedback. The neurophysiological mechanism of internal feedback implies that proprioceptive disorders impair the ability to adjust, improve, and learn new movement. In such circumstances, the patient often compensates for his or her impairments by shifting attention to other sensory resources, which does not allow them to adhere to the basic principles of therapy (Singh, Nagaraj, Palikhe, & Neupane, 2017).

The authors confirm the positive impact of relaxation techniques, rhythmic initiation, a combination of isotonics, stabilizing and dynamic reverse, rhythmic stabilization and movement patterns on the amplitude of motion and motor control of traumatic patients (Adler et al., 2014; Page et al., 2016)

According to the authors, proprioceptive neuromuscular facilitation enhances motor function. As the primary purpose of rehabilitation is to help patients be as efficiently as possible, motor learning principles have been integrated into the PNF concept as a basic philosophical one. This can be achieved in functional tasks with different approaches (Shimura & Kasai, 2002; Ha et al., 2018).

The authors note that the concept provides stability training, improved movement coordination, improved functional activity, improved joint mobility, and increased movement volume (Olędzka & Jaczewska-Bogacka, 2017).

It is important to note that cognitive activity involves a mental process in which the patient is attuned to the activity, understands the goals of therapy and is able to make decisions and answer questions. It is necessary to draw the patient's attention to the problem and move together to solve it. Changes in motor behavior can be as simple as focusing on how a patient performs tasks and verbally controlling or showing how and what to do. Therefore, in our opinion, the use of PNF-therapy techniques for persons with severe mental disorders and cognitive deficits will not maximize the patient's potential (Hawk et al., 2017; D. Park, & S. Park, 2019).

Active participation is required for neuro-muscular rehabilitation. During the active movement, the whole system of motor control works, since in passive movement there is no efferentation and muscular activity (Schmidt et al., 2017).

Learning and restoring movement stereotypes in practice should be relevant to the context of the task. The practice of dissimilar patterns may reduce the outcome of the achievement of the respond goal (Balcı, Yuruk, Zeybek, Gulsen, & Tekindal, 2016).

It is also important to consider a positive approach that assumes no pain during exercise. This is an important component of PNF-therapy, given that most people with constant pain have a fear of performing exercises because their previous experience is associated with pain. People with constant pain have the dilemma - activity may increase short-term pain, but lack of activity will lead to long-term pain (Hors, 2008).

Therefore, suggest that the use of PNF-therapy may have a positive effect on the recovery of movement amplitude in individuals with GL of other joints.

The analysis revealed significant differences between the participants group undergoing PNF-therapy and the CG participants who underwent standard KT and massage (p=0.038; t=6.94). Significant differences were noted at the third and final examination, but positive dynamics were observed throughout the course of PT. Therefore, it can be argued that the use of PNF-therapy in the process of restoring movement amplitude in the shoulder joint produces better results compared to standard KT and massage.

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ORIGINAL SCIENTIFIC PAPER

The Modifications of the Anterior Cruciate Ligament Rupture Physical Therapy Caused by the Anterolateral Ligament Injury

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Abstract

The anterolateral ligament (ALL) is a rotational stabilizer of the knee joint widely investigated the last 13 years as the possible cause of some anterior cruciate ligament (ACL) reconstructions failure. ALL injuries accompany 64% of ACL ruptures. Nevertheless, there are still no publications concerning changes in the ACL rehabilitation process due to the ALL concomitant rupture. We evaluated rotational stability in 12 athletes with the ACL rupture and concomitant ALL injury or Segond fracture treated conservatively before the treatment and 3 months later. The physical therapy comprised the range of motions and strengthening exercises during the immobilization period and thereafter. As only the knee joint was immobilized the physical therapy was conducted to the adjacent joints and muscles at the very beginning. A total of 83.33% of patients became pivot-shift negative in three months. In 16.67% pivot-shift test was questionable. Lachman test remained positive in 91.67%. The ACL is a more important structure than the ALL. So, our treatment strategy focuses mainly on it. Most changes in physical therapy are the immobilization and postponed axial loading with internal rotation. But even these minor changes may influence greatly the overall stability of the knee, particularly rotational stability. It seems to be the single case series assessing the rotational stability recovery after the ALL rupture conservative treatment we found in the scientific literature. Immobilization and non-weightbearing for up to 6 weeks may decrease the rotational instability in conservatively treated ALL injuries concomitant to the ACL ruptures. Further investigations of the physical therapy and rehabilitation of the anterolateral ligament injuries and Segond fractures are necessary.

Keywords: *anterolateral ligament, anterior cruciate ligament, rehabilitation*

Introduction

The anterolateral ligament (ALL) is the rotational stabilizer of the knee joint. It was first described by Segond in 1879 (Claes et al., 2013) and almost forgotten for a century. The ALL gained its popularity back again in 2007 due to the work of Vieira, da Silva, Berlfein, Abdalla and Cohen (2007). Perceptions of its function have changed over time and continue to do so today. ALL is an extremely important structure as its injuries accompany 64% of anterior cruciate ligament (ACL) ruptures (Lee et al., 2018). Nevertheless, there are still no publications concerning changes in the ACL rehabilitation process due to the ALL concomitant rupture.

Now, most of the anterolateral ligament ruptures are viewed through the lens of the ACL concomitant injuries.

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So, their rehabilitation and physical therapy should conform to the ACL injuries rehabilitation principles. And that is why we`ll focus firstly on the ACL concomitant anterolateral ligament ruptures and Segond fractures.

The aim of the study was to assess the necessity and the results of the changes in the rehabilitation process of the anterior cruciate ligament ruptures induced by the concomitant anterolateral ligament injuries or Segond fractures.

Methods

We evaluated rotational stability in 12 athletes with the ACL rupture and concomitant ALL injury (10 patients) and Segond fracture (2 patients) treated conservatively in a non-randomized prospective interventional study. The patients with the ALL injury and Segond fracture were analyzed together in a single group as the same entity because Segond fracture is considered to be the osseous avulsion of the ALL with the similar causes, symptoms and pathomechanics.

Inclusion criteria were: acute injury (up to one week), conclusive and complete rupture of the ACL and the ALL (or Segond fracture) on MRI, conclusive positive Lachman and pivot-shift test, absence of other injuries of the knee (except the tibial collateral ligament ruptures, non-displaced lesions of the medial meniscus, chondral lesions).

Exclusion criteria were: knee locking, contractures, other major injuries to the knee, time from trauma more than one week, inconclusive disputable MRI or clinical signs of the ACL or ALL complete rupture, negative or disputable Lachman or pivot-shift test, the necessity of early surgical treatment of the ACL rupture.

Patients received conservative treatment of 6 weeks of non-weight bearing with crutches and immobilization with a brace in full knee extension for 4 weeks. These braces were changed to the hinged braces with the flexion limit to 30° from the end of the fourth week up to the end of the sixth week. Then the physical therapy program with muscle strengthening and range of motions began (Figure 1). Hinged braces were utilized in further rehabilitation process only in 4 patients with concomitant tibial collateral ligament injuries.

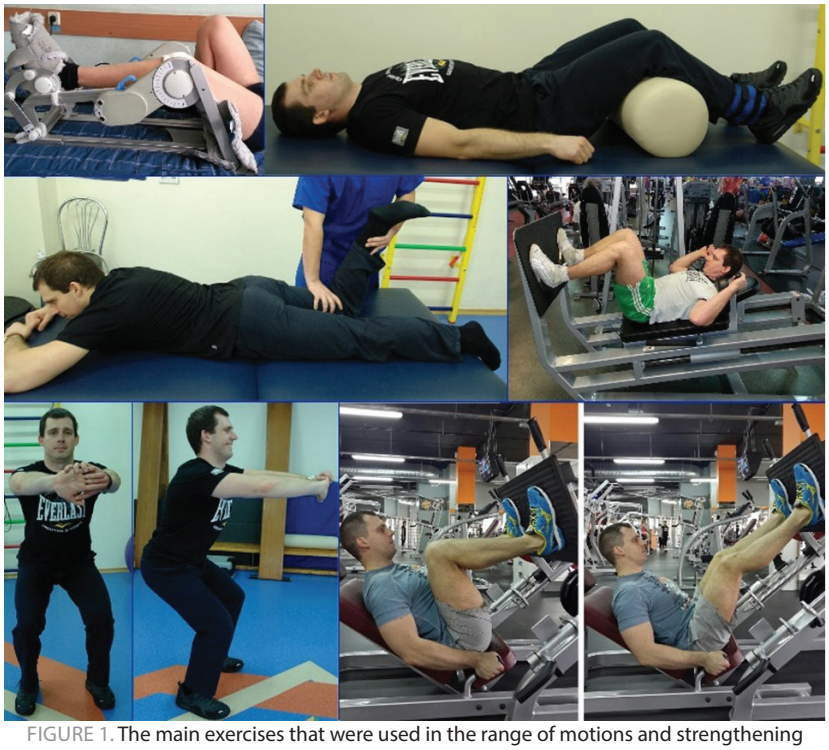

FIGURE 1. The main exercises that were used in the range of motions and strengthening program after the immobilization period and before the surgery

The physical therapy comprised the range of motions and strengthening exercises during the immobilization period and thereafter. As only the knee joint was immobilized the physical therapy was conducted to the adjacent joints and muscles at the very beginning. Range of motion program excluded internal rotation of the lower leg up to the end of the 8th week. Internal rotation with axial loading was excluded for up to 3 months. The muscle-strengthening program began after 8 weeks. There were no other restrictions in physical therapy. But the range of motions and strengthening were gradual.

Full passive extension of the knee including hyperextension as tolerated within the normal range of up to 10° began from the first day of treatment. The brace was unlocked for allowing passive hyperextension 2 times per day for 15-minute sessions of the knee locking exercises with a rolled towel or pillow under the heel and intermittent contracting the quadriceps muscle for 5 seconds to push the knee down and 5-10 seconds rest. After 6 weeks the knee locking exercises were discontinued.

Passive patella mobilization was initiated from the first day. At least three one-minute sets per day were recommended.

After four weeks of immobilization the knee flexion began with help of the knee bolster (2 hours per day) and continuous passive motion machine (CPM) (1 hour per day) with the flexion limit to 30° from the end of the fourth week up to the end of the sixth week. After 6 weeks from the beginning of the treatment full flexion was started with four 30 minute sessions of CPM per day. In a week passive flexion with rehabilitation therapist was added for two 20 minute sessions per day immediately after the CPM in cases when weekly ROM increment

was less than 20° per week.

Active ROM exercises were introduced after 4 weeks in the form of knee active flexion and extension as tolerated but not less than 20 minutes per day in a prone and upright position with the abovementioned ROM limitations of 30° flexion up to 6 weeks of treatment. After 6 weeks ROM limitations were discontinued.

Muscle-strengthening exercises included isometric quadriceps contractions (5 seconds contraction with 5 seconds rest) from the first days. Patients performed at least three such 10-minute sessions per day. The maximal duration of the contraction time, quantity, and duration of these sessions were not limited. Closed kinetic chain strengthening exercises started after 6 weeks of treatment. They included leg presses and squats. We began with the leg press with the weight that allowed 20 repetitions per set for the first two weeks (2 sets per day). Then patients proceeded to the weight that allowed 15 repetitions per set and squats were added. After 8 weeks from the beginning of the treatment we decreased the frequency of leg presses and squats to 3 times a week but increased the intensity. One session consisted of two sets of squats (assisted firstly) followed by the three sets of the leg press with the weight that allowed 15 repetitions per set. The squat depth was as tolerated initially and increased gradually. Rest intervals between the sets were at least 2 minutes.

We evaluated rotational stability and anterior tibia translation with pivot-shift test, Lachman test, active and passive rotation angles measurements in 30°, 45°, 60°, 90° of flexion before the treatment and at the end of conservative treatment at three months.

All these patients were directed to the ACL reconstruction in three months after the near full range of motions was obtained.

This study research protocol was approved by institution's ethics committee (approval number №5, 12 December 2019). Each participant voluntarily provided written informed consent before participating. Since it is a small sample case study, only descriptive statistics were administered and analyzed.

Results

It is difficult to assess the quality of healing of the anterolateral ligament and adequacy of its functional recovery. One possible test is pivot-shift. But despite of its high specificity its sensitivity is rather low. We report only 12 patients that fulfilled our criteria because most patients with the ALL rupture have only inconclusive MRI signs or the signs of incomplete rupture. Many patients with definite ALL rupture MRI signs had other significant injuries leading to rotational instability or had a questionable pivot-shift test results. We did not include them in the investigation.

Ten of these 12 patients (83.33%) became pivot-shift negative in three months. In two patients (16.67%) pivot-shift test was questionable. Lachman test remained positive in eleven of these patients (91.67%). The one patient (8,33%) with a negative Lachman test nevertheless felt his knee given way. We didn`t notice the significant difference in the passive rotation angles in the injured and healthy contralateral knees in 30°, 45°, 60°, and 90° of flexion neither before nor after the conservative treatment. The maximal difference in the passive rotation in the injured and healthy contralateral knees was at 60° of flexion and amounted to 3.00°±1.82° before the treatment and 2.80°±2.24° after 3 months of treatment. The difference in the passive rotation at 30°, 45°, and 90° of flexion was even less. It totaled 2.63°±1.96° before the treatment and 2.60°±2.06° after 3 months of treatment at 30° of the knee flexion, 2.70°±1.66° and 2.70°±1.50° at 45°, 2.82°±1.02° and 2.00°±1.84° after 3 months of treatment at 90°. So, the pivot-shift test was the one and only possible way to access rotational instability. 83.33% of patients became pivot-shift negative in three months. So this may indicate the rotational stability improvement.

All the patients gained the full knee extension and flexion 121°±7° by the end of the 3rd month (after 6 weeks of immobilization and 6 weeks of rehabilitation). Muscle strength was estimated manually according to the Medical Research Council scale and equaled 5 grades in all the patients at the end of treatment. They were all ready for the ACL surgical reconstruction. Ten of them were already surgically treated. Two of them postponed surgery due to different non-medical reasons.

Of course, this is a small case series. But it seems to be the single case series assessing the rotational stability recovery after the anterolateral ligament rupture conservative treatment we found in the scientific literature.

Discussion

The ALL function is somewhat different from the ACL. The ALL is considered to be the lower leg internal rotation restraint. Its importance increases with the increase of the degree of the knee flexion being the most prominent with the knee flexion from 30° to 90° (Parsons, Gee, Spiekerman, & Cavanagh, 2015; Tavlo, Eljaja, Jensen, Siersma, & Krogsgaard, 2016). Sporadic publications endue the ALL with the function of anterior tibia translation restraint (Tavlo et al., 2016) similar to ACL. But most do not. According to the rotation, the ACL is the external and internal tibia rotation stabilizer at the same time (Dargel et al., 2007). But while flexing the knee beyond 35° its internal rotation restraining capabilities are inferior to the ALL (Parsons et al., 2015). So, we consider ACL to be mostly anterior translation and external rotation stabilizer in flexion.

This means that we should protect the injured ALL from knee flexion and internal rotation whether it reconstructed or not.

The anterolateral ligament is located close to the joint capsule. Several authors believe it to be the capsular thickening (Cho & Kwak, 2019; Helito et al., 2013; Kennedy et al., 2015). Our previous investigations and the publications of other researchers (Dodds, Halewood, Gupte, Williams, & Amis, 2014, Parker & Smith, 2018; Runer et al., 2015;) show that at least the outer layer of this ligament is completely extracapsular. Nevertheless, we observe intimate adherence of its inner layer to the joint capsule. The anterolateral ligament is not intraarticular as ACL. So, we may somewhat rely on its healing potential. Furthermore, its structure and location resemble more the tibial collateral ligament than the fibular one. It even more adds to our insight concerning the anterolateral ligament healing potential. Another reason for the possibility of its spontaneous healing in appropriate conditions is the fact that most of its ruptures are not transverse. According to the surgical revisions, 57% of all the ALL injuries are ruptures of its fibers and lateral capsule on different levels (Sonnery-Cottet et al., 2017). All these factors give us the opportunity to reach the anterolateral ligament ruptures healing with conservative treatment. But we are still not sure about the anterolateral ligament or Segond fracture healing potential with the preservation of

their function. The functional outcome may be different for these two entities. Also, we may assume that the ALL may heal with sufficient final rigidity only in cases of early treatment. The later we begin its treatment the more indications for its surgical reconstruction.

We know very little about the isolated anterolateral ligament injuries, though isolated Segond fractures occur (Ollat, 2009; Peltola, Mustonen, Lindahl, & Koskinen, 2011; Ringenberg, Sealy, & Tiller, 2015). But this ligament is the comparably newly described structure. So, we may expect more reports about its isolated injuries in the nearest future. And we should be ready to propose appropriate treatment and rehabilitation strategy. As we consider Segond fracture to be the avulsion fracture as the result of the anterolateral ligament overstretching the rehabilitation strategy may be similar for both of them.

It is generally accepted that the optimal time interval for the ACL reconstruction surgery is the day of injury or period of time usually later than 3-4 weeks after the injury after the inflammation and edema subside (Meuffels et al., 2012). So, if we see the patient without the joint locking in this suboptimal for the ACL surgery time window, we propose to begin with conservative treatment of all the concomitant injuries, even if this wouldn`t influence the ACL itself. The isolated ACL rupture requires immobilization and crutches for only a short period of time, usually in the acute period. The patient should withdraw from them as soon as movements and weightbearing are tolerated. Many patients do not require them at all from the very beginning. But in case of concomitant Segond fracture or anterolateral ligament rupture, we propose immobilization and non-weightbearing with crutches for 4-6 weeks. In cases, if incomplete ruptures of the anterolateral ligament the immobilization may be as short as 3-4 weeks with a subsequent range of motion exercises in the hinged brace. But non-weightbearing should continue up to 6 weeks. Even in cases of early range of motions exercises, we recommend excluding internal rotation in the knee joint for at least up to 6 weeks. But internal rotation with axial loading (while standing or squatting) should be excluded longer. We do not know exactly how long because of the absence of appropriate studies. Taking into account the thinness of the ligament we consider a little bit more time without internal rotation of the lower leg while axial loading as the scar tissue at the site of the ligament healing needs to mature to withstand loading forces. We should understand that laboratory testing of the ALL and the ACL tension in different degrees of the knee flexion and rotation should not be completely extrapolated to the real loading conditions, where axial loading, tibial slope angle et al. influence the anterior tibia translation and resulting tension forces in the ligaments. It was investigated that ALL is the main rotational stabilizer in deep squats while the ACL is the principal rotational stabilizer in not deep ones (Kang, 2019). So, we also may expect that squatting with slight external rotation of the feet may be less dangerous for the healing ALL or Segond fracture as well as squatting not deeper than 30° of knee flexion that may be utilized in the early rehabilitation period.

In the case of concomitant tibial collateral ligament rupture which is common in ACL injuries and well susceptible to healing with conservative treatment (Shea & Carey, 2015) immobilization seems to be even more advisable. We believe that it is wise to give the possibility for as many structures of the knee to heal by themselves as possible. Surgical treatment with early range of motion is another possible option. But surgical treatment usually includes reconstruction with the sacrifice of several tendons that are also of some importance. So, in most cases when achieving an early range of motion is not critically important immobilization for up to 4-6 weeks in full extension is an acceptable treatment strategy.

In cases of necessity of surgical ACL reconstruction before the complete healing of the anterolateral ligament rupture or Segond fracture their simultaneous reconstruction is also recommended in selected patients (Bonanzinga et al., 2017; Hardy, Casabianca, Hardy, Grimaud, & Meyer, 2017; Inderhaug, Stephen, Williams, & Amis, 2017; Nitri et al., 2016). Usually, the indications are ACL revision surgery, high-grade pivot shift test, young sportsmen, pivoting activities, and patients undergoing meniscus repair (Sonnery-Cottet, Vieira, & Ouanezar, 2019). But after such simultaneous reconstruction several authors also advise less aggressive rehabilitation with prolonged intermittent brace immobilization with a gradual range of motion exercises for 4 weeks postoperatively but immediate weight-bearing with brace and crutches as tolerated. The muscle-strengthening program they recommend to begin from 8 weeks postoperatively (Ferretti, 2017). Though the outcome depends on the reconstruction method and its strength as well as on the surgeon's philosophy as no comparative studies were ever conducted.

Further, the third group of patients – are those with their ACL reconstructed surgically on the 1st day from injury. Resulting from the study, we, as researchers recommend immobilizing the knee in case of concomitant anterolateral ligament rupture or Segond fracture. If their ALL or Segond fracture simultaneous repair was conducted the decision about the necessity of immobilization is made by the surgeon depending on the method and strength of reconstruction.

It is accepted today that not all the patients need the anterolateral corner rigid stabilization procedures. But even less rigid healing of the anterolateral ligament may improve knee stability and the results of ACL surgery.

If an early range of motions in the group of patients without already conducted ACL reconstruction is necessary, we consider flexion with simultaneous external rotation. This potentially may decrease tensioning of the healing anterolateral ligament but most of all doesn`t prevent it completely. But after the ACL reconstruction flexion with external rotation puts the ACL transplant into tension condition and should better be avoided.

Yes, most changes in physical therapy we can propose are the immobilization and postponed axial loading with internal rotation. In general, the physical therapy and rehabilitation principles in anterolateral ligament injuries are similar to those in ACL injuries. ACL is a more important structure. So, our treatment strategy focuses mainly on it. But even these minor changes may influence greatly the overall stability of the knee, particularly rotational stability, in some patients.

Conclusions

Immobilization and non-weightbearing for up to 6 weeks may decrease the rotational instability in conservatively treated anterolateral ligament injuries concomitant to the anterior cruciate ligament ruptures. Further investigations of the physical therapy and rehabilitation of the anterolateral ligament injuries and Segond fractures are necessary.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Match and Game Performance Variables in Elite and Junior Men Singles Tennis Players

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Abstract

Junior players although easier approachable in terms of running tests and measurements, are less studied and examined particularly in such popular field of sports science as Performance Analysis. Most of the studies are focusing on elite athletes, whereas juniors are left without attention. This does not help them to successfully progress from junior to senior division. The aim of this study was to investigate the difference of the game structure between Elite Level (EL) and Junior Level (JL) single tennis players. A total of 14 matches were analyzed including semi-finals and finals of International tennis tournaments. The game structure variables selected for this study included match duration (MD), game (set) duration (SD), rallies per game (set) (RPS), shots per rally (SPR), rally length (RL), rest time between rallies (RT), ball in play in seconds (BLs) and ball in play in percentage (BP%). Independent Sample T-test and Mann-Whitney test depending on the normality of data distribution were used for the comparison of game variables between Elite Level and Junior Level. Number of rallies, rest time between rallies, ball in play in percentage, and match duration were tested using Independent Sample T-test. Mann-Whitney test was used for comparing set duration, ball in play in seconds, rally length and shots per rally. There were statistically significant differences among the two categories in number of rallies, ball in play in percentage, ball in play in seconds and rally length (all at $p<0.05$).

Keywords: *tennis, performance analysis, elite players, junior players*

Introduction

Although tennis is not dominant in Asian countries like it is in Europe, there are several athletes who have achieved elite level of performance. For example, Kei Nishikori from Japan is one of the best Asian male tennis players who have reached the final in a Grand Slam – U.S Open 2014 (Puri, 2014). Although Nishikori was not showing any outstanding results while at junior level, after 18 and above he has won 12 singles titles.

Among the areas of tennis dedicated research, particularly in junior division, traditionally more attention is paid to the development of motor qualities (Smajic, Barasic, Javorac, Cokorilo, & Tomic, 2014, Smajic et al., 2015), some attention is paid to tactical and psychological issues (Milenkovic, 2007), some to technical issues (Tajul, Fatemah, & Radzani, 2016), with still less attention paid to performance analysis and match and game structure variables (Donoghue & Ingram, 2001; Filipcic, Caks, & Filipic, 2011). Researchers typically tend to analyze tennis players' performance through analyzing the traditional set of markers provided by of the major ATP professional performance analysts (Kovalchik & Reid, 2017).

The use of video analysis and video-based technology has become one of the favorite methods to analyze performance by sport biomechanics and performance analysis. By recording a video, an important event during performance can be quantified and analyzed in a consistent and reliable manner (Hughes & Barlett, 2002). A video is also recognized as an appropriate medium for obtaining qualitative information about performance such as enhanced feedback using replays,

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real time three-dimensional simulations or superposition of vector graphic. It also can be further used for individual notational analysis and game statistics in remote locations (Liebermann et al., 2002).

As stated by Hughes and Behan (2007), national ranked or elite players used far more complex tactics in their matches compared to other standard athletes or juniors due their superior fitness and technical ability. Technical evaluation is inter-dependent as it depends on technical strength and weakness of players to make a tactical decision. In addition, analysis of technical deficiencies and strengths in players is important for coaches to improve performance (Hughes & Behan 2007).

Once the player enters the elite level, skills and quality of the player increase due to physiological factors, experience and practices that had been mastered as compared to junior players. Thus, video that will be analyzed may help coaches and junior players to reach or master the skill by seeing the playing pattern with technical and tactical strategy. There were very limited studies attempted in tennis with ones particularly related to comparison of international level players in elite and junior divisions. Therefore, in this study an analysis towards game structure may provide some information for further use by coaches and players in order to increase performance especially in Asian countries. As stated by Loh and Krasilshchikov (2015), very limited studies were attempted in racket sports particularly comparing world elite and junior elite players.

A study by Loh and Krasilshchikov (2015) in table tennis stated that lower-level players take longer duration of the game. This may be due to elite players being more experienced and more skillful thus the time taken to finish one set or game is less compared to junior player. By doing a mistake while serving in tennis match will make duration of the game longer. Usually, professional group or elite players made less mistakes compared to junior. This is pointed out by Hazuan et al. (2011) who showed professional group served significantly less faults than under-16 players and under-12 players.

In comparing elite and junior level of tennis players, Hazuan, Reid and Whipp (2011) compared six different indicators in performance analysis, independently of gender in professional players and high-performance players under 16 and under 12. The results showed, male professionals served more aces than the under 16 and under 12 and female professional players. The study also indicated professionals serving significantly fewer double faults, winning a significantly greater percentage of points on first serve and winning significantly more points on second serve return compared to players of U-16 and U-12 groups.

Coaches are spending most of the time teaching effective technique and tactics but there is no guideline which playing patterns are the most suitable. In addition, the coaches also face the challenges to determine which skill and movement pattern fits players within their skill and capacity level.

Thus, this study will attempt helping the coaches and trainers by providing quantitative data on match performance structure of tennis players of Elite level and junior level. The data that will be obtained may help juniors to improve and ease their transition into elite players.

Study objective was to determine and quantify game structure of men's singles tennis players in elite and junior categories and to determine the differences in the game structure between elite men's single tennis players and youth men's players.

Methods

Sampling

Recorded videos of international matches were collected throughout the years of 2016-2017 and the videos analyzed for both junior and elite players. Only matches from semi-finals and finals were selected for further analysis. Inclusion criteria for the video match were collected on male single tennis championships. Total number of the matches analyzed was14 (7 from junior and 7 from elite level) with total 41 games eventually into statistical analysis. Total number of sets analyzed were 16 and 25 respectively for Juniors and Elite category.

Procedures

Type of research design in this study was quantitative analysis focused on game structure of tennis players. The data collected through video recording was consequently analyzed in post-match mode by using Elite Sport Analysis-Focus-X2 PRO. This software allows the user to create code window performance indicators analyzed. In addition, this software enables video to view the record of variables or actions that user is interested through using Category Set. Category Set is created by the users themselves based on their variables of interest.

Then the data of the variables were extracted from matrix and transferred into spreadsheet in Microsoft Excel 2010. From Microsoft Excel, the game structure, match and game variables for each match were calculated.

Nine game structure variables were selected for this study including match duration (s), game duration (s), rallies per set (number), shots per rally (number), rally duration (s), rest time between rallies (s), ball in play (s), ball in play (%) and unforced errors (number). Since the research did not involve physical participation of athletes, ethical clearance was not required.

Statistical analysis

Data collected was analyzed using Statistical Package for the Social Science (SPSS) version 24.0. The result of variables for each match were exported from spreadsheet in Microsoft Excel to SPSS for analysis.

The mean and standard deviations were shown as descriptive statistics for variables of game structure for both groups: Elite group and Junior group. Normality of distribution was determined through Shapiro – Wilk Test. If the data was normally distributed independent t-test was used for game structure variables to compare between both groups. In adverse, variables not normally distributed were analyzed using Man-Whitney test.

Results

Game Structure in Elite Level Players

For Elite Level, the mean for match duration was 5027.14±2222.50 s or equivalent of 83.79±37.04 minutes (min) whereas mean for set duration was 1515.12±486.45s or equivalent to 25.25±8.11 min, 48.08±10.68 number of rallies per game, 6.10±4.51 shots per rally, ball in play of 339.34±142.47 s or equivalent to 5.66±2.37 min or 22.79 % (SD=6.36) of game duration per game, rally length of 6.76±7.28 and rest time between rallies of 1524.56±393.50 s or equivalent to 25.41±6.56 min. The results are presented in Table 1.

Table 1. Mean, Standard Deviation (SD), Median, Interquartile Range (IQR), Minimum (min) and Maximum (max) of game structure variables in Elite Level

Variable	Mean	SD	Median	IQR	Min	Max
MATCH [a]						
Match duration (s)	5027.14	2222.50	5772.0	3962	2347.00	7893
GAME [b]						
Set duration	1515.12	486.45	1402.00	722.5	805.00	2940
Number of rallies per game	48.08	10.68	47.00	13.50	31	75
Shots per rally [c]	6.10	4.51	5.0	5	1	37
Ball in play (s)	339.34	142.47	289	173.5	157	847
Ball in play (%)	22.79	6.36	22.00	12.20	12.20	31.17
Rally length (s) [d]	6.76	7.28	4.00	7	0.50	65
Rest time per rallies (s)	1524.56	393.50	1466	691.50	952	2332

Note; [a] Number of matches, n= 7; [b] Number of games, n= 25 [c] Number of rallies analyzed, n =1137; [d] Number of rallies analyzed, n=1139

Game Structure in Junior Level Players

For Junior Level, the mean for match duration was 3209.14±996.394 s or equivalent to 53.48±16.61 minutes (min) whereas mean for set duration was 1400.88±415.11s or equivalent to 23.35±6.92 min, 61±17.97 number of rallies per game, 6.14±4.37 shots per rally, ball in play of 466.18±188.70 s or equivalent to 7.8±min or 3.14 % (SD=6.36) of game duration per game, rally length of 7.58±7.66 and rest time between rallies of 1445.06±610.94 s or equivalent to 24.1±10.18 min. The results are presented in Table 2.

Table 2. Mean, Standard Deviation (SD), Median, Interquartile Range (IQR), Minimum (min) and Maximum (max) of game structure variables in Junior Level

Variable	Mean	SD	Median	IQR	Min	Max
MATCH [a]						
Match duration (s)	3209.14	996.394	2772.00	1095	2037	5021
GAME [b]						
Set duration	1400.88	415.11	1401.00	746.50	748	197448
Number of rallies per game	61.00	17.97	54.50	31.50	37	100
Shots per rally [c]	6.14	4.37	5.0	5.0	2	34
Ball in play (s)	466.18	188.70	455.50	274.25	251	936
Ball in play (%)	33.38	8.76	31.57	13.40	20.67	51.10
Rally length (s) [d]	7.58	7.66	5.0	8.0	1	63
Rest time per rallies (s)	1445.06	610.94	1482.5	869.75	184	2228

Note; [a] Number of matches, n= 7; [b] Number of games, n= 16 [c] Number of rallies analyzed, n =976; [d] Number of rallies analyzed, n=976

Comparison of Game Structure between Elite and Junior Level Players

Shapiro-Wilk test was used for sample size (n) less than 2000 which is when the p value ≥0.05 showed that null hypothesis of normally distributed data accepted. If P value <0.05, null hypothesis of normality data is rejected. Test for variable which is normally distributed will be tested with Independent t- test where the mean and standard deviation (SD) were compared. Whereas for variables not normally distributed data will be tested using Mann Whitney where the median and interquartile range (IQR) were compared. There was homogeneity of variance as assessed by Levene's Test for equality of variances.

Results presented in Table 3 show that mean and standard

Table 3. Comparison of the Variables in Elite and Junior level

Variables	Elite	Junior	Mean differences (95%CI)	*t(df)*	*p*
	M (SD)	M (SD)			
Match Duration (s)	5027.14 (2222.50)	3209.14 (996.40)	1818 (-187.78, 3823.78)	1.95 (12)	0.07
Game Variables					
Number of rallies per set (number)	48.0 (10.68)	61 (17.97)	12.92 (-21.95, -23.24)	-2.89 (39)	0.006*
Rest time between rally (s)	1524.56 (393.50)	1445.06 (610.94)	79.50 (-236.10, 395.98)	0.51 (39)	0.61
Ball in play (%)	22.79 (6.36)	33.38 (8.76)	10.60 (-15.37, -5.82)	-4.486 (39)	0.001*

Note: *p<0.05, **p<0.01, ***p<0.001

deviation are tested for variables in Elite Level and Junior Level categories, respectively. There were mean significant differences in number of rallies per set (p=0.006) and ball in play % (p=0.001) between Elite Level and Junior Level, when tested using Independent T-test. Whereas for variables of match duration (s) (p=0.07) and ball in play (s) (p=0.61) were no statistically significant differences between Elite Level and Junior Level which is p value more than (p>0.05). Mean for number of rallies per set and ball in play % were significantly higher in Junior Level than Elite Level. Mean for match duration (s) and rest time between rallies(s) were not significantly higher in Elite Level compared to Junior Level.

Results presented in Table 4 show median and standard interquartile range for tested variables in Elite Level and Junior Level categories, respectively. There were median significant differences of ball in play (s) (p=0.01) and rally length (s) (p=0.001) between Elite Level and Junior Level, when tested using Mann-Whitney test. Median of ball in play (s) and rally length (s) where significantly higher in Junior Level compare to Elite Level. Variables of set duration (s) (p=0.487) and shot per rally (s) (p=0.6) were not median statistically significant differences between Elite Level and Junior Level. Median of set duration is not significant which is slightly higher in Elite Level compared to Junior Level while median of shot per rally (s) is same for both categories.

Table 4. Comparison of median and Interquartile Range (IQR) of the Variables in Elite and Junior Level

Variables	Elite Median (IQR)	Junior Median (IQR)	*Z statistic*	*p*
Set Duration (s)	1402 (722.5)	1401 (746.5)	-0.695	0.487
Ball in play (s)	289 (173.50)	455.5 (274.25)	-2.51	0.01*
Rally Length (s)	4.00 (7)	5.0 (8.0)	-3.448	0.001*
Shot per Rally (number)	5.00 (5)	5.0(5.0)	-0.585	0.6

Note: *p<0.05, **p<0.01, ***p<0.001

Discussion

There were no statistically significant differences between match duration of Elite Level and Junior Level in this study. These results might be caused by the rest time between rally is not much different with 1524.56±393.50s or equivalent to 25.41±6.56 min and of 1445.06±610.94 s or equivalent to 24.1±10.18 min for Elite Level and Junior Level, respectively. Based on Fernandez, Villanueva and Pluim (2006), recovery periods are controlled by ITF rules which is rest time between points is 20s, 90s between changeovers and 120 second between sets.

Apparently, in this study Elite players are likely having longer duration 5027.14±2222.50 s or equivalent to 83.79±37.04 minutes than Junior Level 3209.14±996.394 s or equivalent to 53.48±16.61 minute. This is more likely games played by Elite level are longer with the average games played per match being 3.32 while for the Junior level it was 2.3.

Players at Elite level show no significantly longer game duration compared with players at Junior level. In present study, shots per rally between levels were not much different with Elite (6.10 ± 4.51) and Junior (6.14±4.37) which possibly influence game duration not significantly different in in the present study either.

Based on Fernandez et al. (2007), increased number of shots per rally in male single tennis in matches with longer duration will require higher physiological response. Longer duration of the set may demand greater cardiovascular fitness and psychological strength especially when the games are tied up to 13 games. It is recommended for the players to win 6 games which is 2 point ahead from the opponent straightly thus time to exhaustion and requirement of high energy can decrease.

There was a significant difference between number of rallies per game between Elite and Junior Level which is higher in Juniors than in Elite Level with a mean difference of 12.92 (95% CI of mean difference: (-21.95, -23.24), which in turn elevates the physiological demands to the performance in tennis (Johnson & Hugh, 2005).

Based on previous study Leong and Krasilshchikov (2016), showed there was no significant differences in rallies per game between Elite 35.1±5.1 and Youth Level 37.7±3.6 badminton players. Current study results showed that Youth Level play more rallies per game compared to Elite Level.

In the present study, there was no statistical difference of shots per rally between Elite players and Junior Players. One of the factors may be due serve point which players win within one shot in a rally which is ace serve. There are about over 50% (50.8%) of all rally demanded players to execute between 1 and 2 strokes in a game (Fernandez, Villanueva, Garcia, & Terrados, 2007).

Based to the past study, there were significantly higher physiological responses in matches with longer rally duration and increased strokes per rally in male singles (Fernandez et al., 2007). Average shot per rally in Junior tennis players had an average 5.45±0.22 strokes per rally (Luque, Cabello, Raquel, & Garatachea, 2011). In present study, an average was 6.14±4.37 stroke per rally in Junior level which is not similar with past study.

When comparing between levels Junior players showed greater average rally duration as compared to Elite players (Luque et al., 2011). Thus, increased rally length may lead to higher number of shots per rally in the game. Further, higher quality players play more shots per rally and play less rallies per game as compared to lower quality players (Leong & Krasilshchikov, 2016).

There was a significant difference when comparing ball in play(s) in Elite Level and Junior Level in this present study with the median real playing time 7 min (IQR = 4.6) for Junior level and 4.8 min (IQR= 2.89) in Elite Level. Juniors' ball in play was higher compared to Elite Level possibly due to the rally length difference. The fact that rally length in the game is significant can be related to these findings whereby the total real play time increases due to longer duration of the game. Length of the rally may lead to more shots per rally in the game (Luque et al., 2011). Luque et al. (2011) showed that real play time in young tennis players was 34 min in male players and 30 min in female players.

Present study showed significantly higher percentage of ball in play for Junior Level (33.38±6.36 %) compared to Elite Level (22.79±8.76 %) with mean differences 10.60. In regard to percentage of real play time among Junior Tennis players (Luque et al., 2011) reported that male tennis players had a real play time of 31.06±3.20% of the game duration which looks similar in this study.

Percentage ball in play may be affected by rally length of the game. When the rally length is longer in the real playing game thus percentage increase. This can be related to the result from the present study namely significantly different rally length. Elite players show less total ball in play compared to junior due to time it takes to win the game is shorter when compared to Juniors.

Junior players seem to play longer duration as they are less skillful compared to Elite players due to stroke speed, open angle, and the power of the players. Junior level played 5 stroke per rally in 9s whereas Elite Level played 5-6 stroke in 6s (Luque et al., 2011). Hence the number of strokes is similar, but the length of the rally is different. Thus, we can assume that Elite Level played short rallies, but similar stroke number compared to Juniors who played longer duration rallies with same shots number.

The result in rest time between rallies show no significant difference between Elite and Junior players. The reason why because the rest between set, interchanges and game are fixed based on ITF rules. Based on ITF rule tennis rest time not more than 20s between point and not more than 90 s between games may be one of the reason present study are not significant.

Rest time between the rallies in Elite Level by comparing mean 25.40s was not significantly longer than mean of Junior Level which was 24.1s. In comparing with junior players, the results showed that match activity of top junior female tennis players consisted of short bouts (1–8 s) of rallies and short recovery periods (11–20 s) (Fernandez et al., 2007) with our present study showing the rest intervals between the rallies at slightly higher values.

As a conclusion from this study, there were significant differences in the game structure between tennis players in Elite Level and Junior Level. Junior Level associated with higher number of rallies per set, ball in play (%), ball in play (s), and longer rally length compared to Elite Level. Significant differences between these variables were inter-dependent from each other which perhaps contributed to such result.

Practically speaking, junior players can use the information from this study to get themselves prepared while transitioning into Elite Level. Modified training based on this study results may help players to modify their skills, improve their fitness and familiarize themselves in playing longer set and match durations.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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ORIGINAL SCIENTIFIC PAPER

Pequliarities of Schoolchildren Physical Development Self-Assessment Accounting for their Gender Characteristics

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Abstract

The study aims to research the influence of the gender characteristics of boys and girls on their self-esteem regarding their physical development, health status, as well as to determine the relationship between the level of self-esteem and their belonging to the psychological type of personality (masculine, feminine, androgynous) among respondents who engage in and do not engage in sports. The study involved students in grades 5-11 (638 subjects). To study the level of self-esteem of the physical development of schoolchildren, a test questionnaire by "Self-Description of Physical Development", a test questionnaire by "Masculinity-Femininity", cluster analysis, and methods of mathematical statistics were used. It was determined that the self-esteem of the physical development of schoolchildren, for the most part, has a high and overstated level, which is 80-85% of the maximum score. The structure of age groups of boys and girls was determined according to the manifestation of psychological gender signs using cluster analysis. Based on the data obtained, it can be stated that boys and girls have certain common gender characteristics. However, there are distinctive features are more numerous. The data obtained are the basis for the systematization of data on the gender approach in physical education, the definition of limiting and stimulating factors affecting the formation of the individual physical culture of people with various signs of psychological gender.

Keywords: *schoolchildren, gender, physical education, self-assessment of physical development*

Introduction

Issues related to the study and understanding of gender issues occupy one of the leading places in various scientific fields today.

John Evans (1986) first published data exploring the experience of teachers and students in physical education programs from a sociological point of view, addressing a number of issues related to the organization and management of departments of physical education, deviance and disagreement in sports, gender inequality and concepts of community education and leisure.

Scientists rightly note that the importance of a gender approach in the educational system is determined by a number of objective factors, the most prominent of which is the transformation of gender relations in modern society. The issue of implementing a gender approach in the physical education of schoolchildren today has also become relevant. In this regard, physical education classes, based on a gender approach, should be built taking into account the gender characteristics of students, updating their gender roles (Mudrik, 2003; Kikineji, & Kryz, 2004).

Many studies have studied the motivation for physical exercises, as well as the issues of personal physical culture in the hierarchy of values of modern youth devoted their research (Evans, 1986; Krutsevich, & Marchenko, 2015; Kravets, 2013).

Several studies have been devoted to the study of social factors that determine the formation of interest in children and adolescents in physical education and sports (Murdoch,

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1995; Slingerland et al., 2014; Krutsevich, & Marchenko, 2018; Tomenko, & Bondar, 2018).

We believe that at this stage of scientific research, in order to create motivation for physical education and sports, it is necessary to pay special attention to the age and gender characteristics of boys and girls (Popova, 1996; Moskaleva, 2005; Pawlowski et al., 2015).

An analysis of the study of the gender approach in physical education made it possible to determine the contradictions between the objective social and personal significance of the gender approach, as well as the absence of scientifically based conditions for its implementation in secondary schools.

According to leading scientists, the school system of physical education can become effective only when the most favourable conditions are created for the disclosure and development of the physical, spiritual, and moral qualities of students. It should provide each child with a full and harmonious development of his abilities, as well as equip teachers with methods of personality-oriented education, of which a gender approach is an integral part (Evans, 1986; Kogan, 2000; Larina, 2011; Moskalenko, 2014; Marchenko, 2016; Tomenko, & Bondar, 2018).

The research results of several scientists of the world indicate a low level of theoretical knowledge of future specialists in the field of physical education regarding the gender characteristics of children, adolescents and students of physical education (Dickenson, & Sparkes, 1988; Evans, 1986; Pawlowski et al., 2015).

Consequently, effective cross-cultural studies of the problems of gender socialization and gender education of youth are carried out in the European educational space.

The above confirms the relevance of the problem, determines its choice as a topic of scientific research, and is the basis for creating the concept of a gender approach in the physical education of schoolchildren, which has theoretical, practical and social significance.

Methods

Our research aims to study the gender characteristics of self-assessment of the physical development of students, depending on their psychological type, to identify internal motives for physical education and sports.

The study involved students of Grades 5-11, 11-17 years of age of general educational institutions; there were 628 subjects (boys: 282; girls: 346), of whom 126 respondents (97 boys and 29 girls) were involved in the specific sport (swimming, basketball, volleyball, athletic gymnastics, wrestling, taekwondo). The rest were not involved in sports activities.

To determine the gender identity of schoolchildren who go and do not engage in sports, we tested according to the test questionnaire by "Masculinity-Femininity" (Bam, 1993), which provided 60 personality characteristics. The participants in the experiment should highlight those personality traits that are inherent in them. Further, according to a special formula, the indicators of femininity, masculinity, and androgyny were determined. The masculinity-femininity index (IS) was determined by the formula:

IS = (F / 20 - M / 20) × 2,322, where F is the sum of the noted qualities that are related to the femininity stereotype; M is the sum of the noted qualities that are related to the stereotype of masculinity. The value of the IS index in the range from -1 to +1 indicates androgynous, less than 1 (IS <1) - about masculinity, more than 1 (IS> 1) - about femininity.

The test questionnaire of "Self-description of physical development" (Bochenkova, 2000) consists of 70 statements that relate to the field of physical development of a person and sets 10 indicators of physical development and an indicator of general self-esteem of a person. The indicators are: health, coordination of movements, physical activity, harmony of the body, athletic abilities, physical "I", appearance, strength, flexibility, endurance, self-esteem. Evaluation of the results was carried out by correlating the results with generally accepted norms of the level of personality self-esteem, in accordance with which the personality self-esteem scale was used for the following indicators:

- a very high level of self-esteem (overstated) - 75-100% of the maximum number of points;
- high level of self-esteem - 60-74% of the maximum number of points;
- the average level of self-esteem - 45-59% of the maximum number of points;
- low self-esteem - below 45% of the maximum number of points.

Mathematical and statistical processing of the obtained data was carried out using the SPSS Statistics v.17.0 software package and cluster analysis. All participants gave their written informed consent to participate in this study, which was approved by the local ethics committee and was in accordance with the Helsinki Declaration.

Results

One of the factors of effectiveness in communication and education that positively affects the health and formation of a fully fledged personality is a differentiated approach based on individual characteristics of a person (Govorun, & Kikinezhdi, 2004), and one of the main individual characteristics of a person is his gender. In ordinary life, the term "gender" means a wide range of social-behavioural, somatic and some other characteristics that can characterize any person, both male and female (Artamonova, 2008).

A preliminary study of the gender characteristics of the personality of students with the help of the questionnaire of Bem (1993) allowed us to determine the gender identity of students (femininity, masculinity, androgyny).

The complexity of studying these categories is because the previously existing traditional patterns of masculinity/femininity have changed and continue to change in current conditions, which creates certain difficulties for modern youth, who are trying to integrate various social roles, patterns of behaviour and personality traits. According to Bem (1993), 92% of respondents were classified as androgynous. In this regard, the use of Bem test-questionnaire by "Masculinity-femininity" did not fully reveal the sensitivity to determining the characteristics of masculinity and femininity at the individual level.

Using cluster analysis of the results obtained in determining the gender identity of the respondents, we modified the assessment system for the personality psychotype index by the IS Bem method of "Masculinity - Femininity", which is the next value of the studied parameter IS:

Cluster 1: respondents of the androgynous psychological type (1 <IS <1) - 51.0% of the total number of respondents;

Cluster 2: respondents of masculine (IS <–1) and androgynous with signs of masculine (-1 <IS <- 0.46) psychotypes –15.72% of the total number of respondents;

Cluster 3: respondents of a feminine and androgynous psychotype with signs of a feminine (0.58 <IS <1.86) - 33.26% of the total number of respondents.

An analysis of the data given in Table 1 allows us to state that the number of androgynous young men (59.04%) is more than double the number of masculine (27.71%) and more than four times feminine (13.25 %).

Table 1. Distribution of the total number of respondents according to the results of a cluster analysis of the IS parameter of the Bem test "Masculinity-Femininity"

Psychotype					
androgynous	**masculine**	**feminine**	**androgynous**	**masculine**	**feminine**
Young men not involved in sport n=185			*Young women, not involved in sport n=317*		
109	51	24	150	24	143
59.04%	27.71%	13.25%	47.22%	7.50%	45.28%
Young men involved in sport, n=97			*Young women, involved in sport, n=29*		
55	34	8	14	8	7
56.70%	35.05%	8.25%	48.28%	27.59%	24.14%

The number of androgynous and feminine girls with a slight difference (2%) is 47.22% and 45.28%; the masculine among them, only 7.5%. Among athletes, the number of masculine youths is 7.34% more, and 5.0% less among feminine youths - The analysis of the data revealed that with age, the number of persons with signs of masculinity increases (from 13.79% to 30.19%), and with signs of femininity it decreases (from 31.03% to 11.33%). A tendency to increase the number of feminine girls with age was also identified, which allows us to assume the influence of gender stereotypes on the formation of gender identity of adolescents.

However, one should not forget that in adolescence, "masculinity" among young men is primarily associated with physical strength and victories in competitions. It should be noted that playing sports can be one of the main factors of gender socialization of schoolchildren, which, in turn, is one of the means of creating gender identity for boys and girls.

The study of the general level of self-esteem of the physical development of schoolchildren revealed the dominance of a predominantly high level, which is manifested to a greater extent in students aged 11-13 years. With age, the self-esteem of respondents, regardless of their gender, becomes more realistic. However, in boys, the average score of self-esteem in physical development is higher than in girls. So, at the age of 11-13 years, for boys, it makes up 81% of the maximum indicator, and 80% for girls; in the age group of 14-15 years: for boys: 81.85%, for girls: 71.86%; in the age group of 16-17 years: for young men: 76.74%, for girls: 70.15%.

The results of the Self-Description of Physical Development test among respondents who go in for sports are higher for all indicators of the questionnaire, which can be explained by the presence of sports achievements that stimulate and cultivate perseverance, willpower, strengthen self-confidence, which is a factor of confidence in their physical improvement.

To determine the relationship between the general level of self-esteem of young men and women with their type of gender identity (masculinity, androgyny, femininity), we conducted a comparative analysis of the self-description parameters of the respondents' physical development and their IS parameter. Groups of respondents with a level of self-esteem were examined regarding being the corresponding cluster (Table 2 and 3).

Table 2. The general level of self-esteem of the physical development of boys of different psychological types (n=282)

Overall self-esteem	Psychotype					
	androgynous		**masculine**		**feminine**	
	n	**%**	**n**	**%**	**n**	**%**
Overvalued	31	18	25	32	7	22
High	106	62	42	53	18	54
Medium	30	18	12	15	8	24
Low	3	2	0	0	0	0
Total	170	100	79	100	33	100

Table 3. The general level of self-esteem of the physical development of girls of different psychological types (n=346)

Overall self-esteem	Psychotype					
	androgynous		**masculine**		**feminine**	
	n	**%**	**n**	**%**	**n**	**%**
Overvalued	48	28	1	4	17	12
High	80	48	18	64	82	55
Medium	37	22	9	32	45	30
Low	4	2	0	0	5	3
Total	169	100	28	100	149	100

An analysis of the results of the study indicates that masculine schoolchildren of gender identity have better self-esteem. Among those, there were no respondents with low self-esteem.

Representatives of the feminine type mostly have a high and medium level of self-esteem. They underestimate their abilities. Representatives of the androgynous psychological type have a more accurate of their physical development and abilities.

Low self-esteem was determined only among representatives of the feminine and androgynous types of gender identity.

As noted, self-esteem regarding physical qualities and its overall level was higher among athletes. Also, according to the results of our study, it was found that among taekwondo athletes, girls are more masculine than boys.

Discussion

Opinions differ regarding the consideration of sex and gender characteristics of the organization and process of physical education and sports training of boys and girls, men and women (Abraham, Cramer, Fernandez, & Mahler, 2001).

The results of the study confirm the results of research by scientists on the impact of sport on the formation of masculine personality traits in both boys and girls (Ilyin, 2010; Damadaeva, 2010; Dulmukhametova, 2011).

Studies by Afinogenova (2006) showed that feminine personalities prevailed among female athletes involved in "female" sports (51.2%). There were fewer masculine girls (15%) and more androgynous ones (34%). Having analysed the psychological personality types of athletes who engage in "male" sports, it turned out that there are twice as many girls with a masculine psychological type than representatives of "female" sports (Afinogenova, 2006).

Artamonova (2008) examined the issues of the formation of highly qualified athletes of a gender type of personality, depending on the characteristics of sports activities. As a result of her research, sports were identified that contribute to the manifestation of masculinity or femininity in male and female athletes. The researcher concluded that, in general, men are characterized by a higher level of masculinity than women, which is due to their high blood testosterone.

Stambulova (1999), in examining wrestlers, noted a pronounced friendliness, which can be attributed rather to the stereotype of femininity. The results of our study confirm the assumptions made by Istanbul (1999) regarding the psychological characteristics of both empathy for others and the ability to make friends more pronounced among athletes (both boys and girls). At present, there are still sports activities that scientists characterize as more preferable for men or for women (Tarasenko, 2007).

Taekwondo is classified as a masculine sport. According to the results of our study, most of the young men who practise taekwondo have androgynous characteristics (96.1%), which contradicts some previous findings of scientists (Stambulova, 1999).

In turn, Taekwondo girls have 100% masculine characteristics, which confirms the opinion of scientists that sport contributes to the formation of masculine character traits (Afinogenova, 2006; Artamonova, 2008; Damadaeva, 2010; Ilyin, 2010). Girls show masculinity in those forms in which there is a direct contact struggle with an opponent (antagonistic), and increased demands are placed on multilateral technical training and psycho-functional stability.

Gender studies in the field of physical culture and sports are aimed at solving the problems of gender equality and studying the question of how much sports contribute to the formation of gender characteristics (Dickenson, & Sparkes, 1988; Slingerland, Haerens, Cardon, Borghouts, & Slingerland, 2014).

The authors studied the relationship between gender identity and gender characteristics in children. Scientists have proven that boys and girls with high self-esteem and strong own gender identity are more successful in various aspects of education (Tarasenko, 2007). Another study examined the relationship between joint training sessions for schoolchildren in team sports (volleyball, basketball) and the psychological climate in the classroom. Scientists concluded that joint training of boys and girls does not have a significant impact on the level of psycho-emotional climate in the class (Tatarintseva, 1999).

As the results of research by experts, such as Dickenson and Sparkes (1988) and Murdoch (1995), a significant difference was found in the self-esteem of students with motor fitness, starting with the last two grades of elementary school. Young men more emotionally than girls endure their defeats, both in individual and team sports competitions (Dickenson, & Sparkes, 1988; Murdoch, 1995). Researchers point out that girls have an underestimated self-esteem of their abilities, while the boys have the opposite tendency. In our study, self-esteem is quite high, especially in female athletes.

However, in many studies on the differences between boys and girls who play sports, an approach based on biological characteristics was previously used, which is justified. This approach justifies the methodology of physical education and sports training. It differs in the features of the choice of means and methods of physical activity, since physical education and sports are associated primarily with manifestations of a person's physical abilities and are determined by his biological gender. To date, it has not yet been proved that biological factors have no effect on human behaviour, abilities, inclinations, hobbies, or value orientations. In contrast, in psychophysiology, more and more facts are accumulating that confirm the presence of such an influence.

In this case, we consider the gender approach from the point of view of not of gender policy or of equal rights for men and women, but to study their psychosocial characteristics to create adequate organizational and methodological conditions in the process of physical education of schoolchildren. This is not about infringing on the rights of men and women, but about taking into account the differences between them in the interests of the development of society.

It should be noted that these and other studies of the gender characteristics of boys and girls in the field of physical education and sports are the basis for systematizing data on the gender approach in physical education and identifying factors affecting the formation of individual physical culture of schoolchildren with various signs of psychological gender.

Conclusion

Thus, studying the gender aspect of the development of the individual physical culture of schoolchildren, a study was conducted of their psychological gender. It was determined that Bem standardized test questionnaire "Masculinity-femininity" was found to be insensitive to determining the mas-

culine and feminine personality characteristics of students. It was revealed that the vast majority of boys and girls, regardless of age, are of the androgynous type IS (92.77%). In this regard, we modified the evaluation system according to the IS index of the personality psychotype according to method of "Masculinity - Femininity". Based on the results of the study, a system for assessing gender characteristics (psychological type according to the IS index) was further developed for students using a cluster analysis of test results for Bem BSRI (Bem Sex-Role Inventory) questionnaire, "Masculinity - Femininity", according to which they fully reflect all values of the investigated parameter.

As a result of data analysis, it was revealed that with age in young men the number of persons with signs of masculinity increases, and it decreases with signs of femininity.

Studying the influence of the psychological type of personality on the level of self-esteem of the physical development of boys and girls, we determined that overestimated self-esteem is predominantly by young men, who representatives of the masculine psychotype; underestimated self-esteem was determined only among representatives of the feminine and androgynous psychological types of personality.

The results of the self-assessment of the physical development of the respondents showed that there are certain differences between boys and girls that can be related to their lifestyle, the content of the physical education process at school, and also with gender characteristics, that is, with the type of gender identity. The results of a scientific experiment suggest the existence of gender differences in the indicators of self-description of the physical development of schoolchildren, which has a direct impact on the overall level of their self-esteem.

As a result of the study, it was determined that girls who engage in sports are more masculine. They are distinguished by high self-esteem in a number of character traits that are usually associated with masculinity, developed will, high aggressiveness and ambitiousness. Our attention is drawn to the fact that among girls who go in for sports, unlike the total number of schoolgirls, there are 20% more people with masculine symptoms, but 18.14% fewer with feminine ones. It was also determined that young athletes are less likely to show feminine personality characteristics than those who do not engage in sports.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Health Benefits of Balance Exercises in Sport

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Abstract

The research was focused on the development of a deep stabilization system of female handball players by applying balance exercises. The premise was to reduce the number of injuries in the context of the development of the bodily core. The study involved 17 first-league female handball players (N=17 females, age 16.1±1.89 years; weight: 54.9±3.85 kg, height: 1.66±0.03 m, BMI: 20.34±1.41 kg/m2). Following the assessment of the condition of the deep stabilization system, designed intervention programs was designed for core development. Female handball players completed 12 training units with balance equipment. The effects of the balance exercises on injury incidence were assessed comparing the number of injuries during the season and after its completion. Evaluation of the effectiveness of balance exercises revealed the development of the deep stabilization system ($p<0.05$). The injury reduction in the context of the core development was not statistically significant. There was a significant reduction in the number of injuries with a loss of time greater than seven days ($p<0.05$). This study raised the awareness of its participants about understanding the relationship between the deep stabilization system level and injury prevention.

Keywords: *sport games, handball, core training, body building, injury prevention*

Introduction

Sports injuries are a common and unfortunate aspect of participating in an athlete's sports career. If injuries are not treated properly, they affect the athletes' performance and can prevent them from competing. They can also have long-term devastating effects on the body, not only physically but also mentally.

Fear of re-injury, so-called kinesiophobia is defined as an excessive, irrational fear of physical activity and activity resulting from a sense of vulnerability to painful or repetitive injury (Flanigan, 2013). Filbay, Crossley and Ackerman (2016) state that some athletes being afraid of re-injury avoided complex activities and others completely gave up sporting activities.

Several studies focusing on injuries in sport indicate that most injuries happen in team sports. In sport games, 50% of injuries occurred when in contact with another player and 50% after a foul. 80% of players complain of health problems associated with sports. Players most often experience pain as a result of injury to various parts of the body, e.g. to the lumbar spine – 26%, ankle – 22%, knee – 17%, thigh – 14%, cervical spine – 11%, and shoulder – 10%. The authors Kisser and Bauer (2012) conducted a study on the mapping of sports injuries in the European Union. They found that 40% sports injuries requiring hospital treatment occur in team ball games.

In the study named "The Burden of Sport Injuries in the European Union", they introduce the mechanisms of injuries in team ball games. The main injury mechanisms in handball include contact with a moving object (ball), falls, tripping, a bad jump landing, and excessive load (Fuller et al., 2006).

Most expert studies on handball injuries focus on monitoring acute time-loss, as chronic injuries to players are more difficult to track and minor injuries are not recorded at all. In the case of injuries to handball players, the part of the body that is injured is monitored, and whether injuries occurred during a training or match, after contact with an opponent or without contact. Interesting are the findings related to the dependence of the number of injuries on the playing position of the handball player. Handball players most often suffer injuries to the head (15.3%) and upper and lower extremities (22.5%). Most injuries affect the lower extremities regardless of age and gender. The most common types of injuries are

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sprains, contusions, and damaged ligaments (Wedderkopp, Kaltoft, Lundgaard, Rosendahl, & Froberg, 1999; Myklebus, 2010, Luig, & Henke, 2011).

In handball, 35.2% of injuries occur most often after contact with players, 24.6% in jumping or impact after jumping, 13.7% in running, 10.4% in cranks and 14.5% in falls (Myklebust et al., 2003).

Contactless injuries are generally more serious than contact injuries: almost 90% of the rupture of the anterior cruciate ligament occurred without contact with an opponent or teammate (Myklebus, 2013). Seil, Rupp, Tempelhof and Kohn (1998) state that significantly more contact injuries occur during the match than during training. The highest proportion of contact injuries (71 – 92%) occurs during top competitions such as the World Championships, the European Championships or the Olympic Games (Langevoort, Myklebust, Dvorak, & Junge, 2007). The risk of injury also depends on the player's position. In general, players are more at risk of injury in attack than in defence. Attacking clutches suffer the most injuries, followed by attacking pivotmen and players defending in the middle of the defence (Luig & Henke, 2010).

Bliven and Anderson (2013) reviewed existing professional publications in the field of nuclear stability training as a prevention of sports injury and proposed prevention programs. As a result of their research, multilateral programs are needed to reduce injury rates, which include strength, endurance, balance/posture, and neuromuscular control of the nucleus and lower limb. Soomro et al. (2014) carried out a systematic review of published prevention programs in sport (football, basketball and handball) and verified their effectiveness.

Junge, Runge, Juul-Kristensen and Wedderkopp (2016) from the Institute of Physical Education at Odense University in Denmark, in response to the high number of injuries to young female handball players in Denmark (40.7 injuries per 1,000 hours of wrestling), suggested to include a structured warm-up at the beginning of the training unit lasting 10–15 minutes as prevention of knee and ankle injuries. They found out that in the intervention group (n=111), the number of injuries during the match was reduced by 80% and during training by 70% compared to the control group (n=126), which trained without a structured warm-up. In the next phase, Junge et al. (2016) tried to find out whether the implication of balance exercises in a structured warm-up influenced the reduction of the number of injuries. The group that did not use training on a balance platform had 2.6 times higher number of traumatic injuries and approximately 3 times higher number of injuries during training and as well as during the match. In addition, the group using the balance platform had significantly less serious injuries. This proved that the implication of balance exercises in a structured warm-up reduces the number and severity of injuries in handball.

One of the components of prevention programs to reduce injuries in handball is core training (Luig & Henke, 2010, Myklebust et al., 2003; Myklebust, Skjølberg, & Bahr, 2013). Several studies suggest that deficiencies in the stabilization of the body's core and load-bearing muscles may be related to lower limb function and injury (Bliven & Anderson, 2013), which are the most common handball injuries.

Injuries can also be affected by the overall functional state of the body, muscle imbalance, fatigue and, of course, contact with a teammate (Boržiková & Mihalčin, 2015; Kokinda et al., 2018). The findings were a research problem in our study. The aim was to develop a deep stabilization system in the context of reducing the number of handball injuries. We formulated two hypotheses. H1 – The application of the intervention training program will increase the level of the deep stabilization system of female handball players. H2 – Increasing the level of the deep stabilization system of female handball players will have the effect on reducing the number of injuries.

Methods

Participants

The sample consisted of non-randomly sampled female handball players, meeting the requirements defined in advance – female handball players playing the highest competition, age classification in the category of younger and older adolescents, the opportunity to include an intervention program to develop a deep stabilization system in their training plan (Table 1). Based on these conditions, younger and older adolescents, who in the 2018/2019 and 2019/2020 seasons played in the 1st league of younger adolescents and in the 1st league of older adolescents, were selected.

Table 1. Sample characteristics

Variables	Minimum	Maximum	Mean	Standard deviation
Age [years]	14	18	16.1	1.5
Height [cm]	155	178	166.9	6.0
Mass [kg]	49	82	61.2	9.4
Training history [years]	5	8	6.89	1.2
Occurrence of injuries [june 2019]	0.0	2.2	1.57	0.2

Design and procedures

The participants were familiar with the measuring design and signed the written informed consents. Before the measurements were taken, anthropometric data was collected – weight (Electronic scale, Amboss, New York, USA), height (Antropometr A 213, Trystom, Olomouc, Czech Republic), age, and foot size, and a survey was administered among the participants. The study has been approved by the Ethics Committee of the University of Presov, Slovakia (approval no.: 3/2021).

Pre-test

The testing of the state of the deep stabilization system of the players took place at the beginning of the summer training period using field motor tests, which are often used in clinical practice: T1/endurance test of spinal extensors, T2/endurance test of abdominal muscles – flexors, modified by Biering-Sorenson test, T3/side-plank endurance test.

Intervention

The exercises to mobilize and strengthen the muscles of the deep stabilization system with balance equipment were the intervention factor. The intervention lasted for six weeks, with session duration of 55 minutes twice a week. Warm-up exercises included mobilization exercises of the deep stabilization system lasting 10 minutes. The main part of the training unit included 15 exercises divided into 3 series of 5 exercises. The number of repetitions of the exercise depended on the type of the exercise. There was a break of 10 seconds between the exercises in the sets and a break of 30 seconds between the series. The subjects performed the exercises under our supervision and control of the trainer (Figure 1). During the exercises, emphasis was placed on the technically correct performance of the exercises, with a neutral position of the spine, with the correct position of the pelvis and the correct way of breathing during the exercise.

FIGURE 1. Example of exercises during the intervention

Post-test

After completing the intervention program, the post-test was administered in the same way and under the same conditions as the pre-test.

Statistical analysis

We used statistical characteristics of the central tendency position, variance and mathematical-statistical methods to process the obtained data. We used M–mean, SD– standard deviation, max – maximum value, min – minimum value for the calculation. To determine the significance of the differences between the results of the state of the deep stabilization system at pre-test and post-test, we used a paired t-test for dependent variables using the program psppire.exe with an accuracy of 3 decimal places.

Results

Analysis of the development of a deep stabilization system in relation to the used intervention program

Sample characteristics are presented in Table 1. The evaluation of the overall results of the effectiveness of a deep stabilization system development showed statistically significant

Table 2. Analysis of the results of the development of a deep stabilization system

	M [s]	SD	Min [s]	Max [s]	T	P
T1						
Pre-test	49.76	20.08	19	83	5.91	0.00
Post-test	79.94	30.69	35	144		
T2						
Pre-test	44.00	19.67	24.00	96.00	8.06	0.00
Post-test	59.88	18.27	38.00	108.00		
T3						
Pre-test	38.12	11.05	21.00	62.00	8.13	0.00
Post-test	56.76	17.33	34.00	98.00		

Note: T1 - endurance test of spinal extensors; T2 - abdominal muscle endurance test; T3 - strength endurance test (lateral plank); M - mean; SD - standard deviation; T -t value; P - value

differences ($p<0.05$) caused by the action of the experimental factor (Table 2). In terms of improving the level of spinal extensors (T1), the endurance of abdominal muscle strength – flexors (T2) and improving the level of muscle strength securing the lateral plank (T3), we state that significant statistical differences were found in all three motor tests. Based on the average of values, it can be stated that the balance exercises included in the training process had a positive effect on the development of a deep stabilization system.

Analysis of the number of injuries

To determine whether the improvement of the state of a deep stabilization system affected the reduction in the number of injuries, we recorded the number of injuries and information on injuries using the questionnaire during the same time period before and after the intervention.

The research hypothesis that the reduction in the number of injuries depends on the context of the development of a deep stabilization system has not been confirmed (Table 3).

Table 3. Number of acute injuries to body parts at pre-test and post-test

Injured body part	Number of injuries	
	Pre-test Regular season October 2018 - May 2021	Post-test Regular season October 2019 - May 2020
hip	1	0
ankle	6	4
head	4	3
spine	4	3
knee	5	3
hand	4	6
sum	24	19
T	-0.35	
P	0.741	

It is in accordance with the published results of a survey by Bliven and Anderson (2013), who argue that multilateral programs are needed to reduce injury rates.

The success of the handball injury prevention program is seen not only in the reduction of the total number of injuries, but especially in the reduced number of serious injuries that require a long recovery period during which the athlete is out of training and competing (Table 4).

Table 4. Time loss in acute injuries before and after the intervention

Loss of time in the acute injury	Number of acute injuries	
	Pre-test	Post-test
from 4 to 7 days	4	10
less than a month	13	7
more than a month	3	2
T	-2.55	
P	0.027	

We observed in which body parts the number of injuries decreased with more than 7 days loss of training (Table 5).

Table 5. Number of acute injuries to body parts in relation to time loss

body parts	from 4 to 7 days		less than a month		more than a month	
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
hip	0	0	1	0	0	0
ankle	0	0	5	3	0	1
head	1	3	1	0	1	0
spine	2	3	1	0	0	0
knee	0	0	3	2	1	1
hand	1	4	2	2	1	0

Discussion

The primary goal of the study was to identify the possibilities of developing a deep stabilization system of female handball players in the training process. To examine the effect of balance exercises applied in the form of an intervention program, it was necessary to motivate and educate the coach as well as the players.

The first of the motor tests of the deep stabilization system

was the spinal extensor test (T1) modified by the Biering-Sorenson test. At post-test, we found out that the effect of our intervention program improved the strength of the spinal extensors and we achieved an increase in the average value by 30.18 s. Based on the measured values, we state that the female handball player with the lowest level of spinal extensors, despite an improvement of 16 s, did not even reach the pre-test mean value of the handball players. The percentage improvement (ratio of the difference between post-test and pre-test to the pre-test value) was on average 67.2%±42.8%, indicating significant differences in improvement among female handball players.

The second test measuring abdominal muscular endurance – flexors (T2) demonstrated improvement of all players after completing the intervention training program. Every player stayed in the desired position for a longer time during the post-test than the during the pre-test. The percentage improvement – the ratio of the difference between the post-test and post-test value – was on average 42.7%±27.4% indicating significant differences in improvement among tested subjects. Both the percentage improvement in the T2 test and the variance of the values are lower than in the T1 test.

The third test diagnosing the condition of the deep stabilization system was the lateral plank test (T3, lateral plank). After completing the intervention training program, each player's level of muscle strength providing for the lateral plank improved. Each player held the lateral plank position for a longer time at post-test compared with the pre-test. The percentage improvement – the ratio of the difference between post-test and post-test to pre-test– in the side-plank test averaged 50.4%±21.1%, indicating significant differences in improvement among test subjects, although the lowest variance of values was noted in this test.

Regarding the reduction in the number of injuries, we did not notice statistically significant differences after the completion of our proposed intervention program. We did not find a correlation between the monitored variables, such as the development of a deep stabilization system in the context of reducing the number of injuries. In the post-intervention period, the total number of injuries decreased by 5.2% from the number of injuries before the intervention.

After the intervention, the number of injuries to the upper limbs increased, but the number of injuries to the ankle, knee and hip decreased. We expected such a result based on several published studies (Bliven & Anderson, 2013; Junge et al., 2016). Their results pointed out that deficiencies in the stabilization of the body's core may be related to the function of the lower limbs and their injuries, which are the most common injuries of handball players.

The loss of time is directly proportional to the severity of the injury, i.e. the period of time after the injury during which the player is unable to participate fully in the training or match. By analysing the structure of injuries before and after the intervention, we found that after the intervention, the number of less serious injuries increased by 250% with a loss of time of 4 to 7 days. Importantly, the number of injuries with a loss of time of more than a month and the number of injuries with a loss of more than seven days and less than one month decreased. Based on the above, it can be stated that the number of injuries decreased significantly with a loss of time longer than seven, which is a decrease of 66% from the original number, which was statistically significant.

Limitations and future directions

The study was focused on linking biomechanical and kinesiological research. It is recommended to examine the effects of balance exercises from the orthopaedic and traumatological point of view, which would provide a better overview of the causal relationships between the monitored variables. Regarding the study's reservations - in the social field, the sample size may not be sufficient in terms of representativeness. The future research should work with a larger sample. It would also be useful to explore the motivation and approach to the application of specific exercises in sports training and other sports.

Conclusion

To test hypothesis H1 "Application of the intervention training program will increase the level of the deep stabilization system of handball players", we compared the results at pre-test before the intervention program and post-test after the intervention program for the development of a deep stabilization system. Based on the results, we state that each of the three tests from the test battery selected by us showed a statistically significant improvement in the condition of the deep stabilization system, which was reflected in an increase in endurance in the tested positions. Based on these results, we can confirm the validity of the established hypothesis.

At the same time, based on the test results from the used test battery, we can state that the improvement of the state of the deep stabilization system occurred in all players and was observed in each of the three tests used. Based on theoretical background, we expect that this side result of this study– the development of a deep stabilization system of players, had a positive impact on improving health, physical abilities and sports performance of handball players.

Comparing the number of injuries of individual body parts in the monitored periods before and after the intervention program for the development of a deep stabilization system, we found that reducing the number of injuries is not statistically significant and therefore we must reject hypothesis H2 "Increasing the level of the deep stabilization system of handball players will have the influence on decreasing the number of injuries". This is in line with the results published by Bliven and Anderson (2013), who, based on an analysis of published sports injury prevention programs, reported that deficiencies in stabilizing the body's core and load-bearing muscles may be related to lower limb function and injury. Based on this, we could assume that the development of core stabilization will cause a reduction in the number of lower limb injuries. This was confirmed in the monitored injuries.

There was a statistically significant reduction in the number of injuries with a loss of time of more than seven days, which decreased from 26 in the monitored part of the years 2018/2019 before the intervention to 9 in 2019/2020 after the intervention. This reduction was especially appreciated by the players and their coach. If we have contributed to this reduction to some extent by including the intervention programwe have created in the summer training of players, then we can consider this as a positive contribution of our experiment.

The deep stabilization system should be active at all times, only then people can ensure proper and painless posture and also the correct involvement of muscles during exercise, which each of our training makes more effective (Peate, Bates, Lunda, Francis, & Bellamy, 2007).

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Conflict of Interest
The author declare that there is no conflict of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Methodological Aspects of Health Formation for the Practice of Adaptive Physical Education in School-Children Taking into Account the Endoecological Factors

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Abstract

Purpose of the research to define and characterize the projection theory of scientific knowledge prerequisites on the concept of health-forming technologies development in the process of adaptive physical education for school-age children with hearing impairment. The study involved 236 pupils. Depending on age, gender and degree of hearing impairment, pupils were divided into 8 groups. Studied physical development, physical work capability, physical preparedness, morbidity, level of health and peculiarities of children with hearing impairments attitude`s to their own health for substantiation of methodical provisions to concept of health formation for children with hearing impairments. According to the Kettle index, none of the groups of surveyed pupils met the norm. Data showed that almost 60.00% of children were below the average for the vital index, and 40.00% are at the low level. In the morbidity structure of hard-hearing and deaf pupils, regardless of age and gender, the first place was occupied by infectious and parasitic diseases (86.97%), followed by diseases of the nervous system (76.54%) and musculoskeletal system (81.78%). Children with hearing impairments had below average of recovery rate of the cardiovascular system after a standard exercise (57.80%). Only 15.70% of boys and 28.40% of girls considered themselves as practically healthy. All data determine the urgent need for focusing attention on the children with hearing impairments health.

Keywords: *health formation, adaptive physical education, school-children with hearing impairments, technology, endoecological factors*

Introduction

The current state of health in Ukrainian population in general and children and youth in particular is a significant challenge to society and the state and without exaggeration poses a real threat to humanitarian security (Futorny, 2014). Nowadays, views and worldview of young people are influenced and deepened by many factors: environmental, economic, as well as social and demographic crisis, which together create an extremely dangerous environment for the formation of the adolescent's personality, and possibility for socialization (Head, 2010).

Particular social and educational importance of this subject gets towards the representatives of today's youth with limited opportunities for building and maintaining their own health, for the qualitative and quantitative characteristics which was

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often used indicator of disability, most realistic illustrates the sharp decline on functional capacity of the body, its adaptive and protective reactions (Ignatov, 2011).

Current results of scientific research in the field of environmental protection, medicine, toxicology in particular, rightly indicate that the health of children and youth, both directly and indirectly depends on the pathogenetic action mechanisms for three groups of factors: physical (radiant energy, ultraviolet irradiation, geomagnetic factors, atmospheric pressure), chemical (xenobiotics, food allergens), biological (viral infection, bacterial infection, fungal infection, plants, insects, animals) (Maslova, Savchenko, Bohdanovych, Holub, & Shumiychuk, 2018).

Since physiological systems and psychoemotional processes determine the direct and feedback with the outside world, the scientists found that endoecology with the above factors is manifested by the parameters of the body that determine the nature and outcome for interaction of external factors with the subject of perception (Tam, 2006; Sutton, 2013).

In pedagogical research of the last decade the complex approach to the decision for problem of physical, mental and social well-being maintenance of pupils with the functional infringements on activity of sensory systems, in particular with hearing defects is incompletely used. If such work is carried out, it is often episodic events of physical culture and sports-mass orientation (Kashuba, Goncharova, & Butenko, 2018).

This one-sided approach cannot ensure the usefulness and effectiveness of the preservation and strengthening for pupil's health as special education and school-age children who study in schools of education provided and based on updating requires organization (Futornyi et al., 2020).

Purpose of the research to define and characterize the projection theory of scientific knowledge prerequisites on concept of health-forming technologies development in the process of adaptive physical education for school-age children with hearing impairment.

Methods

The study involved 236 pupils 13-17 years old with various congenital or acquired hearing from specialized boarding schools for children with hearing impairments of Kyiv (No. 6, 9, 18) and Bila Tserkva. Depending on age, gender and degree of hearing impairment, pupils were divided into 8 groups: hard-hearing boys 1315 years (n=35); hard-hearing girls 1315 years (n=37); hard-hearing boys 1619 years (n=27); hard-hearing girls 1619 years (n=29); deaf boys 1315 years (n=28); deaf girls 1315 years (n=33); deaf boys 1619 years (n=24); deaf girls 1619 years (n=22). The research was approved by the Institutional Ethics Committee (number 2/2014) and was carried out in compliance with the international principles of the Helsinki Declaration of the World Medical Association (World Medical Association, 2013), and in accordance with the Law of Ukraine "Fundamentals of Ukrainian Legislation on Healthcare" (Law of Ukraine, 1992) on ethical norms and rules for conducting medical research involving human.

Studied were the variables of physical development (body mass; body length; values calculation of the Kettle's index, Robinson's index, Vital index and Power's index, with the subsequent comparison of the received values with the established values of norm), physical work capability (index of Harvard step-test; Rufier's index; the rate of recovery of the cardiovascular system after standard exercise), morbidity (types of morbidity; morbidity structure; temporary disability), level of health and peculiarities of children with hearing impairments attitude`s to their own health (lifestyle characteristics; analysis of living and learning conditions; medical awareness and activity; subjective self-assessment of health) (Kashuba, Maslova, & Rychok, 2018).

All statistical analyses were conducted using software packages MS Excel XP, Statistica 10 (for indicators descriptive statistics: calculation of a sample mean – M, standard deviation SD; representativeness errors m; to determine the reliability of differences in statistical estimates of sample indicators of students with congenital and acquired hearing impairments, which were normally distributed, the Student's t-criterion was used). During the implementation of mathematical analysis of data was taken statistical reliability P=95% (probability of error 5%, i.e., the level of significance $p \leq 0.05$).

Results

We found that the largest number of children with normal body length was observed among a group of deaf boys 1316 and 1719 years (69.40 and 74.30%, respectively). In other groups of subjects, the number of pupils with a body length that corresponds to the norm was in the range of 45.0058.00%, and in the group of deaf girls aged 13 to 16 years, their number was 40.40%.

The results of the study of the lungs vital capacity and the leading hand wrist dynamometry concluded that regardless of age, gender and degree of hearing impairment, the examined pupils have significantly lower average values compared to the established norms. The lungs vital capacity: hard-hearing boys 1315 years (2280.80±113.4 ml per norm 2600 ml); hard-hearing girls 1315 years (1750.40±250.6 ml per norm 2530 ml); hard-hearing boys 1619 years (2770.40±344.7 ml per norm 3520 ml); hard-hearing girls 1619 years (2160.50±248.8 ml per norm 2750 ml); deaf boys 1315 years (2150.40±183.4 ml per norm 2600 ml); deaf girls 1315 years (1930.80±296.7 ml per norm 2530 ml); deaf boys 1619 years (2820.20±341.5 ml per norm 3520 ml); deaf girls 1619 years (2580.40±284.6 ml per norm 2750 ml). The leading hand wrist dynamometry: hard-hearing boys 1315 years (16.30±4.4 kg per norm 21.637.6 kg); hard-hearing girls 1315 years (11.90±2.1 kg per norm 19.928.3 kg); hard-hearing boys 1619 years (35.70±5.6 kg per norm 45.951.0 kg); hard-hearing girls 1619 years (20.40±6.7 kg per norm 31.333.8 kg); deaf boys 1315 years (12.1±5.2 kg per norm 21.637.6 kg); deaf girls 1315 years (10.70±3.3 kg per norm 19.928.3 kg); deaf boys 1619 years (29.50±7.0 kg per norm 45.951.0 kg); deaf girls 1619 years (19.80±4.8 kg per norm 31.333.8 kg).

None of the surveyed pupils groups does not meet the norm of the Kettle index: hard-hearing boys 1315 years (384.50±0.04 c.u. per norm 265.10315.00 c.u.); hard-hearing girls 1315 years (382.90±0.08 c.u. per norm 265.10315.00 c.u.); hard-hearing boys 1619 years (398.70±0.07 c.u. per norm 350.10375.00 c.u.); hard-hearing girls 1619 years (423.40±0.06 kg per norm 350.10375.00 c.u.); deaf boys 1315 years (322.60±0.04 c.u. per norm 265.10315.00 c.u.); deaf girls 1315 years (358.60±0.07 c.u. per norm 265.10315.00 c.u.); deaf boys 1619 years (396.20±0.05 c.u. per norm 350.10375.00 c.u.); deaf girls 1619 years (372.70±0.06 c.u. per norm 350.10375.00 c.u.).

In the groups of hard-hearing girls and deaf boys 1619 years of age, the average values of the Robinson index approached the upper limit of the norm and indicate the presence of negative tendencies to exceed it (94.20±6.8 c.u. per norm 9469 c.u.). Statistical processing of the obtained data showed significant dif-

ferences between the established age norms of Vital index and Power index, and showed a significant lag in the average values for each group of surveyed pupils, regardless of the established nosology and age differentiation.

Data of the pupil's physical preparedness with hearing impairments showed a clear trend towards its deterioration among high school pupils compared to the results of middle school children. A comparative analysis of the data showed that the level of pupil's physical work capaity with hearing impairments according to the Harvard step-test in almost all groups was below average, except for groups of hard-hearing girls 1619 years old (60.80±9.10 c.u.) and deaf boys 1315 (69.90±11.80 c.u.) and 1619 years old (61.10±14.60 c.u.), who have a level of physical work capaity was at an average level. The study of the cardiovascular system functional state on the indicator of cardiac activity in accordance with the results of the Rufier test showed that none of the groups did not meet the norm and received an assessment of t indicator as "satisfactory".

The results of the research showed a negative tendency to increase the number of requests for medical care among deaf children compared to hard-hearing children. Thus, according to the indicator of primary morbidity, the number of requests for medical care among deaf children was almost 2 times higher than among hard-hearing children. Similar data were obtained for indicators of general and infectious morbidity, as well as dispensary morbidity at the ratio of the number of chronic diseases to the total number of diseases registered during the year.

In the structure of morbidity of hard-hearing pupils, regardless of age and gender, the first were infectious and parasitic diseases (87.95%), then diseases of the nervous system (81.45%) and musculoskeletal system (76.07%), severe eye diseases (70.85%) and mental disorders (33.45%). Among deaf pupils, also irrespective of age and gender, at one level infectious and parasitic diseases (86.33%) and diseases of musculoskeletal system (87.48%), further - diseases of an eye (74.23%), diseases of a nervous system (73.10%) and mental frustration (64.38%). It should be noted that our analysis of the students with various hearing impairments structure of morbidity, revealed the presence of associated pathologies - an average of four chronic diseases and two acute conditions in one pupil.

Total numbers of closed sick leaves of hard-hearing pupils were 87 completed forms (on average more than every second pupil issued a sick leave at least once a year), while the number of closed sick leaves among deaf pupils was 101 completed forms (almost every pupil draws up a sick note at least once a year). According to the number of days missed due to illness, 694 days were recorded among deaf pupils (each pupil who drew up a sick leave did not attend classes for 8 full working days). In hard-hearing children, the number of days missed due to illness was 743 days (on average, each pupil who drew up a sick leave did not attend classes for 7 full working days).

Discussion

According to the basics of the scientific knowledge theory and according to the forms of the scientific knowledge functioning we have defined our research idea on how true the knowledge of reality from the subjective point of view to possible conversion and fixation not only exists, but also proper approval, and became the basis for systematizing the process of identifying prerequisites for the concept of health-promoting technologies in the process of adaptive physical education for school-age children with hearing impairments (Figure 1).

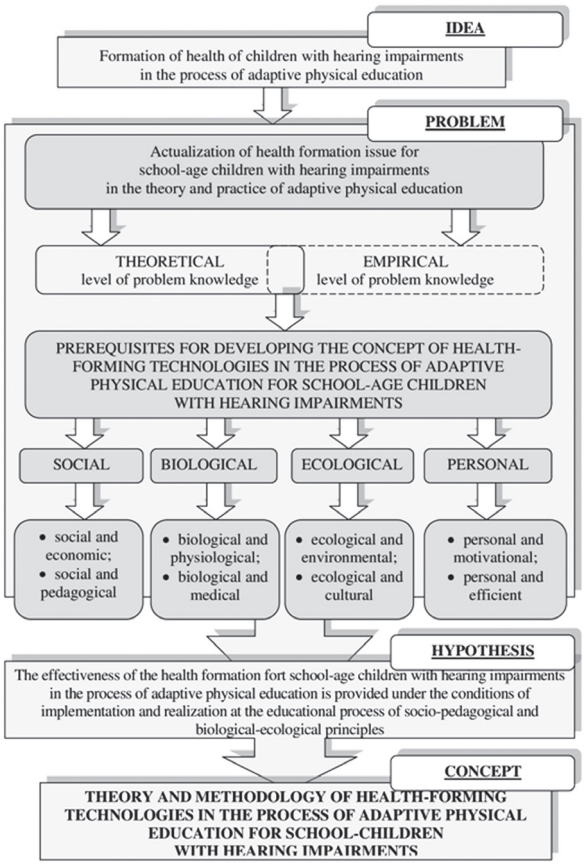

FIGURE 1. The structure of scientific knowledge of the preconditions of the concept of health-forming technologies in the process of adaptive physical education of school-age children with hearing impairments

The proposed scientific knowledge structure of the prerequisites on the concept of health-forming technologies in the process of adaptive physical education for school-age children with hearing impairments included four categories: social, biological, ecological and personal (Maslova, 2020).

The category of social preconditions was the urgent need of modern society for a harmonious physically and mentally developed personality, the ability for successfully integrated as a social member and self-realize in the social environment (Maslova, 2020).

We found that only 20.60% of hard hearing boys and 23.70% of hard hearing girls and 9.50% of deaf boys and 11.60% of deaf girls aged 13 to 15 years are completely satisfied with living and learning conditions. Among schoolchildren aged 16-17, only 11.00% of hard hearing boys and 2.30% of hard hearing girls and 9.50% of deaf boys and 5.00% of deaf girls consider their own living and learning conditions like excellent ($p<0.05$).

Analysis of parents' responses showed compatibility of views with children. Only 2.20% of parents of hard hearing pupils and 8.30% of parents of deaf pupils aged 13 to 15 years noted that the living and learning conditions of their children are excellent and completely satisfactory. Among parents of schoolchildren aged 16-17, a similar opinion was expressed by 7.40% of parents of hard hearing pupils and 6.50% of parents of deaf youth ($p<0.05$).

To the biological preconditions on the concept of health-forming technologies in the process of adaptive physical education for school-age children with hearing impairments, we have included provisions that correspond to the concept of norm and pathology of individual body systems functions, taking into account the impact of healthy lifestyles. Based on the results of the study for the level of morphofunctional development of children with hearing impairments, we calculated the indicators of the Kettle index, Robinson index, Life Index and Power Index, which allowed determining the level of their somatic health according to the method of Apanasenko (Table 1).

A high level of somatic health was found in only two groups of surveyed contingent, a high level was typical for 13.00% of

Table 1. Comparative characteristics of indexes children with hearing impairments and age norms

Index/ Norm	Contingent researched							
	Hard hearing pupils (n=129)				Deaf pupils (n=107)			
	13 - 15 aged		16 - 17 aged		13 - 15 aged		16 - 17 aged	
	Boys (n=35)	Girls (n=37)	Boys (n=27)	Girls (n=29)	Boys (n=28)	Girls (n=33)	Boys (n=24)	Girls (n=22)
Kettle Index, g•cm^{-1}								
Norm	265.10 315.00	265.10 315.00	350.10 375.00	350.10 375.00	265.10 315.00	265.10 315.00	350.10 375.00	350.10 375.00
Results (M±SD)	384.50± 0.04	382.90± 0.08	398.70± 0.07	423.40± 0.06	322.60± 0.04	358.60± 0.07	396.20± 0.05	372.70± 0.06
t value	1.88	1.87	1.65	1.96	0.85	1.73	1.62	0.85
p value	0.08	0.08	0.11	0.06	0.42	0.09	0.11	0.42
Robinson Index, conv. units								
Norm	94.00 69.00	94.00 69.00	94.00 69.00	94.00 69.00	94.00 69.00	94.00 69.00	94.00 69.00	94.00 69.00
Results (M±SD)	89.30± 8.40	87.60± 7.30	94.10± 9.70	81.80± 7.20	92.90± 5.70	89.10± 8.80	87.60± 7.20	94.20± 6.80
t value	0.80	0.81	0.63	0.97	0.60	0.79	0.81	0.63
p value	0.42	0.42	0.51	0.47	0.52	0.42	0.42	0.51
Life Index, ml·kg^{-1}								
Norm	56.00 66.00	47.00 57.00	56.00 66.00	47.00 57.00	56.00 66.00	47.00 57.00	56.00 66.00	47.00 57.00
Results (M±SD)	39.60± 8.40	28.90± 6.10	40.80± 9.10	30.30± 10.40	39.90± 11.80	31.40± 9.80	41.10± 14.60	39.50± 8.40
t value	2.44	2.72	2.42	2.63	2.44	2.66	2.35	2.12
p value	0.02*	0.02*	0.02*	0.02*	0.02*	0.02*	0.03*	0.04*
Power Index, %								
Norm	66.00 81.00	51.00 61.00	66.00 81.00	51.00 61.00	66.00 81.00	51.00 61.00	66.00 81.00	51.00 61.00
Results (M±SD)	28.30± 8.40*	19.70± 9.10*	52.60± 15.20*	28.60± 9.70*	22.40± 5.20*	17.40± 5.70*	42.90± 13.10	30.30± 11.90*
t value	4.01	4.26	3.48	4.01	4.78	4.65	2.77	3.96
p value	0.001*	0.001*	0.002*	0.001*	0.001*	0.001*	0.01*	0.001*

Legend: M –mean; SD – standard deviation; * $p \leq 0.05$

children in each group, the average level was 33.00%, and the rest almost 54.00% on average below low level and low level ($p<0.05$).

In the category of environmental prerequisites for the introduction of health technologies in the process of adaptive physical education for school-age children with hearing impairments, we considered current trends in the formation of ecological culture in the context of balanced development:

- ecological and environmental - reducing the negative impact of the environment and its individual components on the organism through the application of a certain regime and conditions of exercise; understanding the concept of environmental cleanliness and environmental safety in the educational process; implementation of natural environmental conditions in the educational process for its promotion; use of the forces of nature in the system of strengthening the body and improving the quality of life;

- ecological and cultural - the expansion of ecological worldview and consciousness through physical education; instilling ecological behavior and activities to create a system of moral, material and spiritual ecological and cultural values; integration into the education system on optimal norms and ways of society interaction with the environment; formation the system of ecological knowledge and its combination with the system of subject knowledge (Imas, Futorny, Tsyganenko, & Maslova, 2018).

Characterization of personal preconditions on the concept of health-forming technologies in the process of adaptive physical education for school-age children with hearing impairments made it possible to distinguish:

- personal and motivational lack of awareness of the value of health and the desire to follow all the rules and norms of a healthy lifestyle; failure to form a responsible attitude to one's own health and the health of others, an active worldview regarding healthy living; underestimation of own needs and desires to optimize the level of health, increase the level of physical fitness both in the process of physical education and during the independent organization of physical activity; priority of passive lifestyle and distorted perception of new types of addictions (gambling, drug addiction, gadget addiction, internet addiction);

- personal and efficient the formation of behavior individual system for aimed at achieving full physical, psychological and social well-being, based on the categories: "lifestyle", "work and rest", "culture of interpersonal communication", "prevention of bad habits"; low level of theoretical knowledge and practical skills in health care; lack of experience in shaping one's own health and positive emotional support of health development activities (Maslova, & Hopey, 2017).

The studying of self-assessment for the level of formation the practical skills and abilities of children with hearing impairments showed that more than 67.00% of pupils, regardless of age and degree of hearing impairment, are at an uncertain (indifferent) level. Almost 27.00% of children and adolescents assess their practical skills at the elementary level, and only 6.00% of pupils believe that their level of practical skills and skills to carry out health-building activities corresponds to a sufficient level ($p<0.05$).

Analysis of the responses allowed to outline the range of the most difficult skills for children with hearing impairments, among which they noted those related to the organization of optimal motor mode (83.50%), with independent drawing up of a program of physical training and health classes (91.30%), with the application of knowledge about the specifics of the certain types of impact of exercise on the body (84.90%), with the control of physical activity in the classroom (95.50%) ($p<0.05$).

The obtained results of pedagogical observation showed ignorance of almost 77.00% of children with hearing impairments in the issues of drawing up individual programs for physical culture and health classes; development of complexes of morning hygienic gymnastics; diets substantiation ($p<0.05$).

The results of research and studying of pedagogical foundations to create conditions for physical, mental and social well-being of children with hearing impairments allowed us to develop the basic provisions on the concept of health-forming technologies in the process of adaptive physical education of school-children with hearing impairments.

The development of the theoretical basis on the concept of health-forming technologies in the process of adaptive physical education of school-age children with hearing impairments directed us to determine the synthesized provisions of the author's concept based on a review of existing principles of modern pedagogy, education and health (Kashuba, & Goncharova, 2018).

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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SportMont

ORIGINAL SCIENTIFIC PAPER

Model Morpho-Functional Characteristics of Qualified Volleyball Players

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Abstract

The significant influence of somatic and functional characteristics on the sports result makes it advisable to justify the model indices of qualified players who are considered to be ideal models in their sport. The purpose of the study was to determine the model morpho-functional characteristics of qualified male and female volleyball players of the Ukrainian Super League. The study involved 12 female and 13 male volleyball players that were qualified as masters of sport, candidates for masters of sports. Morpho-functional diagnostics aimed at determining the body composition of players (fat, muscle, bone components, total water content). According to the results of the anthropometric measurement and morpho-functional diagnostics of qualified volleyball players, we came up with 18 indicators that characterized the constitution and the body composition of athletes' weight. The analysis of the obtained data showed a slight skewness in the distribution of fat and muscle components in the athletes' legs and arms, which was explained by the nature of the volleyball game. The significant potential of Ukrainian volleyball players, the availability of the reserved functional resources was evidenced by their anthropometric indicators, the content of fat and muscle components in the body, which were not significantly different from the similar indicators of the players of the leading national teams and professional volleyball clubs. The results of the research can serve as a guide and facilitate the selection, training and specialization of gifted Ukrainian youth.

Keywords: *volleyball players, Super League, fat content, muscle content, bone components, model*

Introduction

The development of volleyball at the present stage is characterized by continuous increase in speed and athleticism of the game, constant additions to the official rules aimed at increasing of the entertainment and intensity of matches (Shchepotina, 2015; Malikova, Doroshenko, Symonik, Tsarenko, & Veritov, 2018; Kostiukevych et al., 2019). Stiffer competition among volleyball teams of different levels leads to different researches aimed at identifying the most important factors that determine the effectiveness of competitive activity and the achievement of high sports results on both national and international arenas (Kostiukevych et al., 2019). In particular, Zhelezniak, Portnov, Savin and Leksakov (2004) distinguish 12 components in the structure of the competitive activity of volleyball players, which are based on the morphological indicators (Kostiukevych et al., 2019). Moreover, the basic model of a qualified athlete developed by Kuznetsov, Novikov and Shustin (1975) in addition to the competitive model (first level) and the skilled model (second level), includes the third level – a model of sports resources (morphological indicators, age, athletic experience, functional and psychological characteristics), which is largely contingent on the results of the first two levels.

The analysis of the scientific literature indicates that a great number of researches were devoted to the detailed substantiation of the influence of morpho-functional indicators on the sports results of players (Kostiukevych et al., 2020; Shynkaruk, Shutova,

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Serebriakov, Nagorna, & Skorohod, 2020). In particular, Dopsaj, Nešić and Ćopić (2010) studied the constitutional features of volleyball players of different qualifications, which determined the competitiveness of women's volleyball. In the scientific work of Stech (2010) the correlation analysis proved the interrelation of somatic-age characteristics of volleyball players with the level of their sports mastery, which was determined on the basis of the expert evaluation of the coaches of the efficiency of competitive activity of female athletes. Moreover, Stech (2010), as well as Acar and Eler (2019) substantiated experimentally the influence of somatic characteristics of volleyball players on the jumping performance, which, in turn, significantly determine the effectiveness of performing such technical and tactical actions in volleyball as attack hit and block. It also should be mentioned that in our previous studies (Shchepotina, 2016), the results of correlation analysis were described, which proved the correlation of the morpho-functional characteristics of qualified volleyball players with both their physical fitness and competitive performance.

Therefore, the above mentioned information indicates a significant impact of somatic and functional characteristics on volleyball players' fitness and their athletic performance. As far as qualified athletes are considered to be ideal models in their kind of sport, carefully selected and well-organized model morphological characteristics of these athletes can be used as a guideline and facilitate the selection, training and specialization of gifted youth (Byoung–Goo & Kim, 2005). Therefore, a great number of scientific works were devoted to the establishment of the model of qualified volleyball players of national teams (Valleser et al., 2018) and the leading volleyball clubs (Mala et al., 2015; Muniz et al., 2017). At the same time we consider it necessary to present the model morpho-functional characteristics of the players of female and male teams of the Ukrainian Super League, because of the lack of corresponding attention to the above mentioned problem on the Ukrainian sport arena.

The purpose of the study was to determine the morpho-functional model characteristics of qualified male and female volleyball players of the Ukrainian Super League, including anthropometric data, as well as indicators of the body composition.

Methods

Participants

The study involved 12 female and 13 male volleyball players that were qualified as masters of sport and candidates for masters of sports. The inclusive criteria were to be a starter or an active backup player. They were all the members of the top 4 women and top 3 men teams, according to the results of the Championship of Ukraine among women's and men's teams of the Super League and were located in Vinnitsa (VC "Bilozgar-Medical University" and VC "MHP-Vinnitsa"). Informed consent to participate in this experiment was obtained from all participants. The study was approved by the Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University research ethics committee.

Organization of the research

The study was conducted in a competitive period when the players were in their optimal competition form (Kostiukevych et al., 2019). Anthropometric measurement using a standard Stadiometer was performed to obtain the athletes body height. Morpho-functional diagnostics involved determining the body composition of players using a Tanita BC-601. To avoid errors the measurements were taken before physical load and not earlier than in 2 hours: a) after meals; b) after consuming a large amount of fluid; c) after taking a bath or a sauna.

The total body fat (%), total muscle mass (skeletal, smooth, heart muscle together with water) (kg) and their content in the body segments of volleyball players as well as bone mass (inorganic constituents of bone, such as calcium) (kg), total body water (%), body mass (kg) and body mass index ($kg \cdot m^{-2}$) were studied with Tanita BC-601. The obtained data were subjected to the mathematical processing on the basis of statistical methods of processing the measurement results.

Statistical analysis. While the mathematical processing of the results of the study descriptive statistics was used. The studied variables have been described with the mean (M), standard deviation (SD) and coefficient of variation (V).The Student's t-test was used to determine the significance of the differences between male and female volleyball players morpho-functional indicators. The difference between the indicators was considered significant at the significance level $p<0.05$. The mathematical processing of the study results was carried out using the MS Excel software package (Byshevets et al., 2019).

Results

All the results obtained in the processing of the initial measurement data of the examined female and male volleyball players are shown in Table 1. The analysis of the table 1 allowed us to note a fairly young age of both female (22.92±5.22 years) and male (21.92±4.19 years) professional teams of Ukraine ($p>0.05$).

Table 1. Model morpho-functional characteristics of highly qualified volleyball players of the Ukrainian Super League

Morpho-functional indices	Statistic indices				t-test	p-value
	Female volleyball players (n=12)		Male volleyball players (n=13)			
	M±SD	V, %	M±SD	V, %		
Age (years)	22.92±5.22	22.8	21.92±4.19	19.1	0.531	0.601
Body height (m)	1.80±0.04	2.2	1.98±0.06	3.2	8.887	0.000*
Body mass (kg)	72.56±4.82	6.6	90.49±11.83	13.1	5.031	0.000*
Body mass index (kg/m^2)	22.53±2.27	10.1	23.06±2.46	10.6	0.560	0.581
Total body fat (%)	21.52±4.08	19.0	11.42±2.22	19.4	7.599	0.000*
Total muscle mass (kg)	53.98±4.20	7.8	76.10±7.75	10.2	8.963	0.000*
Bone mass (kg)	2.88±0.22	7.5	3.90±0.39	10.0	8.132	0.000*
Total body water (%)	57.13±2.98	5.2	63.06±3.02	4.8	4.939	0.000*

Notes: * – $p<0.05$; M – mean; SD – standard deviation; V – coefficient of variation

At the same time, large coefficients of variation (22.8 and 19.1%, respectively) indicated a significant age difference between young and experienced players.

Body height is one of the most stable somatometric indicators, which is largely due to heredity. At the same time, height is of great importance for volleyball, as it can make it easier to compete directly near the volleyball net, which is elevated above the ground for 2.24 m in women and 2.43 m in men. Statistically significant differences could be easily predicted ($p<0.05$) in the height of the female volleyball players (1.80±0.04 m) and male volleyball players (1.98±0.06 m).

Body mass is an important indicator of general physical development, but it is not sufficiently informative. The body mass index allows to assess the degree of correspondence of a person's mass to his height. The body mass index of female volleyball players (22.53±2.27 kg/m2) and male volleyball players (23.06±2.46 kg/m2) lay under normal limits.

Much attention in our research was devoted to the study of both components: the total body fat and muscle mass of volleyball players, and their content in segments of the body of players (Figure 1, a-b; Figure 2, a-b).

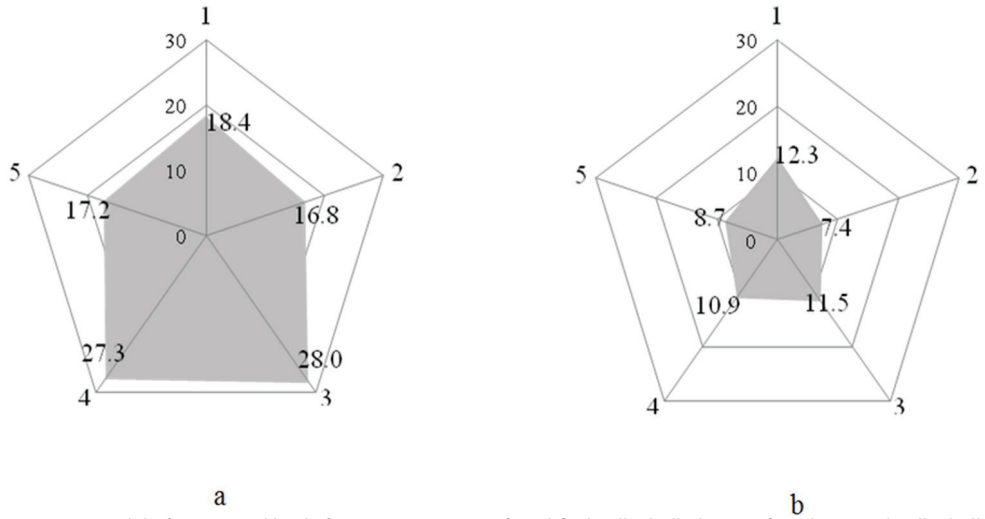

FIGURE 1. Model of segmental body fat percentage (%) of qualified volleyball players / female (a) and volleyball players / male (b) of the Ukrainian Super League. 1 – fat percentage in the trunk; 2 – fat percentage in the right arm; 3 – fat percentage in the right leg; 4 – fat percentage in the left leg; 5 – fat percentage in the left arm

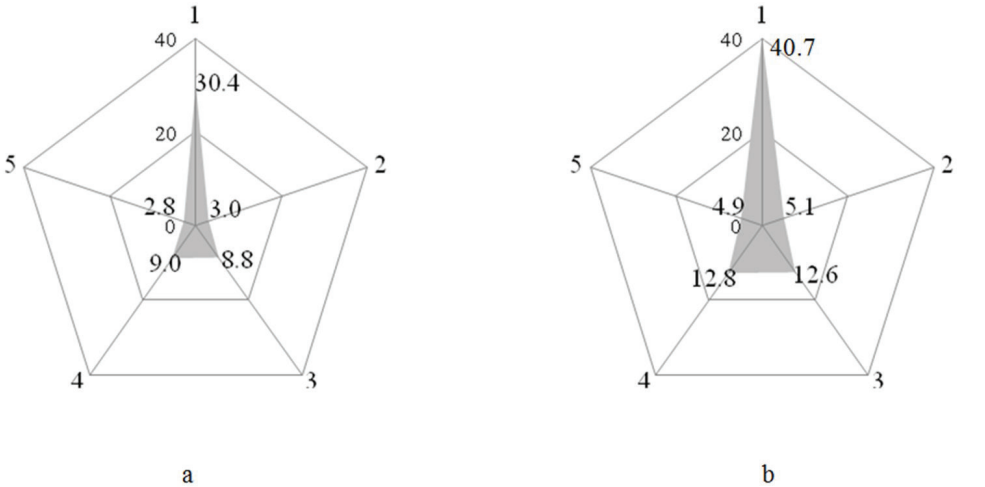

FIGURE 2. Model of segmental body muscle mass (kg) of qualified volleyball players / female (a) and volleyball players / male (b) of the Ukrainian Super League. 1 – muscle mass in the trunk; 2 – muscle mass in the right arm; 3 – muscle mass in the right leg; 4 – muscle mass in the left leg; 5 – muscle mass in the left arm

The total body fat of qualified female volleyball players was 21.52±4.08% and male volleyball players– 11.42±2.22% ($p<0.05$). In particular, a part of the body fat was concentrated in the legs of the players (Fig. 1, a-b). It was noticeable that the content of fat component in the players' right leg was slightly higher than the fat content in the left leg (by 0.70% for women and 0.62% for men). In addition, there was more muscle mass in the left leg than in the right: 0.17 kg for both women and men (Figure 2, a-b). The content of fat component in the right arm was lower than in the left arm (0.42% for women and 1.23% for men), and the content of the muscle mass in the right arm exceeded its share in the left arm (0.24 kg in the women's team and 0.15 kg in the men's team).

In the structure of bone tissue the following components were distinguished: mineral component makes up about 50% of the total bone mass and provides its strength, organic component makes up 40% of the bone mass and ensures its elasticity, fluid – 10% makes up the vascular canals and cellular space (Platonov, 2013). The analysis of bone mass (mass of inorganic substance of bones) of the examined players (2.88±0.220.06 kg

by women and 3.90±0.390.11 kg by men, $p<0.05$) revealed a significant excess of the accepted by Tanita norms for women and men, who do not play sports.

The total body water is the largest weight component of the body molecular level. Water plays the key role in many processes in the body: it is contained in every cell, tissue and organ; regulates body temperature, delivers essential nutrients to all organs, removes slag. According to the results of our study, the total body water of female volleyball players was 57.13±2.980; 90% and of male volleyball players – 63.06±3.02% ($p<0.05$), which was higher than the norm for women and men, who don't play any sports.

Discussion

The determination of model indicators with the subsequent development of the models of morpho-functional status of qualified athletes at different stages of annual and long-term training creates preconditions for sports improvement in the selected kind of sport due to the organization of selection and orientation, evaluation of readiness for achievement of high sports results, creation of conditions for effective training (Byoung – Goo & Kim, 2005; Kostiukevych et al., 2018). In the context of the above mentioned the model morpho-functional characteristics of qualified Ukrainian male and female volleyball players are innovative and make a significant contribution to the development of Ukrainian volleyball.

According to Wilmore, Costill and Kenney (2012) the body composition of the athlete provides more accurate information about his abilities than the height and weight of the athlete. Excessive body weight of the athlete is usually not a particular problem, while the excess of the body fat usually has a negative effect on the athletic performance. The comparison of the obtained results with the previous ones, in such items as height and body mass, body mass index, total body fat and muscle mass, the total body water showed that the indicators of Ukrainian male and female volleyball players do not differ significantly from the indicators of the players of the leading national teams and volleyball clubs (Malý, Malá, Zahálka, Baláš, & Čada, 2011; Abazi, Milenkovski, Telai, & Zivkovic, 2017; Konstantinos, Panagiotis, & Ioannis, 2019). This speaks for the considerable potential of the Ukrainian athletes, the availability of the reserved functional resources for the future realization in the process of long-term training.

Quite young age of the players, but, at the same time, the high indices of groups' variation of the examined athletes indicate a significant difference in the age between young and experienced players. This proves the relevance of the idea that three generations of players namely young, middle-aged, veterans are to be present in the sports full team (Zhelezniak et al., 2004; Stroganov et al., 2020).

The results of the research conducted by Kutáč and Sigmund (2017) based on the peculiarities of the distribution of fat and muscle components in the body segments (arms, legs and trunk) of qualified volleyball players (male and female) were updated in our research. In particular, the extremely intense skewness of the distribution of fat and muscle components in the athletes' legs and arms was confirmed, which relates to the nature of the movement activity of players in the volleyball game (all the examined athletes were right-handers). Thus, more load on the left leg while performing a stopping step and repulsion during attack hits cause more content of the muscular component in the left leg compared to the right and, at the same time, greater content of the fat component in the right leg than in the left one. The specificity of the performance of technical elements in volleyball – attack hits, serving, passing, etc., which players mainly perform with the help of the leading right hand, causes the redistribution of the components of the body in the leading arm: the increase of muscle component and reduction of fat.

The significant excess of bone mass (mass of inorganic substances of bones) for women and men, who do not go in for sports, in the examined athletes is also proved by Platonov (2013) and correspond with Tanita norms. This axcess concerns the adaptation of bone tissue under the influence of physical activity, which is manifested in the increase of bone mass and bone strength.

The results of our research confirm the data, that were described in the studies of Nikolaev, Smirnov, Bobrinskaia and Rudnev (2009) concerning the total body water, which may exceed the norm by 5% for average women and men who do not play sports. This stems from the muscle mass of athletes.

Conclusions

Generalization of the scientific literature has shown that the prediction of sports results of athletes becomes possible, among other things, on the basis of their constitutional features. At the same time, of great interest is the body composition, which provides comprehensive information about the athletes' resources. In addition, the analysis of the body composition of athletes also allows to correct the training influences in the training process.

In the process of anthropometric measurement and morpho-functional diagnostics (based on bioelectric impedance) of qualified male and female volleyball players 18 indicators that characterize the constitution and body composition of the athletes' were differentiated. The analysis of the obtained data showed a slight skewness in the distribution of fat and muscle components in the athletes' legs and arms, which was related to the nature of volleyball game.

The significant potential of the Ukrainian volleyball players, the reserved functional resources availability, the content of fat and muscle components in the body, which are not significantly different from the similar indicators of the players of the leading national teams and professional volleyball clubs are proved by the anthropometric indicators of the examined athletes.

As qualified athletes are considered to be ideal models in the chosen sport, the obtained indicators of the body composition of the male and female volleyball players of the Ukrainian Super League can be characterized as model and serve as a guideline for assessing the youth perspectives.

The direction for further scientific research is seen in the determination of the model morpho-functional indicators of the athletes of team game sports at the stages of long-term preparation.

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Conflict of Interest
The authors declare that there are no conflicts of interest.

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Revised September 2019

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Body Composition of Elite Soccer Players from Montenegro

Original Scientific Paper

Elite Soccer Players from Montenegro

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E-mail: jovan@ucg.ac.me

Word count: 2,946

Abstract word count: 236

Number of Tables: 3

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Duffield, R., & Marino, F. E. (2007). Effects of pre-cooling procedures on intermittent-sprint exercise performance in warm conditions. *European Journal of Applied Physiology, 100*(6), 727-735. doi: 10.1007/s00421-007-0468-x

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Thesis and dissertation:

Pyun, D. Y. (2006). *The proposed model of attitude toward advertising through sport.* Unpublished Doctoral Dissertation. Tallahassee, FL: The Florida State University.

Book:

Borg, G. (1998). *Borg's perceived exertion and pain scales*: Human kinetics.

Chapter of a book:

Kellmann, M. (2012). Chapter 31-Overtraining and recovery: Chapter taken from Routledge Handbook of Applied Sport Psychology ISBN: 978-0-203-85104-3 *Routledge Online Studies on the Olympic and Paralympic Games* (Vol. 1, pp. 292-302).

Reference to an internet source:

Agency. (2007). Water for Health: Hydration Best Practice Toolkit for Hospitals and Healthcare. Retrieved 10/29, 2013, from www.rcn.org.uk/newsevents/hydration

2.5. Tables

All tables should be included in the main manuscript file, each on a separate page right after the Reference section.

Tables should be presented as standard MS Word tables.

Number (Arabic) tables consecutively in the order of their first citation in the text.

Tables and table headings should be completely intelligible without reference to the text. Give each column a short or abbreviated heading. Authors should place explanatory matter in footnotes, not in the heading. All abbreviations appearing in a table and not considered standard must be explained in a footnote of that table. Avoid any shading or coloring in your tables and be sure that each table is cited in the text.

If you use data from another published or unpublished source, it is the authors' responsibility to obtain permission and acknowledge them fully.

2.5.1. Table heading

Table heading should be written above the table, in Title Case, and without a full stop at the end of the heading. Do not use suffix letters (e.g., Table 1a, 1b, 1c); instead, combine the related tables. *See* example:

- ✓ **Table 1.** Repeated Sprint Time Following Ingestion of Carbohydrate-Electrolyte Beverage

2.5.2. Table sub-heading

All text appearing in tables should be written beginning only with first letter of the first word in all capitals, i.e., all words for variable names, column headings etc. in tables should start with the first letter in all capitals. Avoid any formatting (e.g., bold, italic, underline) in tables.

2.5.3. Table footnotes

Table footnotes should be written below the table.

General notes explain, qualify or provide information about the table as a whole. Put explanations of abbreviations, symbols, etc. here. General notes are designated by the word *Note* (italicized) followed by a period.

- ✓ *Note.* CI: confidence interval; Con: control group; CE: carbohydrate-electrolyte group.

Specific notes explain, qualify or provide information about a particular column, row, or individual entry. To indicate specific notes, use superscript lowercase letters (e.g. $^{a, b, c}$), and order the superscripts from left to right, top to bottom. Each table's first footnote must be the superscript ^{a}.

- ✓ ^{a}One participant was diagnosed with heat illness and n = 19.^{b}n =20.

Probability notes provide the reader with the results of the texts for statistical significance. Probability notes must be indicated with consecutive use of the following symbols: * † ‡ § ¶ || etc.

- ✓ *P<0.05,†p<0.01.

2.5.4. Table citation

In the text, tables should be cited as full words. *See* example:

- ✓ Table 1 (first letter in all capitals and no full stop)
- ✓ ...as shown in Tables 1 and 3. (citing more tables at once)
- ✓ ...result has shown (Tables 1-3) that... (citing more tables at once)
- ✓ ....in our results (Tables 1, 2 and 5)... (citing more tables at once)

2.6. Figures

On the last separate page of the main manuscript file, authors should place the legends of all the figures submitted separately.

All graphic materials should be of sufficient quality for print with a minimum resolution of 600 dpi. SM prefers TIFF, EPS and PNG formats.

If a figure has been published previously, acknowledge the original source and submit a written permission from the copyright holder to reproduce the material. Permission is required irrespective of authorship or publisher except for documents in the public domain. If photographs of people are used, either the subjects must not be identifiable or their pictures must be accompanied by written permission to use the photograph whenever possible permission for publication should be obtained.

Figures and figure legends should be completely intelligible without reference to the text.

The price of printing in color is 50 EUR per page as printed in an issue of SM.

2.6.1. Figure legends

Figures should not contain footnotes. All information, including explanations of abbreviations must be present in figure legends. Figure legends should be written bellow the figure, in sentence case. *See* example:

- ✓ **Figure 1.** Changes in accuracy of instep football kick measured before and after fatigued. SR – resting state, SF – state of fatigue, *p>0.01, †p>0.05.

2.6.2. Figure citation

All graphic materials should be referred to as Figures in the text. Figures are cited in the text as full words. *See* example:

- ✓ Figure 1
  - × figure 1
  - × Figure 1.
  - ✓ ….exhibit greater variance than the year before (Figure 2). Therefore…
  - ✓ ….as shown in Figures 1 and 3. (citing more figures at once)
  - ✓ ….result has shown (Figures 1-3) that... (citing more figures at once)
  - ✓ ….in our results (Figures 1, 2 and 5)... (citing more figures at once)

2.6.3. Sub-figures

If there is a figure divided in several sub-figures, each sub-figure should be marked with a small letter, starting with a, b, c etc. The letter should be marked for each subfigure in a logical and consistent way. *See* example:

- ✓ Figure 1a
- ✓ …in Figures 1a and b we can…
- ✓ …data represent (Figures 1a-d)…

2.7. Scientific Terminology

All units of measures should conform to the International System of Units (SI).

Measurements of length, height, weight, and volume should be reported in metric units (meter, kilogram, or liter) or their decimal multiples.

Decimal places in English language are separated with a full stop and not with a comma. Thousands are separated with a comma.

Percentage	Degrees	All other units of measure	Ratios	Decimal numbers
✓ 10%	✓ 10º	✓ 10 kg	✓ 12:2	✓ 0.056
× 10 %	× 10 º	× 10kg	× 12 : 2	× .056

Signs should be placed immediately preceding the relevant number.		
✓ 45±3.4	✓ p<0.01	✓ males >30 years of age
× 45 ± 3.4	× p < 0.01	× males > 30 years of age

2.8. Latin Names

Latin names of species, families etc. should be written in italics (even in titles). If you mention Latin names in your abstract they should be written in non-italic since the rest of the text in abstract is in italic. The first time the name of a species appears in the text both genus and species must be present; later on in the text it is possible to use genus abbreviations. *See* example:

- ✓ First time appearing: *musculus biceps brachii*

Abbreviated: *m. biceps brachii*

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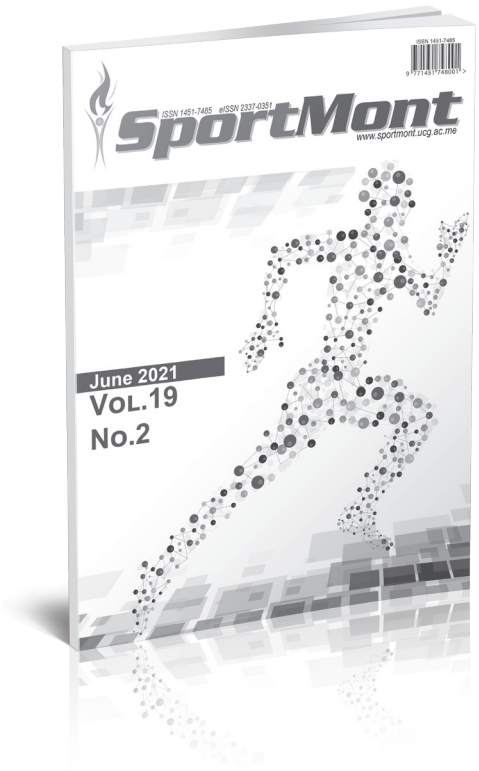

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SM is published three times a year, in February, June and October of each year. SM publishes original scientific papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in the fields of Sports Science and Medicine, as well as it can function as an open discussion forum on significant issues of current interest.

SM covers all aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

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Winter issue – February 2022
Summer issue – June 2022

MONTENEGRIN SPORTS ACADEMY

Founded in 2003 in Podgorica (Montenegro), the Montenegrin Sports Academy (MSA) is a sports scientific society dedicated to the collection, generation and dissemination of scientific knowledge at the Montenegrin level and beyond.

The Montenegrin Sports Academy (MSA) is the leading association of sports scientists at the Montenegrin level, which maintains extensive co-operation with the corresponding associations from abroad. The purpose of the MSA is the promotion of science and research, with special attention to sports science across Montenegro and beyond. Its topics include motivation, attitudes, values and responses, adaptation, performance and health aspects of people engaged in physical activity and the relation of physical activity and lifestyle to health, prevention and aging. These topics are investigated on an interdisciplinary basis and they bring together scientists from all areas of sports science, such as adapted physical activity, biochemistry, biomechanics, chronic disease and exercise, coaching and performance, doping, education, engineering and technology, environmental physiology, ethics, exercise and health, exercise, lifestyle and fitness, gender in sports, growth and development, human performance and aging, management and sports law, molecular biology and genetics, motor control and learning, muscle mechanics and neuromuscular control, muscle metabolism and hemodynamics, nutrition and exercise, overtraining, physiology, physiotherapy, rehabilitation, sports history, sports medicine, sports pedagogy, sports philosophy, sports psychology, sports sociology, training and testing.

The MSA is a non-profit organization. It supports Montenegrin institutions, such as the Ministry of Education and Sports, the Ministry of Science and the Montenegrin Olympic Committee, by offering scientific advice and assistance for carrying out coordinated national and European research projects defined by these bodies. In addition, the MSA serves as the most important Montenegrin and regional network of sports scientists from all relevant subdisciplines.

Over the years the Montenegrin Sports Academy (MSA) has established a productive pool of vital partnerships within the sports science related industry. Apart from two-way visibility, these partnerships provide mutual exchange of scientific research and competence.

Most of the MSA activities and services it provides would not be possible without the continuous support of its partners.

The Montenegrin Sports Academy very much appreciates the support of:

Ministry of Science of Montenegro
Ministry of Education of Montenegro
Ministry of Health of Montenegro
University of Montenegro
Montenegrin Olympic Committee
Institute of Public Health of Montenegro
European College of Sports Science
Volleyball Federation of Montenegro
Faculty for Sport and Physical Education a University of Montenegro
Athletic Federation of Montenegro
Regional Diving Center
Karate Federation of Montenegro
Karate club "Budućnost"
Football Club "Sutjeska"
Football Club "Mladost"
Water Polo and Swimming Association of Montenegro

The main scientific event organized by the Montenegrin Sports Academy (MSA) is the annual conference held in the first week of April.

Annual conferences have been organized since the inauguration of the MSA in 2003. Today the MSA conference ranks among the leading sports scientific congresses in the Western Balkans. The conference comprises a range of invited lecturers, oral and poster presentations from multi- and mono-disciplinary areas, as well as various types of workshops. The MSA conference is attended by national, regional and international sports scientists with academic careers. The MSA conference now welcomes up to 200 participants from all over the world.

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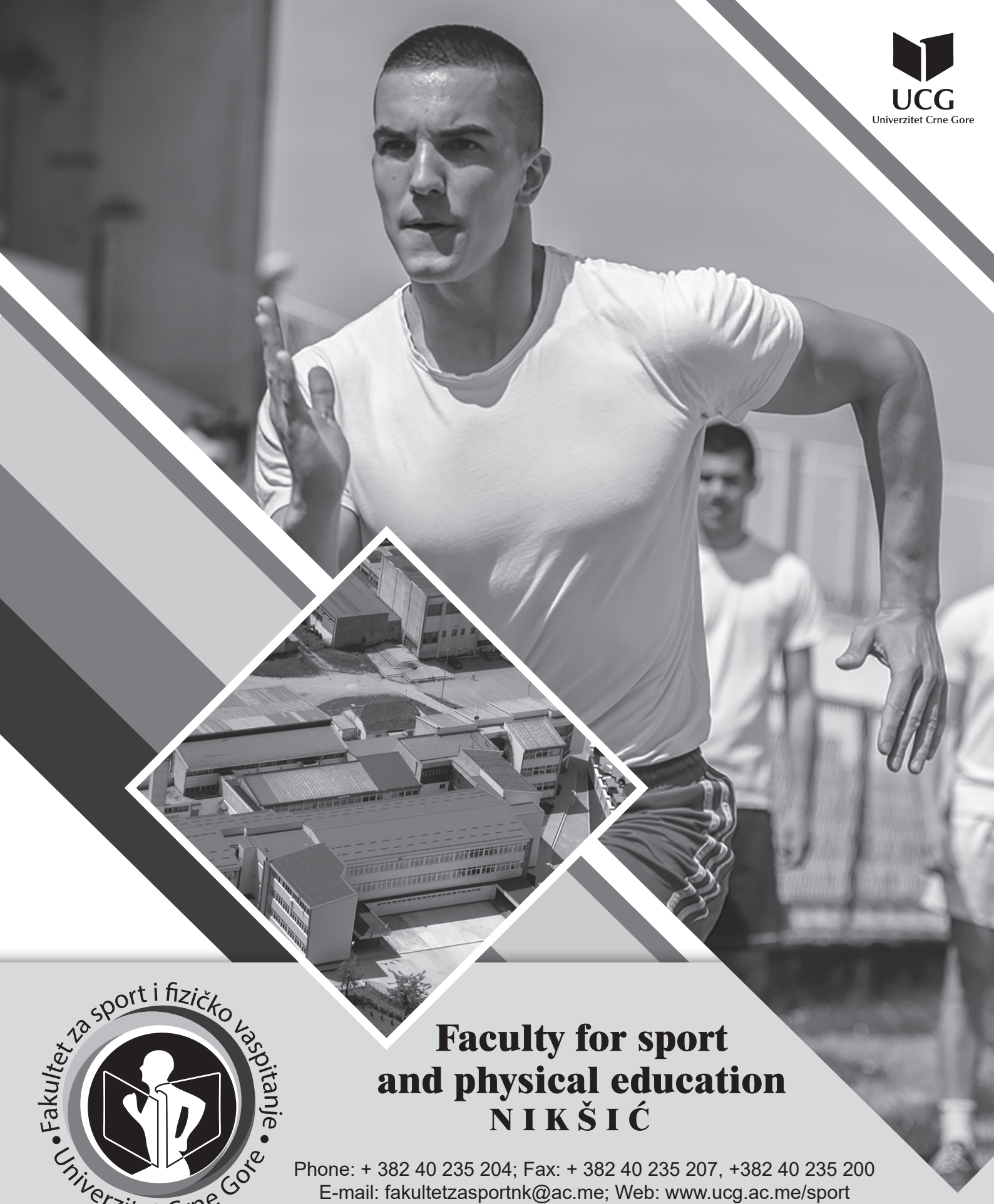
MONTENEGRIN OLYMPIC COMMITTEE



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Montenegrin Journal of Sports Science and Medicine

MONTENEGRIN JOURNAL OF SPORTS SCIENCE AND MEDICINE

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MJSSM is published biannually, in September and March of each year. MJSSM publishes original scientific papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in the fields of Sports Science and Medicine, as well as it can function as an open discussion forum on significant issues of current interest.

MJSSM covers all aspects of sports science and medicine; all clinical aspects of exercise, health, and sport; exercise physiology and biophysical investigation of sports performance; sport biomechanics; sports nutrition; rehabilitation, physiotherapy; sports psychology; sport pedagogy, sport history, sport philosophy, sport sociology, sport management; and all aspects of scientific support of the sports coaches from the natural, social and humanistic side.

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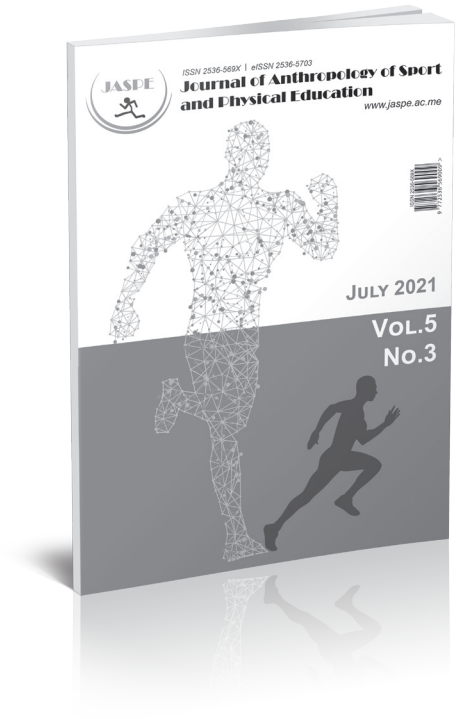
Autumn issue – September 2022

Journal of Anthropology of Sport and Physical Education



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- Post-publication tools to indicate quality and impact;
- Community-based dialogue on articles;
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JASPE is published four times a year, in January, April, July and October of each year. JASPE publishes original scientific papers, review papers, editorials, short reports, peer review - fair review, as well as invited papers and award papers in the fields of Anthropology of Sport and Physical Education, as well as it can function as an open discussion forum on significant issues of current interest.

JASPE covers all aspects of anthropology of sport and physical education from five major fields of anthropology: cultural, global, biological, linguistic and medical.

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Bojan MASANOVIC, *Editor-in Chief – bojanma@ucg.ac.me*

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EAPA-BCH

SCIENTIFIC PROJECT

Efekti autofagije i fizičke aktivnosti na tjelesnu kompoziciju, indeks tjelesne mase, stres, zdravstveno ponašanje, kognitivne sposobnosti i društvenu uključenost starijih osoba

(Projekat finansiran od strane Ministarstva nauke, direktorijata za mlade, a koji sprovodi Fakultet za sport i fizičko vaspitanje Univerziteta Crne Gore)

Glavni cilj projekta je da se primjenom naprednih praksi utvrde efekti autofagije i fizičke aktivnosti na tjelesnu kompoziciju, indeks tjelesne mase, trenutni nivo doživljaja stresa, zdravstveno ponašanje, kognitivne sposobnosti i nivo društvene uključenosti starijih osoba.

Projekat ima i svoj radni dio koji podrazumijeva organizovanje besplatnog vježbanja starijim osobama 3 puta nedeljno u trajanju od 6 mjeseci.

Učesnici mogu biti sve osobe iznad 50 godina a prijave se primaju na mail adresu fakultetzasportnk@ucg.ac.me i telefon fakulteta +38240235207. Svi su koji žele da uzmu aktivno učešće u ovom projektu koji njima može unaprijediti život, a naučnoj zajednici Crne Gore može donijeti značajna teorijska znanja koja će se u budućnosti koristiti u praktične svrhe su dobrodošli.

Svim učesnicim će na početku biti ponuđena najsavremenija dijagnostika, koja će im pružiti uvid u vlastito zdravstveno stanje, kako fizičko tako i kada su neki psihološki parametri u pitanju. Nakon toga će učesnici biti prema sopstvenim interesovanjima podijeljeni u grupe koje će raditi prema različitim programima.

1. Prva grupa će vježbati 3 puta nedeljno 6 mjeseci u prostorijama Fakulteta za sport i fizičko vaspitanje.

2. Druga će samo primjenjivati izmijenjeni način ishrane i voditi tačnu evidenciju o stepenu poštovanja zadataka koji im se postave. Ishrana će biti takva da se napravi pauza u unošenju hrane u trajanju 16 sati između poslednjeg dnevnog obroka i prvoga obroka u sledećem danu, a sve u cilju pokretanja procesa Autofagije koji ima blagotvorno dejstvo na organiza.

3. Treća grupa će kombinovati vježbanje i izmijenjenu ishranu, tj. biće kombinacija prethodno pomenutih zadataka.

4. Četvrta grupa će biti kontrolna. Njeni članovi će proći dijagnostiku i pomoći da se utvrdi kakve su prirodne promjene u organizmu za pomenuti šestomjesečni period, odnosno da li ih ima.

Svim prijavljenim osobama, koje imaju interesovanje za to, će prije poćetka rada biti održana dva predavanja o pomenutom izmijenjenom načinu ishrane koji danas postaje sve popularniji u svijetu pa ga primjenjuju i vrhunski sportisti poput Novaka Đokovića.

Još jednom treba napomenuti da će svaka od 4 grupe na poklon dobiti najsavremeniju dijagnostiku kompletnog psihofizičkog stanja koja je inače i nedostupna i skupa.

Prijavljivanje može da počne odmah, broj učesnika za grupe koje bi vježbale u prostorijama fakulteta je ograničen.

VLADA CRNE GORE
MINISTARSTVO NAUKE

Fakultet za sport i fizičko vaspitanje • Univerzitet Crne Gore •

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