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Study of the reaction of the choice of combat athletes using computer technology

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Abstract

Purpose: to develop a methodology for evaluating the reaction of the choice of combat athletes using computer technologies and to conduct research on testing and determining its validity.

Materials and methods: the total number of participants in the study was 77 people (mean age: 13.8±0.7 years, 28% girls, 72% boys). To evaluate the choice reaction, the computer program «Visuomotor Choice Reaction» for mobile devices was developed and implemented. The following methods have been studied: analysis of scientific and methodological information and Internet sources; summarizing best practices; computer programming method; methods of mathematical statistics.

Results: the study was carried out in three stages. At the first stage, the correspondence of the selected colors and shapes to the tasks that should be solved during the test was determined. Measuring the speed of response to a single color and to individual shapes showed that the values are evenly distributed, the range of variation for the response to color was 50,7 ms, and the response to shapes was 133,4 ms. At the second stage, indicators of the reaction of choice were obtained and the operation of the computer program was tested in the "field conditions". The practical application of the program made it possible to obtain indicators of the reaction of the choice of taekwondo novice athletes and determine the stability of its work. The obtained data of the third stage determined the reliability and validity of the proposed method for assessing the reaction of choice.

Conclusions: based on the analysis of scientific and methodological literature and the competitive activity of martial artists of various specializations, conversations with coaches and qualified athletes, a computer program «Visuomotor Choice Reaction» was developed to assess the choice reaction. According to the results of the study of the reaction of choice of taekwondo novice athletes using the proposed methodology, in order to test it, it can be argued that the «Visuomotor Choice Reaction» computer program allows you to obtain indicators of sensorimotor reactions, is simple and reliable when using it. According to the results of the correlation and dispersion analysis, it can be argued that the proposed method for assessing the choice reaction is reliable and has a significant level of validity and meets all metrological requirements.

Анотація

В'ячеслав Романенко, Світлана П'ятисоцька, Юрій Тропін, Лукаш Ридзік, Наталія Бойченко. Дослідження реакції вибору єдиноборців з використанням комп'ютерних технологій. Мета: розробити методику оцінки реакції вибору єдиноборців з використанням комп'ютерних технологій та провести дослідження щодо апробації та визначення її валідності. **Матеріал, учасники та методи.** Загальна кількість тих, хто приймав участь у дослідженні склало 77 осіб (середній вік: 13,8±0,7 років, 28% дівчата, 72% хлопці). Для оцінки реакції вибору було розроблено та впроваджено комп'ютерну програму «Visuomotor Choice Reaction» для мобільних пристроїв. В дослідженні використані наступні методи: аналіз науково-методичної інформації та джерел інтернету; узагальнення передового практичного досвіду; метод комп'ютерного програмування; методи математичної статистики. **Результати:** дослідження було проведено в три етапи. На першому етапі було визначено відповідність обраних кольорів та фігур завданням, які треба вирішувати протягом тесту. Вимірювання швидкості реагування на окремий колір і на окремі

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фігури показало, що значення розподілені рівномірно, размах варіації для реакції на колір складало 50,7 мс, а для реакції на фігури 133,4 мс. На другому етапі були отримані показники реакції вибору та перевірка роботи комп'ютерної програми в «польових» умовах. Практичне застосування програми дозволило отримати показники реакції вибору таеквондистів-новачків та визначити стабільність її роботи. Отримані дані третього етапу визначили надійність та валідність запропонованої методики оцінки реакції вибору.

Висновки. На підставі аналізу науково-методичної літератури та змагальної діяльності єдиноборців різних спеціалізацій, бесід з тренерами та кваліфікованими спортсменами було розроблено комп'ютерну програму «Visuomotor Choice Reaction» для оцінки реакції вибору. За підсумками дослідження реакції вибору таеквондистів-новачків з використанням запропонованої методики, з метою її апробації, можна стверджувати, що комп'ютерна програма «Visuomotor Choice Reaction» дозволяє отримувати показники сенсомоторних реакцій, проста та надійна при її застосуванні. За результатами проведеного кореляційного та дисперсійного аналізу можна стверджувати, що запропонована методика оцінки реакції вибору є надійна та має значимий рівень валідності та відповідає усім метрологічним вимогам.

Introduction

Visual sensorimotor reactions (simplified, simple, complex, combined) are used in psychophysiological diagnostics to determine the balance of the main nervous processes - excitation and inhibition, as well as to determine the state of a person's psychomotor development (Plokhikh, 2021).

Sensorimotor reactions reflect the unity of neurophysiological and mental processes and the interaction of sensory and motor components in the performance of all types of human mental activity. On the basis of sensory and kinesthetic information coming from the analyzers, the launch, regulation, control and correction of all types of psychomotor and the formation of cognitive functions in the process of individual human development are carried out. Coordination of sensory and motor components of a motor act has an expediently adaptive nature and at the same time is the most important condition for optimal interaction and functioning of the brain analyzer systems, which is the basis for the formation of adequate images of the surrounding world. When performing sensorimotor tests, the subject is usually offered various visual stimuli and the parameters of the person's extremely fast response to the action of the stimulus are recorded by a simple act predetermined by the experimenter (Malhazov, 2002).

Complex visual-motor reaction (CVMR) - the choice reaction is a type of complex sensorimotor reactions and, unlike a simple visual-motor reaction (SVMR), carried out to one light stimulus, registers the responses of a person to the presentation of several different light stimuli. According to this procedure, the process of information processing in the visual sensory system proceeds not only according to the principle of determining the presence or absence of a light signal by a person, but also according to the principle of distinguishing visual sensory stimuli by selecting a signal of the corresponding color (Malhazov, 2009).

Human cognitive activity largely depends on the functional state of the visual sensory system and the integrative activity of the brain. Due to the more complex cognitive process of information processing in the visual sensory system, the latent

periods of the CVMR are longer in duration than the speed of the SVMR, that is, the time spent by the subject on the implementation of the motor act during the discrimination reaction is greater compared to a simple visual-motor reaction (Navroc'ka et al., 2017).

One of the most important indicators of effectiveness for athletes in martial arts is neuromuscular conduction and the dynamics and speed of muscle reaction associated with it. In this case, the advantage in the speed of response to various stimuli that differ in shape, size, color, etc is especially important. (Korobejnikova et al., 2021; Smyrnovs'kyj, 2017). For effective diagnostics of this type of reactions, it becomes necessary to create a standardized complex test task. It is most expedient to use special computer programs for its implementation, which, on the one hand, can be universal for many sports that require the manifestation of a complex visual-motor reaction, and on the other hand, the most appropriate types of reactions in martial arts. It should also be noted that the use of software products based on the most reliable operating systems and computer devices to date will make it possible to standardize the testing procedure as much as possible and minimize errors (Pjatisockaja et al., 2020).

The activity of an athlete in a competitive duel is associated with the constant influence on the visual analyzers of various constantly changing visual signals, namely the position of the arms, legs, torso of the opponent, the color of sports equipment, the color of the areas of the site (dayang, tatami, wrestling mat) where the duel takes place and others. Therefore, it is important for a martial artist to accurately and quickly recognize visual stimuli both in color and in shape.

Choice reaction is a person's ability to make the choice of an adequate response to a variety of stimuli as soon as possible in conditions of time and space deficit (Gucul, 2017; Rovnyj & Romanenko, 2016). This kind of complex reaction is very important in a sports duel. It allows the athlete to form rational attacking or counterattacking actions depending on the situation.

When implementing the reaction of choice, the information processing process takes place, including the reception of the signal, its analysis, the adoption of an execution strategy for its implementation, the implementation of this decision, and the motor act itself. This is due to the complex analytical-synthetic activity of the brain and the "switching on" of a different number of brain structures. The implementation of a complex reaction requires the inclusion of many functional units of the brain. The more difficult the task, the more these units are formed (Makar-enko et al., 2018).

For a more detailed assessment of the reaction of the choice of combatants, it is necessary, when performing a test task, to create conditions that are close, in terms of their influence on the sensory mechanism of an athlete, to the conditions of a competitive duel.

Purpose of the study: to develop a methodology for evaluating the reaction of the choice of combat athletes using computer technology and to conduct a study to test and determine its validity.

Material and Methods of the research

Participants

The total number of participants in the study was 77 people (mean age: 13,8±0.7 years, 28% girls, 72% boys). The pedagogical research was carried out in three stages. The first stage involved 30 people of all ages (mean age: 17,8±1,43 years) and gender (girls 28%, boys 72%). Among the participants were those who are engaged in martial arts and not. In the study

at the second stage, novice taekwondo athletes ($n=30$, average age: $9,9\pm 0,31$ years, girls 23%, boys 77%) took part in the «Vulkan» Sports School of the Cherkasy City Council. The third stage was attended by persons of different genders ($n=17$, average age: $13,7\pm 0,58$ years, girls 35%, boys 65%), those who are engaged in martial arts and not.

All participants verbally consented to the study and were made aware of the purpose and procedures for testing and the possibility of withdrawing consent at any time for any reason. Participants under the age of 18 had their parents' consent to participate and were present during the study.

The study was conducted in compliance with the main bioethical provisions of the Council of Europe Convention on Human Rights and Biomedicine (dated April 4, 1997), the World Medical Association Declaration of Helsinki on ethical principles for medical research involving humans (1964–2008), as well as the Ministry of Health Ukraine No. 690 dated 09/23/2009

Methods

The following methods were used in the study: analysis of scientific and methodological information and Internet sources; summarizing best practices; computer programming method; methods of mathematical statistics.

Procedure

To assess a complex visual-motor reaction, a choice reaction, a computer program “Visuomotor Choice Reaction” was developed and implemented for mobile devices of the company Apple (iPad, iPhone, iPod).

As mentioned above, the pedagogical research was carried out in three stages. At the first stage, an algorithm for test tasks was developed and the features of the reaction to color and shape were determined. At the second stage, the developed methodology was tested. The indicators of the reaction of the choice of taekwondo novice athletes and general impressions about the work of the computer program in the “field conditions” were obtained. At the third stage, initial and repeated testing was carried out. A second test was performed three weeks after the first test. The reliability and validity of the proposed method for evaluating the reaction of choice has been determined.

Statistical analysis of the obtained data was performed using the STATISTICA program. To select the method of statistical analysis, the test results were checked for compliance with the normal distribution law using the Kolmogorov-Smirnov criterion. Spearman's rank correlation coefficient was used to determine the relationship between the results of the initial and repeated testing. The Kruskal-Wallis test was used to determine the reliability of the test (Bazylevych, 2016; Bezverhnja, 2011).

Results of the research

Based on the analysis of scientific and methodological literature (Kozina et al., 2011; Lyzohub et al., 2021; Podrigalo et al., 2017), analysis of the competitive activity of combatants of various specializations, conversations with coaches and qualified athletes, the computer program “Visuomotor Choice Reaction” to assess a complex visual-motor reaction, a reaction of choice.

The program “Visuomotor Choice Reaction” has the following options for conducting test tasks. Firstly, it is the ability to select the number of attempts at the stage (from 5 to 20). There is also the presence of the “Demo” mode, which offers the order of passing the test for review (2 attempts at each stage).

The “Visuomotor Choice Reaction” program has three test modes:

1. Test tasks that include responding to color and shapes;
2. Test tasks that include responding only to color;

3. Test tasks that contain responses only to shapes.

In each mode, you can select the time of occurrence of visual stimuli: 3...5 s; 2...5 s, 2...6 s, 3...8 s.

The first mode of the test is the main one, and the subsequent ones can be considered as training ones.

The test task (the first test mode) is divided into four stages, according to the principle from simple to complex, in terms of the impact on the sensory system. The reaction time for the shapes will be longer because there will also be more details that require reflection. The first stage is the response to colored stimuli, the second stage is the response to colored stimuli when counteracting the disruptive stimuli, the third stage is the response to the shapes, the fourth stage is the response to the shapes while counteracting the disruptive stimuli.

Based on a study of the competitive activity of combatants (Romanenko, Tropin, Kulida, 2021), the duration between active actions in a sports duel ranges from 3 s to 8 s. The time of occurrence of visual stimuli in the computer program was chosen in the range from 3 s to 5 s, which made it possible to obtain the required duration of the entire test. The duration of the test, with 10 attempts per stage (about 40 attempts for the entire test) is about 3 minutes, which corresponds to the duration of the round in many types of martial arts.

The stimuli that bring down these are colored balls or figures. During the stage, they randomly move across the screen of the mobile device at different speeds and image intensities (from 20 to 90%). The range of values for the emergence and changes of stimuli that confuse is selected from 0,2 s to 2,0 s. The duration of the movement of stimuli along random coordinates is 0,3 s, which ensures sufficient dynamics of their movement on the screen of a mobile device. The choice of colors of visual stimuli (Figure 1) used to create a computer program (yellow, green, red, blue and gray) was made based on the principles of color theory.



Fig. 1. Meaning of yellow color (DCI-P3 standard)

Johannes Itten (Swiss expressionist, artist, designer, teacher, writer and theorist). According to this theory, there are three primary colors: red, yellow and blue. The remaining colors of the color wheel are formed by mixing these three in different proportions (Simon, 2003).

When mixing colors according to the additive model, in addition to red and blue, there is also green. Gray is an achromatic color (colorless color), more precisely, the set of all colors obtained by combining red, green and blue in equal concentrations.

Color saturation was chosen experimentally. Saturation is the intensity of a certain tone, that is, the degree of visual dif-

ference between a chromatic color and an achromatic (gray) color equal in light. The intensity of a certain tone can be called «juicy», «deep», less saturated - «muffled», close to gray (Simon, 2003). The intensity of the tone of each color in the computer program is set in such a way that the visual perception of stimuli is at the same level.

According to the DCI-P3 (color space) standard, the color was set at (Figure 1): yellow - R: 254, G: 250, B: 83; blue - R: 90, G: 10, B: 246; green - R: 95, G: 199, B: 59; red - R: 234, G: 64, B: 37; gray - R: 169, G: 168, B: 169.

As mentioned above, the implementation of a complex reaction requires the inclusion of many functional units of the brain, the more difficult the task, the more of these units are formed, therefore, volumetric shapes were chosen as shapes for the test task, which have more various details for visual comprehension (Figure 2). The following shapes were chosen for the test task: Cylinder, Octahedron, Cube, Sphere, Square Pyramid. These figures are the most recognizable. The color of the figures was chosen to be gray as an achromatic color so that the test taker reacts to the figure and not to the color.

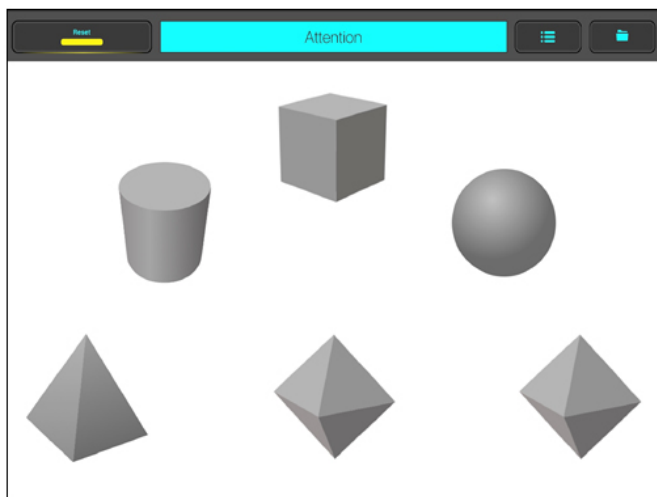


Fig. 2. Visual stimuli, shapes

The first stage of the study was devoted to determining the correspondence of the selected colors and shapes to the tasks that need to be solved during the test.

Measuring the speed of response to a single color and to individual shapes showed that the values are evenly distributed, the range of variation for the response to color was 50.7 ms, and the response to shapes was 133,4 ms, which may indicate that the user perceives visual stimuli fairly evenly (Figure 3).

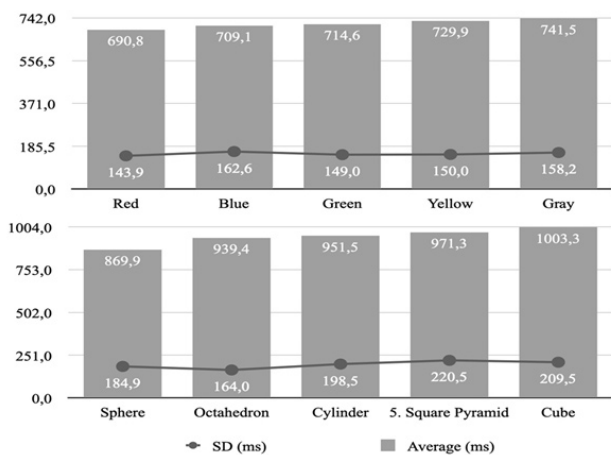


Fig. 3. Reaction time for colors and shapes

The response to the “Sphere” figure was 869.9 ms, this is confirmation that the response to an object that has less details for identification will be better than the response to more complex objects (Square Pyramid, Cube).

At the second stage, a pedagogical study was organized, the purpose of which was to obtain indicators of the choice reaction and to test the operation of the computer program “Visuomotor Choice Reaction” in the “field conditions”.

Table 1

Results of pedagogical testing of taekwondo novice athletes (n=30)

Stage	Time (ms) $\bar{X} \pm m$	SD (ms)	Error (n)
S1	815,0±47,7	151,0	0,20
S2	889,2±52,1	164,8	0,27
S3	1119,2±80,1	253,4	0,37
S4	1147,1±77,9	246,2	0,63

Note: stages of passing the test: S1 (first stage) is a reaction to color stimuli, S2 (second stage) is a reaction to color stimuli when counteracting distracting stimuli, S3 (third stage) is a reaction to shapes, S4 (fourth stage) reaction on the shapes under the counteraction of confounding stimuli

The testing methodology has a unified procedure for conducting and evaluating. To familiarize yourself with the test task in the computer program, there is a “Demo” mode that provides a clear and unambiguous understanding of the testing procedure by all its participants. As a result of testing the proposed methodology, it can be argued that it meets such a criterion as standardization.

To determine the reliability and validity of the proposed methodology for assessing the reaction of choice, a study was conducted. The results of the initial and repeated testing (n=17) were received. A second test was performed three weeks after the first test. During the study, the conditions for its conduct according to the regulations and requirements were clearly observed.

As for the reliability of devices (iPad, iPhone, iPod) on which you can install the “Visuomotor Choice Reaction” program, it can be argued that Apple’s mobile devices meet all user requirements regarding the accuracy and speed of measuring time intervals.

Also, the procedure for checking a software product before placing it in the App Store (mobile application store) provides the user with an additional guarantee for its use.

To select the method of statistical analysis, the test results were checked for compliance with the normal distribution law according to the Kolmogorov-Smirnov criterion. Since the results in the groups do not correspond to the law of normal distribution, Spearman’s rank correlation coefficient was used to determine the relationship between the results of the primary and secondary testing (Table 2). It was determined that the correlations are close between all stages of the test and are at a significant level ($p < 0,05$), which indicates a high level of reproducibility of the test results after a given period of time.

Further, for the analysis, the Kruskal-Wallis test was used - this is a non-parametric alternative to one-dimensional (between-group) analysis of variance. It allows to test null hypotheses, according to which different samples were taken from the same distribution, or from distributions with the same medians. This type of analysis is recommended by experts to determine

the reliability of the test (Bazylevych, 2016; Kostjukevych et al., 2016). The analysis was carried out separately to compare the results of each stage of the test with the retest (Table 3).

Table 2

Results of the correlation analysis according to the Spearman coefficient between groups after the primary and secondary testing

Stage	S1	S2	S3	S4
S1	0,685*	-	-	-
S2	-	0,761*	-	-
S3	-	-	0,877*	-
S4	-	-	-	0,723*

Note: * significance at $p < 0.05$. Stages of passing the test: S1 (first stage) is a reaction to color stimuli, S2 (second stage) is a reaction to color stimuli when counteracting distracting stimuli, S3 (third stage) is a reaction to shapes, S4 (fourth stage) reaction on the shapes under the counteraction of confounding stimuli.

Table 3

Comparison of the reaction time of choice between the individual stages of the test in the groups of primary and secondary testing according to the Kruskal-Wallis test

Stage	Primary (I) / Secondary (II)	Sum of Ranks	Mean Rank	Kruskal- Wallis test (H)	P
S1	I	324,50	19,09	0,865	0,352
	II	270,50	15,91		
S2	I	310,50	18,26	0,201	0,654
	II	284,50	16,74		
S3	I	328,50	19,32	1,140	0,286
	II	266,50	15,68		
S4	I	307,00	18,06	0,107	0,743
	II	288,00	16,94		

Note: Stages of passing the test: S1 (first stage) is a reaction to color stimuli, S2 (second stage) is a reaction to color stimuli when counteracting distracting stimuli, S3 (third stage) is a reaction to shapes, S4 (fourth stage) reaction on the shapes under the counteraction of confounding stimuli.

Since the reliability of all calculated Kruskal-Wallis coefficients turned out to be greater than the critical level ($p > 0.05$), it can be argued that there are no significantly significant differences in the distributions of the results of the primary and secondary testing of the choice reaction time at each of the test stages, taking into account internal and external group variation.

Discussion

Many scientists have studied the sensorimotor reactions of athletes in different sports, so Iermakov et al. (2016) compared the indicators of sensorimotor reactions in athletes of boxing and wrestling martial arts, on the basis of which they

established the most significant psychophysiological qualities for success in martial arts.

Korobejnikov et al. (2016) found a connection between the fighting styles of qualified boxers and psychophysiological characteristics.

Pervachuk et al. (2016) developed model characteristics of sensorimotor reactions and specific perceptions of qualified Greco-Roman wrestlers and offered practical recommendations for improving the training process.

Shevchenko et al. (2021) made a comparative analysis of the indicators of sensorimotor reactions of wrestlers and athletes of sports games with rackets.

Romanenko et al. (2022) conducted an analysis of the preparedness of highly qualified wrestlers based on the assessment of sensorimotor reactions, on the basis of which the characteristics of some aspects of the preparedness of athletes were formed.

Gorelov et al. (2021) in their research to analyze the benefits of sensorimotor response tests and the analysis of competitive progress in modern mixed martial arts.

Lyzohub and others. (2021) studied the speed characteristics of simple and complex visual-motor reactions of choosing one and choosing two excitatory and inhibitory signals to assess the individual typological properties of the central nervous system (CNS) in adolescents aged 10-11 years. The results of their research show that the speed characteristics of complex neurodynamic acts, in contrast to simple ones, can be used as quantitative characteristics of the typological properties of the CNS.

Korobejnikov et al. (2021) to assess the state of psychophysiological functions, they proposed the complex of psychodiagnostics "Multipsychometr-05" and found that the study of the psychophysiological state of wrestlers and the possibility of using this methodological complex should be used for the needs of current control.

Ouergui et al. (2021) investigated physiological and sensorimotor responses to taekwondo sessions depending on different zone sizes and sparring partners in a round.

Ceccarelli et al. (2019) conducted an analysis of self-compassion and psychophysiological recovery after the mentioned sports failure. It has been found that self-compassion promotes adaptive physiological and psychological responses in athletes to sports failure and may have implications for improved performance, recovery, and health outcomes. In addition, addressing athletes' fears of self-compassion may also be important to promote optimal psychological recovery.

Summing up, we can say that the process of training athletes of different sports should be based on the indicators of sensorimotor reactions. The conditions for conducting test tasks to determine sensorimotor reactions, if possible, should correspond to the conditions of the competitive activity of single combat athletes. The advantage of the proposed technique is that the computer program "Visuomotor Choice Reaction" during testing allows you to create conditions that more accurately reflect the activity of a single combat athlete in terms of their influence on sensory mechanisms. Also, the ability of the program to demonstrate visual signals, different in color or shape, will allow researchers to identify the characteristics of the perception of athletes of various sports and qualifications.

The method for evaluating the choice reaction proposed in this study can be recommended for use both in martial arts and in other sports that require this type of reaction, in particular sports games.

Prospects for further research will be aimed at assessing

the complex visual-motor reaction, the choice reaction of athletes in different sports.

Conclusions

The analysis of scientific and methodological information and the generalization of advanced practical experience made it possible to establish that martial arts are sports with a significant variability of motor activity and high requirements for the speed of response to the opponent's actions during the fight. Therefore, the diagnosis of the ability to respond quickly, especially in the face of distractions, is of great importance in pedagogical control.

Based on the analysis of scientific and methodological literature and competitive activity of martial artists of various specializations, conversations with coaches and qualified athletes, a computer program "Visuomotor Choice Reaction" was developed to assess the choice reaction.

According to the results of the study of the reaction of the choice of taekwondo novice athletes using the proposed methodology, with the aim of testing it, it can be argued that the "Visuomotor Choice Reaction" computer program allows you to

obtain indicators of sensorimotor reactions, is simple and reliable in its application.

According to the results of the correlation and dispersion analysis, it can be argued that the proposed method for assessing the choice reaction is reliable and has a significant level of validity and meets all metrological requirements.

Author Contributions

Vyacheslav Romanenko: collection, data entry, data analysis, manuscript preparation, statistics. Svitlana Piatysotska: design, data interpretation. Yuriy Tropin: data interpretation, analysis and literature search. Łukasz Rydzik: design, data interpretation. Valerii Holokha: design, study planning. Natalia Boychenko: research planning.

Conflicts of Interest

The authors declare no conflict of interest.

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Monitoring of morphological and functional indicators of taekwondo athletes aged 14–15 years

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Abstract

Purpose: comparative analysis of the manifestation of morphological and functional indicators of taekwondo athletes aged 14–15 years.

Material and Methods: The study involved 60 taekwondo athletes aged 14–15 years. Athletes' qualification 1-2 category. At least 5 years of experience in Taekwondo WTF. The assessment of morphological and functional indicators of taekwondo athletes was carried out at the age of 14 and 15 years.

Research methods: analysis and generalization of scientific, methodological and special literature, information on the Internet; anthropometric methods; index method; methods of mathematical statistics.

Results: The average body weight of taekwondo athletes aged 14-15 increased by 16,5%, and body length by 4,7%. The indicator of chest excursion increased by 4,8%, carpal dynamometry indicators of the left hand increased by 15,2%, the right hand - by 15,3%. 33,6% of 15-year-old athletes are underweight in terms of body mass index, 2,9% are overweight; 14 year olds: 21,56% underweight, 13,7% overweight. Athletes aged 14–15 have a normosthenic body type. According to the constitution of the physique, 7,84% of 14 year old athletes have a strong physique, 15,68% have a good physique, 5,88% have an average physique, 27,45% have a weak physique, 43,15% have a very weak one. 12,12% of 15-year-old taekwondo athletes have a strong physique, 24,24% have a good physique, 9,1% have an average physique, 24,24% have a weak body, and 30,3% have a very weak body. 13,7% of 14-year-old taekwondo athletes have good physical development, 3,9% - average, 76,4% - weak 15-year-old athletes: 17,6% - good physical development, 14,8% - average, 67,6% - weak.

Conclusions: The study of morphological and functional indicators is one of the important criteria for the training of taekwondo athletes, the use of indices allows you to move on to relative indicators, that is, to standardize anthropometric indicators and supplement them. This will contribute to the rational selection of means and methods of training athletes, taking into account their personal characteristics. Our research can be used in monitoring the functional state of athletes involved in taekwondo WTF.

Анотація

Ігор Пашков, Володимир Потоп, Вікторія Пашкова. Моніторинг морфофункціональних показників тхеквондистів 14–15 років. Мета: порівняльний аналіз прояву морфофункціональних показників тхеквондистів 14–15 років. **Матеріал і методи:** у дослідженні взяли участь 60 тхеквондистів у віці 14–15 років. Кваліфікація спортсменів 1–2 розряд. Стаж занять тхеквондо WTF не менш 5 років. Оцінка морфофункціональних показників тхеквондистів здійснювались у віці 14 та 15 років. **Методи дослідження:** аналіз і узагальнення науково-методичної та спеціальної літератури, інформації в мережі Internet; антропометричні методи; метод індексів, методи математичної статистики. **Результати:** Середній показник маси тіла тхеквондистів 14–15 років зріс на 16,5 %, а довжина тіла на 4,7 %. Показник екскурсії грудної клітини збільшився на 4,8 %, Показники кистьової динамометрії, лівої руки збільшилися на 15,2%, правої – 15,3%. 33,6 % 15 річних спортсменів мають недостатню масу тіла за показником індексу маси тіла, 2,9 % – надлишкову; 14 річні: 21,56 % недостатню масу тіла, 13,7 % – надлишкову масу тіла. Спортсмени 14–15 років мають нормостенічний тип статури. За конституцією будови тіла 7,84 % 14 річних спортсменів мають міцну статуру, 15,68 % – добру статуру, 5,88 % – середня, 27,45 % – слабку, 43,15 % дуже слабку. 12,12 % 15 річних тхеквондистів мають міцну статуру, 24,24 % – добру статуру, 9,1 % – середню, 24,24 % слабку, 30,3 % – дуже слабку. 13,7 % 14 річних тхеквондистів мають гарний фізичний розвиток, 3,9 % – середній, 76,4 %

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Ключові слова:

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індекси фізичного розвитку
довжина тіла
вага
кистьова динамометрія

– слабкий 15 річні спортсмени: 17,6 % – гарний фізичний розвиток, 14,8 % – середній, 67,6 % – слабкий. **Висновки:** Дослідження морфофункціональних показників є одним із важливих критеріїв підготовки тхеквондистів, застосування індексів дозволяє переходити до відносних показники, тобто стандартизувати антропометричні показники та доповнити їх. Це сприятиме раціональному підбору засобів та методів підготовки спортсменів з урахуванням їх індивідуальних особливостей. Наші дослідження можуть використовуватися у моніторингу функціонального стану спортсменів які займаються тхеквондо ВТФ.

Introduction

In the scientific and methodological literature, there are a large number of works devoted to the problem of analyzing the morphological and functional characteristics of athletes in martial arts, which is widely used in the analysis of the physical development of martial arts athletes (Banik, 2022; Holyaka & Hlukhov, 2018; Podryhalo et al., 2016; Podrihalo et al., 2020; Rovnyy et al., 2013).

The results of modern research allow us to conclude that the study of the morphological and functional characteristics of athletes should take into account the specifics of the sport. This will optimize the selection procedure and significantly increase the effectiveness of monitoring and predicting the success of performance in competitions (Holyaka & Hlukhov, 2018; Kotko et al., 2021; Platonov, 2020; Podryhalo et al., 2016; Rovnyy et al., 2013).

The study of the morphological and functional characteristics of athletes is common not only in martial arts: boxing, wrestling, taekwondo (Banik, 2022; Holyaka & Hlukhov, 2018; Hrubar, 2018; Podryhalo et al., 2016; Rovnyy et al., 2013; Strelchuk et al.,) but also in many sports: athletics, arm wrestling, football, etc. (Hrubar & Hrabyk, 2020; Kotko et al., 2021; Podrihalo et al., 2020; Podrigalo et al., 2017).

According to the results of the study (Rovnyy et al., 2013), anthropometric indicators (body length, body weight, arm span, leg length, chest coverage at rest, on inhalation, on exhalation) are the leading factors for athletes involved in taekwondo WTF. For example - an advantage in height and length of the limbs, allows you to conduct a sports fight at a long distance, effectively attack and be invulnerable to opponent's attacks.

Improving the quality of training of football players, the introduction into practice of effective means and methods of training indicate the need for special study and search for fundamentally new approaches to the organization of the training process. First of all, it is necessary to focus on stable, little-variable factors in the course of development, which correspond to morphological indicators (Hrubar & Hrabyk, 2020).

The results obtained allow us to state that the level of sportsmanship in armwrestling and kettlebell lifting is largely determined by the anthropometric features of development. The most convenient method is the calculation of physical development indices, which fairly quickly and objectively assess the level of physical development of athletes. The use of such indices can be used for preliminary selection of athletes in the section of strength sports, control of the level of physical preparedness (Podryhalo et al., 2007).

The data of morphological and functional indicators of athletes of different types of body constitution are of decisive importance in terms of solving the problem of improving various aspects of the sports training of wrestlers and rowers, taking into account their individual characteristics of physical develop-

ment (Serhiy Holyaka & Ivan Hlukhov 2018).

Without the use of morphological indicators, it is impossible to ensure the effectiveness of such components of the training process as: forecasting, control, reliability of selection and organization of various stages of long-term training of athletes. For the formation of motor skills of karatekas, their anthropometric data, primarily the longitudinal links of the body, are of great importance. The absolute and relative dimensions of individual parts of the body are of decisive importance for the improvement of sportsmanship and effective performance during sports competitions (Hrubar, 2018).

Determining the morphological and functional indicators of taekwondo athletes aged 14–15 years is important for building the training process and predicting the success of athletes in competitions.

Relationship of research with scientific or practical tasks, plans, programs. The study is carried out in accordance with the topic of the research work of the Kharkiv State Academy of Physical Culture for 2021–2025, “Optimization of the training process in martial arts” (state registration number 0121U112873).

Purpose of the study: a comparative analysis of the morphological and functional indicators of taekwondo athletes aged 14–15 years.

Material and Methods of the research

Members. The study involved 60 taekwondo athletes aged 14–15 years. Qualification of athletes 1-2 category. At least 5 years of experience in Taekwondo WTF. All participants agreed to participate in the study. Assessment of morphological and functional indicators of taekwondo athletes was carried out at the age of 14 and 15 years.

To solve the tasks set, the following **research methods** were used: analysis and generalization of scientific and methodological and special literature, information on the Internet; anthropometric methods; index method, methods of mathematical statistics.

To assess morphological and functional indicators, surveys were conducted in compliance with the basic requirements of unified anthropometric research methods, taking into account the recommendations of international standards for anthropometric assessment ISAK (Marfell-Jones et al., 2012).

During the study, morphological parameters were measured. For comparative analysis, anthropometric indicators were determined, traditionally used in the analysis of the physical development of athletes: body length (cm), body weight (kg), chest circumference (cm), inhalation and exhalation circumference and their difference (excursion) (cm), wrist dynamometry with both hands (kg).

To assess the physical development of taekwondo athletes, we used anthropometric indices: strength index of the right and left hands (%), body mass index (kg/m²), Pinier index (c.u.), Erisman index (cm), Verweck index (c.u.).

Statistical analysis of the obtained data was performed using the MS Excel (2010) licensed program. Descriptive statistics indicators were determined: arithmetic mean, standard deviation, error of the arithmetic mean (Antomonov, 2006).

Results of the research

An analysis of the morphofunctional parameters of taekwondo athletes aged 14–15 years (Table 1) showed that the average body weight of athletes increased by 16,5%, and body

length by 4,7%, which reflects the rapid period of development of athletes inherent in adolescence.

The indicators of development of the thorax of taekwondo athletes increase over the year, in particular: the circumference of the chest on inhalation increased by 5,4%, on exhalation – 4,5%, the difference between the circumference on inhalation and exhalation (excursion) increased by 4,8%, this is a reflection the fact that 15-year-old athletes have a more developed and mobile chest. This contributes to better ventilation of the lungs, so that athletes can endure a greater load.

Wrist dynamometry indicators in 15-year-old taekwondo athletes are higher compared to 14-year-olds, the left hand is 15,2% and the right hand is 15,3%.

Due to the fact that, according to many experts in the field of physical education and sports, anthropometric indicators do not fully reflect the physical development of athletes, therefore, we applied the index method. (Po dryhalo et al., 2021, Hrubar. 2018, Rovnyy et al., 2013).

The analysis of indices of physical development of taekwondo athletes (Table 2) showed that the average body mass indices of taekwondo athletes aged 14 and 15 are within the normal range. 33,6% of 15-year-old athletes are underweight, 2,9% are overweight, and 14-year-olds: 21,56% are underweight, 13,7% are overweight.

We have found that over the course of 14-15 years, athletes have a decrease in the strength index by 1,7% of the left and 1,2% of the right hand.

These indicators characterize a more rapid increase in body length in relation to body weight, with a tendency to stretching processes, in athletes 15 years old.

According to the average indicators of the Verweck index, where it is $0,87 \pm 0,01$ for 15-year-old taekwondo athletes and $0,93 \pm 0,01$ for cadets, both groups of athletes have a normos-thenic body type.

In 14-year-old athletes, the value of the Pinier index corresponds to such an assessment of the constitution of the physique: 7,84% have a strong physique, 15,68% have a good physique, 5,88% have an average physique, 27,45% have a weak, 43,15% have a very weak. In 15 year old athletes, the following indicators were revealed: 12,12% have a strong physique, 24,24% have a good physique, 9,1% have an average physique, 24,24% have a weak constitution, 30,3% have a very weak one.

The Erisman Index indicates that 14-year-old taekwondo athletes have a good physical development of 13,7%, 3,9% - average, 76,4% - weak. In 15-year-old athletes, these indicators are better: 17,6% good physical development, 14,8% - average, 67,6% - weak.

Discussion

The greatest contribution to the formation of the growth of the functional system of sportsmanship is characterized by anthropometric indicators (length and weight of the body, chest circumference, wrist dynamometry, shoulder width) (Podryhalo et al., 2016).

One of the important criteria for the preparation of athletes in any sport is anthropometric indicators, and the level of sportsmanship is determined by a large number of factors, among which a special place belongs to the structure of the athlete's body (Hrubar & Hrabky, 2020; Rovnyy et al., 2013).

Achieving great sports results in WTF taekwondo depends on the physical development and morphological and functional indicators of athletes. This is reflected in the work of Hrubar & Hrabky, 2020, which states that one of the important criteria for the preparation of athletes in any sport is anthropometric data, and the level of sportsmanship is determined by a large

Table 1

Morphological and functional indicators of taekwondo athletes

№	Indicators	Taekwondo athletes 14 years old		Taekwondo athletes 15 years old		
		$\bar{X} \pm m$	σ	$\bar{X} \pm m$	σ	
		1.	Body weight, kg	45,77±2,18	15,55	53,32±2,57
2.	Body length, cm	152,72 ±0,02	0,13	159,98 ±1,65	11,82	
3.	Chest circumference, cm	Inhale	81,31 ±1,29	9,19	85,86 ±1,26	9,06
		Exhale	74,09 ±1,16	9,19	78,29 ±1,09	7,83
		Excursion	7,19 ±0,22	1,58	7,54 ±0,24	1,77
		Pause	76,08 ±1,24	8,84	80,63 ±1,17	8,38
4.	Wrist dynamometry, kg	Right	20,31 ±0,89	6,36	23,42 ±0,91	6,45
		Left	17,89 ±0,93	6,68	20,61 ±1,54	7,53

Table 2

Indicators of indices of physical development of taekwondo athletes

№	Indicators	Taekwondo athletes 14 years old		Taekwondo athletes 15 years old		
		$\bar{X} \pm m$	σ	$\bar{X} \pm m$	σ	
1.	Body mass index, kg/m ²	19,11± 0,49	3,52	20,54 ±0,47	3,37	
2.	Pinier index, c.u.	30,86± 2,02	14,48	26 ±2,12	15,21	
3.	Erisman index, cm	-0,27± 0,75	5,42	0,65± 0,82	5,87	
4.	Strength Index, %	Right	45,49± 1,28	9,19	44,92± 1,34	9,59
		Left	40,11± 1,49	10,68	39,41± 1,63	11,68
5.	Verweck index, c.u.	0,93± 0,01	0,12	0,87± 0,01	0,11	

number of factors, among which a special place belongs to the physique of an athlete. Burdukiewicz et al., 2018, confirmed the effectiveness of the study of morphometric and somatotype characteristics for assessing success in martial arts.

Studies have found that taekwondo athletes have an increase in body length by 4.7% over the course of 14–15 years, and is reflected in the fact that 15-year-old athletes are 12.04% underweight compared to 14-year-olds. It is also a manifestation of the influence of physical activity and the specifics of the sport on the morphological parameters of taekwondo athletes. This coincides with the statement of Podrihalo et al., 2020, that the proximity of morphological and functional indicators is determined by the level of physical preparedness of athletes and is the result of specialized training. Anthropometric, physiological and physical characteristics, anaerobic and aerobic power, body length, body weight, body mass index and body fat percentage, speed and agility are significantly associated with success and are of greater importance for taekwondo athletes (Arazi et al., 2016).

33,6% of athletes, 15 years old, are underweight in terms of body mass index, 63,5% are normal. This coincides with the studies of Cular et al., 2021., which indicate that the parameters of anthropometric characteristics and body composition of junior athletes Croatian taekwondo, by weight categories, there is a proportional increase in average values for almost all morphological and functional indicators in all weight categories, with the exception of total body water (%), which decreases in heavy categories. In addition, the higher categories were significantly heavier, taller, and with a higher body mass index than the lower ones ($p < 0,01$). In WTF taekwondo, indicators of morphological and functional features are partly related to weight categories; however, in the same weight category, athletes with different body lengths can succeed. A body mass index of about 21 kg/m² for men is associated with the performance of highly skilled taekwondo athletes (Agopyan et al., 2022; Bridge et al., 2014; Cular et al., 2021). The absolute values of anthropometric measurements of body length, body weight, body fat percentage, and body mass index in elite and non-elite athletes indicate that elite athletes tend to be taller and leaner than non-elite athletes (Norjali et al., 2019).

Prospects for further research will be aimed at developing a training program for 15-year-old taekwondo athletes in the annual macrocycle, taking into account morphological and functional features.

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Conclusions

The study of morphological and functional indicators is one of the important criteria for the training of taekwondo athletes, the use of indices allows you to move on to relative indicators, that is, to standardize anthropometric indicators and supplement them. This will contribute to the rational selection of means and methods of training athletes, taking into account their personal characteristics. Our research can be used in monitoring the functional state of athletes involved in taekwondo WTF.

Studies have established that the age of 14-15 years in athletes specializing in taekwondo is characterized by a rapid period of development, which is reflected in an increase in body weight by an average of 7.55 kg and height - 7.26 cm, this reflects the physiological period of development of athletes inherent in adolescence.

According to the results of the study, it was found that in terms of body mass index, 33,6% of 15-year-old athletes are underweight, 2,9% are overweight, and 14-year-olds: 21.56% are underweight, 13,7% are overweight. 14 year old athletes have: 7,84% strong physique, 15,68% good, 5,88% average, 27,45% weak, 43,15% very weak. 15 year old athletes: 12,12% have a strong physique, 24,24% are good, 9,1% are average, 24,24% are weak, 30,3% are very weak. 13,7% of 14-year-old taekwondo athletes have good physical development, 3,9% - average, 76,4% - weak. 15 year old athletes have the best physical development: 17,6% good, 14,8% average, 67,6% weak.

Author Contributions

Igor Pashkov: collection, input, data analysis, manuscript preparation, statistics. Vladimir Potop: design, data interpretation. Viktoriia Pashkova: analysis of scientific and methodological literature and the Internet, data interpretation, manuscript preparation, statistics.

Conflicts of Interest

The authors declare no conflict of interest.

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Technology of organizing inclusive education in modelship sports in institutions of out-of-school education

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Abstract

The organization of high-quality work with children with special educational needs in sports and technical sports requires the search and implementation of new forms, methods and means that make up the technology of inclusive education. In order to implement inclusive training in sports and technical sports, including modelship sports, it is necessary to take into account the strengths and weaknesses, as well as the opportunities and threats that may arise. An important role in the process of implementing the technology of inclusive education belongs to the organizational and methodical aspects, which play an important role in the formation of the educational environment and allow adapting the educational and training process to the needs and capabilities of each pupil.

Purpose: justification of the technology of organizing inclusive education in modelship sports in order to create conditions for the socialization of children with special educational needs.

Material and methods: analysis and generalization of scientific and methodical literature, documentary materials and Internet materials; questionnaire, expert survey of methodologists and heads of departments of sports and technical profile of out-of-school education institutions, trainers/heads of modelship sports in the number of 30 respondents; methods of mathematical statistics.

Results: on the basis of the generalization of the results of the questionnaire and expert survey, the technology of inclusive training in model ship sports was developed, which includes conditions, methods, forms and tools that should be used when working in groups with children with special educational needs. The goals and tasks aimed at the development and socialization of children, as well as success factors and problems affecting the success of inclusive education are defined. The developed technology of inclusive education is the basis of the model ship training program for teaching children with special educational needs.

Conclusions: the developed technology for organizing inclusive training in model ship sports is aimed at creating conditions for the socialization of children with special educational needs by identifying optimal conditions, forms, methods and means, as well as taking into account problems and success factors. It became the basis for the development of a curriculum for extracurricular education in the scientific and technical direction for teaching children with disabilities, which in turn is aimed at the formation of three competencies: cognitive, project-technological, and social-psychological.

Анотація

Слизавета Шитікова, Ірина Когут, Вікторія Маринич. Технологія організації інклюзивного навчання у судномодельному спорті в закладах позашкільної освіти. Організація якісної роботи з дітьми з особливими освітніми потребами у спортивно-технічних видах спорту вимагає пошуку та впровадження нових форм, методів, засобів тощо, що в комплексі складає технологію інклюзивного навчання. Для реалізації інклюзивного навчання у спортивно-технічних видах спорту, в тому числі судномодельному, необхідно враховувати сильні та слабкі сторони, а також можливості та загрози, що можуть виникати. Важлива роль у процесі реалізації технології інклюзивного навчання належить організаційним та методичним аспектам, які відіграють важливу роль у формуванні освітнього середовища та дозволяють адаптувати навчально-тренувальний процес до потреб та можливостей кожного вихованця. **Мета:** обґрунтування технології організації інклюзивного навчання у судномодельному спорті задля створення умов для соціалізації дітей з особливими освітніми потребами. **Матеріал і методи:** аналіз і узагальнення науково-методичної літератури, документальних матеріалів та матеріалів мережі Інтернет; анкетування, експертне опитування методистів та керівників відділів спортивно-технічного

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Key words:

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Ключові слова:

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освітніми потребами
судномодельний спорт

профілю закладів позашкільної освіти, тренерів/керівників гуртків судномодельовання у кількості 30 респондентів; методи математичної статистики. **Результати:** на основі узагальнення результатів анкетування та експертного опитування розроблено технологію інклюзивного навчання у судномодельному спорті, яка включає умови, методи, форми та засоби, що доречно використовувати під час роботи в групах з дітьми з особливими освітніми потребами. Визначені мета та завдання, що спрямовані на розвиток та соціалізацію дітей, а також фактори успішності та проблеми, що впливають на результативність інклюзивного навчання. Розроблена технологія інклюзивного навчання покладена в основу навчальної програми з судномодельного спорту для навчання дітей з особливими освітніми потребами. **Висновки:** розроблена технологія організації інклюзивного навчання у судномодельному спорті спрямована на створення умов для соціалізації дітей з особливими освітніми потребами за рахунок виявлення оптимальних умов, форм, методів та засобів, а також з урахуванням проблем та факторів успішності. Вона стала підґрунтям для розробки навчальної програми з позашкільної освіти науково-технічного напрямку для навчання дітей з ООП, яка в свою чергу спрямована на формування трьох компетентностей: пізнавальної, проектно-технологічної та соціально-психологічної.

Introduction

Initiatives that are currently being implemented in the EU countries on inclusion are being actively implemented in education, sports, culture, etc. and essential for full participation in society. In addition to education, physical activity and sports contribute to the formation of a tolerant attitude towards children with SEN, and also allow them to socialize and integrate with other social groups (European Commission, 2021).

In recent years, inclusive education has been actively introduced in educational institutions, including extracurricular ones. According to scientific research, this learning model contributes to the development of children with SEN as individuals and, in accordance with their abilities and talents in the field of education, science, culture, physical culture and sports, technical and other creativity, contributes to the satisfaction of physical, intellectual needs and communication (Kolupaeva, 2016-2018; Bykovska, 2018). For the qualitative introduction of inclusive education in the system of out-of-school education, it is necessary to create conditions that would meet certain requirements for the formation of a socially adapted and harmoniously developed personality.

Researchers note that technologies leading to the creation of conditions for high-quality and affordable education for each category of children are called inclusive education technologies (Voloshinova, 2017). This is a system of knowledge about the optimal forms, methods, means and ways of organizing the education of children with SEN (Chaika, 2018).

Analysis of foreign literature sources by Losadetal (2021), Kamberidou (2019), Syed (2022) and studies of domestic scientists Romanyuk (2019), Hordiychuk (2021), Dubych (2011), Nagorna (2020) made it possible to generalize the views of specialists on the need to develop technology for inclusive education. And a survey of specialists became the basis for identifying key organizational and methodological aspects for developing a technology for organizing inclusive training in modelship sport.

The relevance of developing a technology for teaching children with SEN in sports and technical section, in particular

in ship modeling classes, is justified by the need to improve the educational and methodological support for training athletes in modelship sports, as well as identifying optimal organizational forms for working with children with SEN, which will make technical sports are available for every category of children.

Relationship of research with scientific or practical tasks, plans, programs. The scientific work was carried out in accordance with the Research Plan of the National University of Physical Education and Sports of Ukraine for 2021-2025. on topic 1.4. Theoretical and methodological foundations for the development of professional, non-Olympic and adaptive sports in Ukraine in the context of reforming the sphere of physical culture and sports (state registration number 0121U108294).

Purpose of the study is to substantiate the technology of organizing inclusive education in modelship sports in order to create conditions for the socialization of children with special educational needs.

Material and Methods of the research

Participants

The study involved coaches, heads of section, methodologists and heads of departments of sports and technical profile of out-of-school education institutions with a total of 30 respondents aged from 18 to 60 years old, who have experience of participating in competitions as athletes, hold the position of heads of section and coaches of modelship sports, as well as have relevant qualifications and teaching experience. All participants signed an informed consent form to participate in the study.

Methods

Among the methods used in the study was the analysis of the website of the European Commission on sports and inclusion and strategies for the rights of persons with disabilities for 2021-2030, the synthesis of scientific and methodological literature on the technology of inclusive education, educational resources on the Internet; questioning, expert survey; methods of mathematical statistics.

Procedure (organization of the study)

To achieve the set goals, an analysis of the sites was applied: the European Commission, the Ministry of Education and Science of Ukraine, the Federation of Modelship and Modelship Sports of Ukraine; educational portals and search engines GoogleScholar, ResearchGate; international scientific journals and Internet materials; questioning, expert survey; methods of mathematical statistics.

The results of the survey made it possible to identify and systematize the organizational and methodological aspects of the implementation of inclusive education in modelship sections, as well as, based on the data obtained, to develop a technology for teaching children with SEN when working in inclusive groups.

Statistical analysis

In order to process the obtained data, methods of mathematical statistics were applied. The results were processed using the Microsoft Excel 2016 program. The question about identifying key teaching methods was designed to select three answers. To determine the conditions, forms and means of training ship modelers athletes, which are the basis of the training technology, the ranking method was applied, which made it possible to identify the location of statements in order of their importance. To obtain a high (optimal) degree of agreement among experts on the coefficient of concordance (W , at $p < 0.01$), in the process of analyzing the data obtained, the answers that

differed significantly from the average statistical indicators were not taken into account, therefore, the results of a survey of 23 people were included in the analysis. In the studied results are presented in percentage terms.

Results of the research

Inclusive education in out-of-school education is a new and promising direction, in particular, in sports and technical sections, which include modelship sections. Therefore, there is a need to develop a technology for organizing this learning model for these sections, which would take into account the needs of all pupils in one environment.

Based on the analysis and generalization of scientific and information sources, the results of the research, in particular, a survey of specialists in sports and technical sports, including the heads of section / coaches in modelship sports, and our own practical experience, we have developed a technology for organizing inclusive training in modelship sports (Figure 1). The proposed technology is aimed at forming an individual learning trajectory by improving the organizational and methodological support of educational, training and competitive activities.

The developed technology has specific goals and objectives, organizational components (conditions, methods, means, forms) and results of training activities. Among the key teaching methods in modelship sections that are appropriate to use while working in an inclusive class, they singled out practical work (83.33%), the use of visualization methods (56,67%) and team games (36,67%). Among the most effective means of training ship modellers athletes are the use of various visual aids (33%), graphic aids (drawings, diagrams, templates) (27%) and information and communication technologies (simulators, computer programs) (20 %) (Shytikova, et al., 2022).

In each technology, organizational and pedagogical components are distinguished. The organizational aspects included

in the technology of inclusive training in modelship sports include the conditions, forms, methods and means that, in the course of the study, the experts identified as the most appropriate when working in inclusive groups. Among the pedagogical factors, one should single out those that the coach uses in the process of preparing athletes. For example: differentiation and individualization of the educational process, the search for ways to overcome difficulties and barriers in the classroom, the interaction of section members and the formation of their social competence, the development of communication skills, the assessment of the achievements of pupils.

The developed technology of inclusive education in modelship became the basis for the curriculum of out-of-school education in the scientific and technical direction for teaching children with SEN. The goal of training is to create conditions for the socialization and technical and technological development of children in an inclusive environment by means of modelship sports (FMSS, 2021).

The objectives of the program are the formation of appropriate competencies that determine the child's readiness for independent living and his active participation in the life of society. Inclusive training in modelship sports is aimed at developing three competencies in children (cognitive, design-technological and socio-psychological), and classes in the section - moral standards, motivation and mutual support, as well as the ability to realize equal opportunities and diversity of children.

One of the aspects of the developed technology is comprehensive support, in particular, the need to involve not only coaches or heads of section, but also parents or other specialists (social workers, psychologists, child assistants, rehabilitators or speech pathologists).

Within the framework of the developed technology for organizing inclusive education in modelship sports, the advantages and significance of joint classes for practically healthy children and children with SEN are summarized (Figure 2).

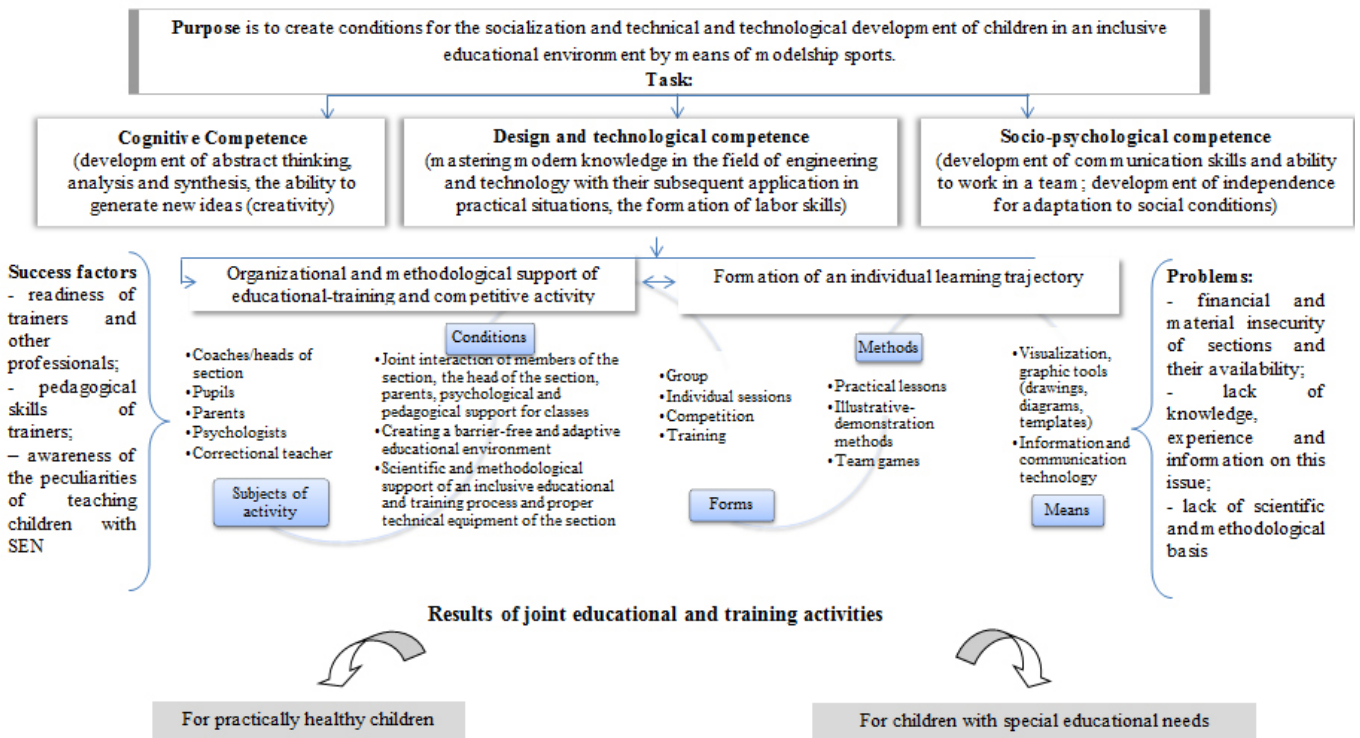


Fig. 1. Technology for organizing inclusive training in modelship sports

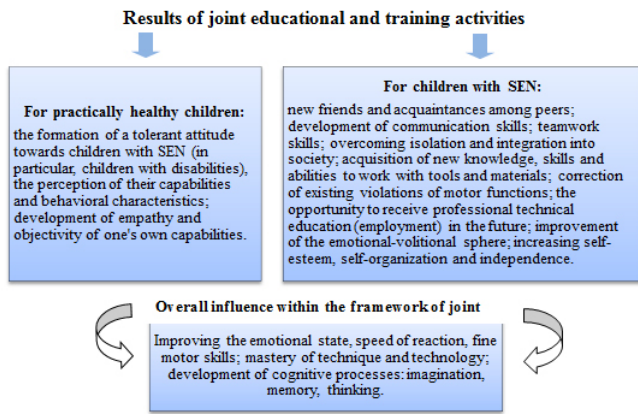


Fig. 2. Results of educational and training activities in the context of inclusive training in modelship sports

The creation of an inclusive educational environment in sports and technical sports and the implementation of the developed technology directly depends on the preliminary planning of classes and preparation for them. The organization of the training process with children with SEN and the organization of a high-quality educational environment depends on the readiness of trainers, their level of skill, theoretical and practical training, psychological attunement, and other factors.

Discussion

Technologies leading to the creation of conditions for high-quality and affordable education for each category of children are called technologies of inclusive education (Voloshinova, 2017). In his research, Dubych (2011) substantiates the technology of inclusive education as a system of knowledge about the optimal forms, methods, means and ways of organizing the education of children with SEN. Our study identified the key and most optimal conditions, forms, methods and means that, in the opinion of trainers / heads of section, it is appropriate to use and take into account when working with children with SEN.

When organizing education in an inclusive environment, it is necessary to take into account the individual characteristics and capabilities of children, as well as take into account their needs and interests. Such an approach, as noted by Nagorna (2020), requires the improvement of the forms, methods and technologies of teaching. Individualization of the training process underlies the technology of inclusive training in modelship sports and is associated with the organizational and methodological support of classes, and also depends on factors that generally contribute to the successful implementation of inclusive training.

Teachers with experience in inclusive education note that one of the key technologies of inclusive education is the formation of vital skills or social competence (skills of interaction, mutual assistance, productive activity, etc.). In the technology presented by us, training is aimed at developing social and psychological competence in children, namely: at developing communication skills and the ability to work in a team; independence for adaptation to social conditions.

Scientists (Voloshinova, 2017; Chaika, 2018) distinguish two groups of inclusive technologies: organizational and pedagogical. Some researchers (Mykhalsky et al., 2020) add health-saving technologies to the named components of inclusive education technology.

Organizational technologies are directly related to the cre-

ation of a high-quality inclusive environment, the relationship of a trainer (teacher, lecturer) and other specialists and, in general, the organization of the educational and training process, the formation of an adaptive educational environment and the programming of classes.

Among the pedagogical technologies that can be successfully used during inclusive education, scientists (Voloshinova, 2017) highlight:

1. Technologies of differentiated learning and individualization of the educational process.
2. Technologies for correcting educational difficulties that arise in children in the educational process.
3. Technologies aimed at the formation of social competence.
4. Technologies for evaluating student achievement.

In our study, pedagogical technologies are associated with the approach of the trainer/teacher to the implementation of the educational and training process. They are provided through the individualization and differentiation of the learning process, the formation of the necessary competencies of pupils, and the assessment of achievements. Differentiated learning should be seen as an approach that shows the teacher's acceptance of the diversity of the team: their knowledge, level of preparedness, educational interests, individual learning opportunities, etc.

As Kolupaeva (2018) notes, during the organization of the educational process as part of the work in an inclusive section, the professional skills of teachers, their desire to promote children to a higher level, contribute to their personal success, providing the necessary support and assistance, are clearly manifested. A necessary condition for successful learning is awareness of the ultimate goal and result, as well as planning your own actions to achieve them.

Health-saving technologies include the creation of a favorable microclimate in the team, the development of fine motor skills, communicative development and, in general, the differentiation of education, taking into account the capabilities of children and the ultimate goal of classes.

Previous studies have made it possible to determine that the readiness and qualifications of trainers/heads of section make it possible to create and provide a safe inclusive educational environment, taking into account the specifics of such a learning model and, in general, be able to work with children with SEN in the general team. (Шитікова, 2021).

The conducted survey of experts allows us to confirm the opinion of scientists (Dubich, 2011; Chaika, 2018) on the organizational basis for the implementation of inclusive education. In particular, the implementation of this model of training in modelship should be based on the need to train performers (trainer/heads of section), organization of their work and coordination of activities at different levels; providing scientific and methodological assistance to specialists and monitoring their activities with a view to further improvement; general analysis of the technologization process. In general, in order to implement the technology of inclusive education, it is necessary to create conditions for all areas: empowered school leaders, appropriate infrastructure, better selection and training of teachers, parent involvement and, above all, quality content, effective assessment and appropriate skills for students.

Therefore, in order to organize high-quality inclusive education in modelship sports, it is necessary to take into account a number of organizational and methodological aspects that form the technology for organizing inclusive education. In particular, to find the optimal forms, methods, means and ways of

teaching children with SEN in the same environment as practically healthy children. The totality of this knowledge and their structuring make up the technology of inclusive education in modelship sports.

Conclusions

1. Based on previous studies, analysis of scientific and methodological literature and our own practical experience, a technology for organizing inclusive education in modelship sports was developed, aimed at creating conditions for the socialization of children with SEN by identifying optimal conditions, forms, methods and means, as well as taking into account problems and achievement factors.

2. The developed technology of inclusive education has become the basis for the development of the curriculum for out-of-school education in the scientific and technical direction for

teaching children with special educational needs and is aimed at the formation of three competencies: cognitive, design-technological and socio-psychological.

Author Contributions

Yelyzaveta Shytikova – research planning, data collection, manuscript preparation; Iryna Kohut – data interpretation, data analysis; Viktoriia Marynych – data analysis, literature analysis.

Conflicts of Interest

The authors declare no conflict of interest.

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Modern approaches to the organization children's and youth basketball: abroad experience

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Abstract

Purpose: the high level of basketball players' individual skill at the international arena requires radical changes in the approaches to the preparation of a high-quality reserve and the enlargement of the Ukrainian children's and youth basketball system, taking into account modern world trends in the evolution of the game. The study of practical experience and the generalization of the foreign specialists' opinions will contribute to the buildout of a high-quality training process of young basketball players. The aim of the study is to summarize the modern features of the organization of children's and youth basketball based on the study of the professional opinions of foreign coaches.

Material and methods: 10 foreign basketball coaches who have been engaged in the international youth competitions, who got high results in the championships of their own countries and trained young players in youth national teams, were chosen as qualified experts. They were proposed to answer 10 questions in special questionnaire regarding the modern trends in the youth basketball. Theoretical analysis and generalization of data from scientific and methodological literature, and Internet resources, questionnaires in Google form using the ranking method, and the method of expert evaluations were applied in the research.

Results: the opinions of foreign coaches who successfully work with young basketball players were studied and summarized. That made it possible to determine the current trends in the development of children's and youth basketball. Consistency of experts' opinions was confirmed using Kendall's concordance coefficient, all examinations were confirmed, experts' opinions were agreed.

Conclusions: the priority objects of the examination were formed according to the distribution of experts' evaluations, namely: preference was given to the experience of the USA as a reference point for the evolution of basketball; the young basketball players' training system as a combination of education and training with multi-level selection on the basis of a basketball school (academy) is idealized; the overwhelming majority chose the focus on planning the educational and training process taking into account modern approaches to the psychological characteristics of young basketball players as a priority component; a common vision was expressed regarding the selection of players for the teams entered in the national championships, which should take place taking into account the combination of current skill and prospects for realizing individual potential; the existing need for scientific substantiation of a new style of management, taking into account the peculiarities, needs, motives and interests of the individual, is indicated.

Анотація

Оксана Комоцька, Руслана Сушко. Сучасні підходи до організації дитячо-юнацького баскетболу: закордонний досвід. **Мета:** високий рівень індивідуальної майстерності баскетболістів на міжнародній арені потребує кардинальних змін у підходах до підготовки якісного резерву і розбудови українського дитячо-юнацького баскетболу з урахуванням сучасних світових тенденцій розвитку гри. Вивчення практичного досвіду і узагальнення думок закордонних спеціалістів сприятиме формуванню якісної організації процесу підготовки юних баскетболістів. Мета дослідження – узагальнити сучасні особливості організації дитячо-юнацького баскетболу на основі вивчення фахових думок іноземних тренерів. **Матеріал і методи:** 10 закордонних тренерів з баскетболу, які мають досвід міжнародної участі у дитячо-юнацьких змаганнях, високі результати у чемпіонатах власних країн та підготовлених юних вихованців для дитячо-юнацьких збірних команд, відповіли у якості кваліфікованих експертів на 10 питань спеціально сформованої анкети стосовно сучасних тенденцій розвитку дитячо-юнацького баскетболу. У дослідженні застосовано теоретичний аналіз і узагальнення даних науково-методичної літератури та даних мережі Інтернет, анкетування за допомогою гугл-форми методом ран-

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Key words:

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Ключові слова:

баскетбол
тренер
сучасні тенденції
закордонний досвід

жування та метод експертних оцінок. **Результати:** вивчено і узагальнено думки діючих закордонних тренерів, які успішно працюють з юними баскетболістами, що дозволило визначити сучасні тенденції розвитку дитячо-юнацького баскетболу. Узгодженість думок експертів підтверджена за допомогою коефіцієнта конкордації Кендалла, всі експертизи відбулися, думки експертів узгоджені. **Висновки:** за розподілом оцінок експертів сформовано пріоритетні об'єкти експертизи: віддано перевагу досвіду США, як орієнтиру розвитку баскетболу; ідеалізовано варіант організації підготовки юних баскетболістів у поєднанні освіти і тренування з багаторівневим відбором, на базі баскетбольної школи (академії); переважною більшістю обрано спрямованість на планування навчально-тренувального процесу з урахуванням сучасних підходів до психологічних особливостей юних баскетболістів як пріоритетної складової; висловлено спільне бачення стосовно відбору гравців до команд, заявлених у національні чемпіонати, який має відбуватись з урахуванням поєднання поточної майстерності і перспектив реалізації індивідуального потенціалу; зазначено наявну потребу наукового обґрунтування нового стилю управління з урахуванням особливостей, потреб, мотивів та інтересів особистості.

Introduction

Modern trends in the evolution of basketball throughout the world testify to the growth of individual and team skills of players, which forms the existing need for implementing the radical changes in the educational, training and competitive process of the growing generation of basketball players (Borisova & Sushko, 2016).

Training and education of a high-quality reserve for participating in the international competitions is possible taking into account modern trends in the development of the game, globalization changes that have fully covered sports, and the study of foreign experience with further interpretation of the results obtained (Sushko & Doroshenko, 2016; Bezmylov & Shinkaruk, 2020).

A variety of the game - 3x3 basketball (men, women), which has been included in the program of the Olympic Games since 2020, is rapidly developing in the modern conditions of the international sports movement. The published research materials of domestic experts in this field confirm the high level of effectiveness of competitive activity in modern 3x3 basketball, the exciting spectacle of the game and the powerful informational demand from fans, mass media and scientists (Musienko & Tsymbalyuk, 2021; Shutova et al., 2022).

Ukrainian and foreign experts take care of the issues of improving sportsmanship in basketball by types of training, researching training effects through the use of special exercises (Koryahin et al., 2020), determining the effectiveness of physical preparation (Mancha-Triguero et al., 2019), analyzing the structure of competitive activity (Doroshenko et al., 2020; Greenha et al., 2022), studying the psychological characteristics of selection (Sushko et al., 2019; Khurbanov, 2022), studying the psychological characteristics of selection (Sushko et al., 2019; Khurbanov, 2022), emphasizing the importance to determining the features of competition systems (Jimenez et al., 2020) and monitoring the training of young basketball players (Mitova et al., 2022; Shinkaruk & Mitova, 2017).

Theoretical aspects of the development of modern sports in general, including basketball, contain contradictions, which are substantiated by the authors of scientific works, creating

a precedent for scientific discussion (Sutula et al., 2016). Specialists do not stop at ascertaining and characterizing modern trends, but creatively approach the search for ways to solve these problems (Bondar et al., 2021).

Selection work is recognized as a significant criterion for improving the quality of the training and competition process. The experience of selection in the training system of basketball players in Ukraine and abroad is studied and properly analyzed by authors who take care of the issues of a long-term training system's successful optimization (Bilokon & Anikeyenko, 2022; Bezmilov & Murzin, 2016).

The organization of the basketball clubs' activities requires a comprehensive approach to the preparation of a high-quality reserve, which is offered based on a higher education institution (Pavlenko, 2019; Jia, 2017). This will contribute to solving the problems of recruiting talented young basketball players to higher education institutions, continuing their systematic training, taking into account the request from professional club teams.

The high level of the basketball players' individual skills in the international arena requires radical changes in the approaches to the preparation of a high-quality reserve and the enlargement the Ukrainian youth basketball, taking into account modern world trends in the evolution of the game. The creation of innovative approaches to the process of young basketball players' training system is possible due the study of practical experience and the generalization of the foreign experts' opinions.

The aim of the study is to summarize the modern features of the organization of youth basketball based on the foreign coaches' professional opinions investigation.

Material and Methods of the research

Participants. Basketball coaches who have experience in the international participation in youth competitions, high results in the local championships and a number of the trained young athletes for youth national teams took part in the study. Only foreign coaches were selected as respondents: representatives from the United States of America (3), Bosnia and Herzegovina (1), Spain (1), Cyprus (1), Latvia (1), Lithuania (1), Slovakia (1), Slovenia (1).

Methods. The theoretical analysis and generalization of data from scientific and methodological literature and the Internet resources, questionnaires with a Google form using the ranking method, and the method of expert evaluations are applied in the study.

Procedure. Set of 10 questions of the questionnaire is created, specifically for the definition of modern trends in the youth basketball, which required the clarification of expert opinions. The discussion significance of the proposed questions was confirmed by the obtained results. Answer options are presented for nine questions, having the one open-ended question. The question was designed in the form of a questionnaire using a Google form, which needed to be determined by the ranking method (minimum rank - 1; maximum rank - 4, it is not possible to assign the same ranks or leave the answer without a rank).

Statistical analysis. Algorithm of the expert evaluation by the method of preference are the following:

1. Filling in the examination table by each of the experts using the preference method.
2. Assessing agreement among the interviewed experts' opinions using the Kendall's coefficient of concordance (W).
3. Creating a conclusion about the quality of the expertise

depending on the degree of agreement of the experts' opinions.

Kendall's coefficient of concordance is calculated by the formula:

$$W = \frac{12S}{m^2(n^2 - n)}$$

where S is the sum of squared deviations and it is defined as:

$$S = \sum_{i=1}^n ((\sum_{j=1}^m x_{ij}) - \bar{x})^2$$

where m is the number of experts; n is the number of examination objects, x_{ij} is the i -th assessment of the j -th expert; \bar{x} is the average score given by m experts for all n objects of expertise, which is defined as:

$$\bar{x} = m \cdot (n + 1) / 2$$

where m is the number of experts; n is the number of examination objects.

Kendall's coefficient of concordance, in fact, represents the averaged rank correlation and varies in the range $0 < W < 1$, with 0 being complete disagreement, 1 being complete unity.

Testing of the null hypothesis $H_0: W = 0$ (experts' opinions do not agree with each other) with the alternative $H_1: W \neq 0$ (experts' opinions agree) is carried out using Pearson's chi-squared test (χ^2). Empirical value of Pearson's χ^2 test is defined as:

$$\chi^2 = m(n-1) \cdot W$$

and it is compared with the critical $\chi_{\alpha}^2(n-1)$ calculated for the number of degrees of freedom $df = n-1$ and the corresponding significance levels α . The concordance coefficient is significantly different from zero if the empirical value falls into the critical region:

$$\chi^2 > \chi_{\alpha}^2(n-1)$$

- if the Kendall's coefficient of concordance (W) is significant, the examination took place, the experts' opinions are agreed;

- if W is insignificantly different from zero, the examination did not take place, the experts' opinions are not agreed.

Results of the research

The first question of the questionnaire summarizes the existing need to determine one's own vision of priority regarding the experience of countries that can serve as a reference point for the evolution of basketball in the respondent's country. The answer options are offered taking into account the significant systemic achievements of the national teams of the countries on the international arena in the highest-class competitions (European, world championships, Olympic Games): USA; Spain; Australia; France.

The experts gave the highest ranking (4 points) to the experience of the US basketball school - 60%, the second position was chosen by Spain, as a titled representative of European basketball (30%), the third position was given to the experience of the Australian national team (10%), taking into account the high results competitive activity and modern approaches to competitive and training activities of basketball players of the 'green' continent. The last priority of experience and achievements was left behind the French national teams, although no respondent gave them the highest rating.

Consistency of experts' opinions was confirmed using Kendall's coefficient of concordance, according to this ex-

perience, $W=0.468$ is statistically significant at the level of $p = 0.00285$ (the empirical value of Pearson's χ^2 test - $\chi^2 (n = 10, df = 3) = 14.04$). Therefore, we can conclude that the expertise took place; the experts' opinions are agreed.

Table 1

Assessment of solutions to the question about one's own vision of priority regarding the experience of countries that can serve as a reference point for the development of basketball in the respondent's country (n=10)

Object of expertise	Statistical indicators			
	Average rank	Sum of ranks	\bar{X}	S
USA	3.3	33	3.3	1.1
Spain	3.0	30	3.0	0.9
Australia	2.4	24	2.4	0.7
France	1.3	13	1.3	0.7

The logical continuation in the second question was the clarification of the idealized version of the young basketball players' training system for the respondent's country. Creating a basketball school (academy), based on a combination of education and training with multi-level selection, which is financed by professional clubs or the state for the purpose of training national teams with various age categories, was given the strong preference (70%).

The mass educational and training process in sports schools (academies) aimed at improving the health and high-quality motor activity of schoolchildren by means of basketball is given the second position of significance in terms of the distribution of the maximum rank grades (30%). It should be explained by the need for further possibility of selection with an orientation to the sports results of coaches who participate in high-level youth competitions, take prize places in national championships, participate in youth club continental tournaments and prepare representatives for the national teams of their own countries.

Answers regarding approaches to the training system aimed at the mass educational and training process in sports schools (academies) with a preference for multi-level selection for national teams with different age categories and the position of the need to form a vertical long-term training system for young basketball players in the professional club did not receive the highest rank and received the same number of ranks based on the sum of the ranks.

Consistency of experts' opinions was confirmed using Kendall's coefficient of concordance, according to this expertise, $W=0.272$ is statistically significant at the level of $p = 0.0428$ (the empirical value of Pearson's χ^2 test is $\chi^2 (n = 10, df = 3) = 8.16$). Therefore, we can conclude that the expertise took place; the experts' opinions are agreed.

It is widely known that the effectiveness of a coach's and basketball player's work depends on the training process, which has different signs and characteristics in each country. The third question specifies the methodological support for the athletes' training and the upgrading of the coaches' qualifications in different countries. The differentiation of the basketball coaches' individual qualifications through the implemented licensing system received a significant advantage of the maximum ranks (90%) in the answers of foreign experts. Meanwhile a proposition to implement a licensing in the Ukrainian basketball system, initiated by the Basketball Federation of Ukraine, at the initial stage, met with a strong negative response from

Table 2

Assessment of solutions to the question regarding the idealized version of the young basketball players' training system for the respondent's country in his/her opinion (n=10)

Object of expertise	Statistical indicators			
	Average rank	Sum of ranks	\bar{X}	S
created vertical of long-term training system for young basketball players in the professional club	2.1	21	2.1	0.9
basketball school (academy), based on a combination of education and training with multi-level selection for national teams with various age categories, which is financed by professional clubs or the state	3.5	35	3.5	0.8
mass educational and training process in sports schools (academies) with multi-level selection for national teams with different age categories	2.1	21	2.1	0.9
mass educational and training process in sports schools (academies) aimed at improving the health and quality of motor activity of schoolchildren by means of basketball	2.3	23	2.3	1.3

Table 3

Assessment of solutions to the question of how the respondent's country takes care of modern methodological support for the athletes' training and upgrading the coaches' qualifications (n=10)

Object of expertise	Statistical indicators			
	Average rank	Sum of ranks	\bar{X}	S
differentiation of the basketball coaches' individual qualifications through the implemented licensing system	3.9	39	3.9	0.3
systematic methodological and practical seminars for professional development with the involvement of leading specialists (judges, domestic and foreign coaches, managers, etc.)	2.9	29	2.9	0.6
foreign training (internship) of coaches in the system of the National Basketball Association	1.2	12	1.2	0.4
basketball coaches' progressive self-growth with online education, Internet technologies, etc.	2.0	20	2.0	0.7

domestic coaches. An answer about systematic methodological and practical seminars for professional development with the involvement of leading specialists (judges, domestic and foreign coaches, managers, etc.) is received one maximum rank (10%). Answers regarding basketball coaches' progressive self-growth with the online education and Internet technologies, and foreign training (internship) for coaches through the system of the National Basketball Association are got no maximum ranks, and took 3rd and 4th positions, respectively, according to the sum of the ranks.

Consistency of experts' opinions was confirmed using Kendall's coefficient of concordance, according to this expertise, $W=0.812$ is statistically significant at the level of $p = 0.00002$ (the empirical value of Pearson's χ^2 test - $\chi^2 (n = 10, df = 3) = 24.6$. Therefore, we can conclude that the expertise took place; the experts' opinions are agreed.

The fourth question is about a hierarchy of priorities in the main components of work with the reserve. Coaches from different countries are united by specific general approaches to prioritizing the components of the preparatory process in youth basketball, due to trends, generally accepted requirements for the level and quality of young basketball players' training proc-

ess in accordance with the request of the national teams.

The appropriate percentage value (80%) is stated by the respondents' attitude to the planning of the educational and training process taking into account modern approaches to the young basketball players' psychological characteristics. It indicates the significance of their influence on the efficiency of the work process and the result. The modeling of the educational and training process based on the indicators of competitive activity is marked with 20% of respondents with a maximum rank of 4 points and got the second place by the sum of ranks. According to the sum of the ranks, only the third position is given to the traditional methods of the educational and training process regarding the physical and technical-tactical preparation of young basketball players. The planned sports selection of players with division into the appropriate groups (main team, stable reserve, extended training reserve, prospective reserve) with permanent athletes' selection has received the lowest rank among experts.

Consistency of experts' opinions was confirmed using Kendall's coefficient of concordance, according to this expertise, $W=0.708$ is statistically significant at the level of $p = 0.00009$ (the empirical value of Pearson's χ^2 test is $\chi^2 (n = 10, df = 3) =$

21.2. Therefore, we can conclude that the expertise took place; the experts' opinions are agreed.

A difficult and critically controversial decision while discussing the results of players selection for teams participating in national championships (youth leagues) is the question of such a choice. For practicing coaches, such a decision is combined with a definition that characterizes the priority aspects of their personal work. It is scientifically valuable to study the experts' opinions who took part in the survey, because of their huge involvement in the significant achievements of young basketball players in local championships.

The respondents did not limit themselves to taking into account the projected perspective of the players, only one vote with the maximum rank (10%), 20% emphasized on the importance to the effectiveness of the players' competitive activity at the present time. Although the vast majority of coaches chose the possibility of taking into account the current skills demonstrated by basketball players today in combination with possible prospects of realizing individual potential in the future - 70%. The high level of coaching activity of the interviewed experts and work for the result did not contribute to the choice of the answer that all young athletes should receive competitive prac-

tice. That is why, based on the sum of the ranks, this statistical indicator is close to the minimum possible.

Consistency of experts' opinions was confirmed using Kendall's coefficient of concordance, according to this expertise, $W=0.644$ is statistically significant at the level of $p = 0.00023$ (the empirical value of Pearson's χ^2 -test - $\chi^2 (n = 10, df = 3) = 19.32$). Therefore, we can conclude that the expertise took place; the experts' opinions are agreed.

The sixth question regarding the motives of the desire to work as a coach became significant in the study of the selected specialists' practical experience. Among the proposals, the vast majority (70%) chose passion for coaching, the desire to share the experience and knowledge to the younger generation, understanding the importance of developing physical, psychological and moral features of young athletes. The ratio of other proposed answers was divided by priority as follows: 20% marked their personal leadership ambitions, knowledge and desire to realize themselves in the profession with the highest rank, although this is only the third position in the sum of ranks; building a successful coaching career and meeting a high professional level is at the second place with the only one maximum rank; the last place is for the feeling of support and motivation

Table 4

Assessment of solutions to the question about the priority of the components of the preparatory process in youth basketball (n=10)

Object of expertise	Statistical indicators			
	Average rank	Sum of ranks	\bar{X}	S
planning the educational and training process taking into account modern approaches to the psychological characteristics of young basketball players	3.8	38	3.8	0.4
modeling the educational and training process based on indicators of competitive activity	2.9	29	2.9	0.9
applying the traditional methods of the educational and training process regarding the physical and technical-tactical preparation of young basketball players	2.0	20	2.0	0.5
planned sports selection of players with division into the appropriate groups (main team, stable reserve, extended training reserve, prospective reserve) with permanent athletes' selection	1.3	13	1.3	0.7

Table 5

Assessment of solutions to the question of how players should be selected for teams participating in national championships (youth leagues) (n=10)

Object of expertise	Statistical indicators			
	Average rank	Sum of ranks	\bar{X}	S
exclusively taking into account the projected prospects of the players	2.4	24	2.4	0.7
in accordance with the effectiveness of competitive activity at the present time (principle: the best today player will play in a team)	3.0	30	3.0	0.7
taking into account the combination of current skill demonstrated by basketball players today and possible prospects for realizing individual potential in the future	3.5	35	3.5	1.0
all young athletes should receive competitive practice	1.1	11	1.1	0.3

Table 6

Assessment of the solutions to the question why the respondent strives to work qualitatively as a coach (n=10)

Object of expertise	Statistical indicators			
	Average rank	Sum of ranks	\bar{X}	S
you have natural leadership ambitions, knowledge and desire to realize yourself in the profession	2.2	22	2.2	1.2
you feel the support and motivation of the team management, and achievements will contribute to the growth of financial fortunes	1.7	17	1.7	0.8
you plan to build or have built a successful coaching career and must meet a high professional standard	2.6	26	2.6	0.8
you are in love with coaching, strive to share the experience and knowledge to the younger generation, understanding the importance of developing the physical, psychological and moral features of young athletes	3.5	35	3.5	0.8

Table 7

Assessment of solutions to the question of whether the respondent feels the team management is interested in the results of the work (winning in the championship, training players for the national teams) (n=10)

Object of expertise	Statistical indicators			
	Average rank	Sum of ranks	\bar{X}	S
I am motivated to work well because of the prestige of the school (academy)	1.2	12	1.2	0.6
I am motivated to work hard to get better training time	2.2	22	2.2	0.6
I am motivated to work well for been financially rewarded	2.6	26	2.6	0.5
I am motivated to work well, because I have common interests with my athletes in the desire to win and the creation of personality growth	4.0	40	4.0	

Table 8

Assessment of solutions to the question of how the training of athletes in youth basketball should be funded (n=10)

Object of expertise	Statistical indicators			
	Average rank	Sum of ranks	\bar{X}	S
at the expense of the government	2.4	24	2.4	1.2
sponsorship	2.5	25	2.5	1.0
at the expense of young athletes' parents	1.7	17	1.7	0.9
a combined form of financing	3.4	34	3.4	0.8

of the team management and hopes that the achievements will contribute to the growth of financial fortunes, which proves the altruistic intentions of the coaches.

Consistency of experts' opinions was confirmed using Kendall's coefficient of concordance, according to this expertise, $W=0.348$ is statistically significant at the level of $p = 0.0152$ (the empirical value of Pearson's χ^2 test is $\chi^2 (n = 10, df = 3) = 10.44$. Therefore, we can conclude that the expertise took place; the experts' opinions are agreed.

The seventh question was clarifying whether the respondent feels that the management is interested in the results of their own work (winning in the championship, training players for the national teams). The proposed answer options are based on common motivational incentives for effective coach-

ing. Unanimity of opinion (100%) was obtained at the maximum rank of motivation due to the priority of professional interest in the result and the creation of personality growth.

Consistency of experts' opinions was confirmed using Kendall's coefficient of concordance, according to this expertise, $W=0.808$ is statistically significant at the level of $p = 0.00002$ (the empirical value of Pearson's χ^2 test - $\chi^2 (n = 10, df = 3) = 24.2$. Therefore, we can conclude that the expertise took place; the experts' opinions are agreed.

The financing of educational and training activities has an important place in the effective process of the young basketball players' training system. The eighth question is designed to find out the general experience of successful coaching in different countries, namely, at whose expense the economic issues

should be resolved. Respondents' opinions were distributed in percentage values according to the maximum rank as follows: 20% of respondents consider the government to finance activities; 20% of respondents vote for sponsoring support; 60% of respondents preferred the combined form of financing. None of the coaches gave the maximum rank for ensuring the training of young athletes at the expense of their parents.

Consistency of experts' opinions was confirmed using Kendall's coefficient of concordance, according to this expertise, $W=0.292$ is statistically significant at the level of $p = 0.0327$ (the empirical value of Pearson's χ^2 test - $\chi^2 (n = 10, df = 3) = 8.76$. Therefore, we can conclude that the expertise took place; the experts' opinions are agreed.

The ninth question of the questionnaire was the main, which characterized the need to determine the foreign experts' opinions regarding the style of managing competitive, educational and training activities. Modern trends in coaching dictate new requirements for 'coach-athlete' interaction, which, as it turned out, is relevant not only in the domestic level. Despite the diversity of opinions regarding what management style is the most favorable for successful coaching communication with the modern generation of young basketball players, the vast majority of experts tends to consider the existing need for scientific substantiation of a new management style taking into account the peculiarities, needs, motives and interests of the individual, which is required today (80% of coaches set the maximum rank). Well-known styles of management by the sum of ranks are presented in accordance with current trends in the development of a tolerant society.

Consistency of experts' opinions was confirmed using Kendall's coefficient of concordance, according to this expertise, $W=0.540$ is statistically significant at the level of $p = 0.00103$ (the empirical value of Pearson's χ^2 test is $\chi^2 (n = 10, df = 3) = 16.2$. Therefore, we can conclude that the expertise took place; the experts' opinions are agreed.

The last question of the questionnaire was an open-ended question to find out the current trends that characterize children's and youth basketball in the respondent's country. There are grounds for generalization due to the high percentage of similar answers noted by the interviewed experts. Experts criticized the lack of a built-in training system, which is explained by the decrease in the number of quality coaching staff ready for changes taking into account the current trends in youth basketball throughout the world. The difficulty of taking into account the individual psychological characteristics of the growing generation, their needs, opportunities and interests regarding the form of presentation of theoretical and practical material for studying

and acquiring the necessary skills is highlighted. It is noted that professional clubs do not show interest in the development of youth basketball, prioritizing prestige and financial growth.

The coaches emphasized the problem, which is also a special feature of the Ukrainian youth basketball. It is the need for parents to finance training and competition activities of their kids, which makes it possible for them to intervene in the training process. American coaches are united in pointing out the trends towards professionalization and specialization (engagement in only one sport, even from a very early age) and a shifting towards prioritizing clubs and academies, which are more interested in financial gain.

The positive side of the modern youth basketball is the possibility of obtaining scholarships for studying in universities, which stimulates the desire to compete at a professional level. The Spanish experts analyzed the need to improve individual skills as the main feature of modern basketball in Spain. The representatives of the Yugoslav basketball school were united by the vision of intelligent cooperation between schools and clubs, improvement of the competition system at all levels, and the upgrading the preparation of coaches through practical seminars.

Discussion

The hypothesis regarding the need for drastic changes in coaching served as the basis for the research. Therefore, studying the foreign experts' experience in the training of youth basketball teams allows to confirm the existing acquisitions and highlight the differences.

Current scientific achievements in sports training system allow us to assert the continuous growth of sports results, which requires a constant creative search for new approaches to the educational and training process (Sutula et al., 2016). It is confirmed by the research of the authors who studied the development of sports games in conditions of globalization changes (Borisova & Sushko, 2016; Sushko & Doroshenko, 2016; Bezmylov & Shinkaruk, 2020). The conducted research confirmed the focus of foreign coaches on planning the educational and training process taking into account modern approaches to the psychological characteristics of young basketball players and the need to justify a new style of effective management and communication in order to achieve sports results.

Scientists, who investigate the selection and control in basketball, have made a powerful informational contribution to the study of the basketball players' morpho-functional fea-

Table 9
Assessment of solutions to the question, which style of management of competitive, educational and training activities is the most favorable for successful coaching communication with the modern generation of young basketball players (n=10)

Object of expertise	Statistical indicators			
	Average rank	Sum of ranks	\bar{X}	S
authoritarian	1.4	14	1.4	0.8
democratic	2.6	26	2.6	0.8
liberal	2.3	23	2.3	0.8
there is a need for scientific substantiation of a new style of management, taking into account the peculiarities, needs, motives and interests of the individual	3.7	37	3.7	0.7

tures, their psychological qualities, the growth rates of training capability, as well as monitoring the state of health (Bezmilov & Murzin, 2016; Shinkaruk & Mitova, 2017; Koryahin et al., 2020; Bilokon & Anikeyenko, 2022; Mitova et al., 2022). However, our research expanded the selection approaches taking into account the need to combine the current skills demonstrated by basketball players on today and the possible prospects of realizing individual potential in the future. It poses new challenges to researchers and requires the development of high quality forecasting of the educational and training process.

Conclusions

The conducted survey of foreign coaches helped to clarify the current trends in the youth basketball throughout the world. The distribution of experts' assessments provided the basis for creating the main generalized priorities for the objects of expertise:

- a preference was given to the experience of the USA, which can serve as a guide for the development of basketball;
- the ideal option for organizing the training of young basketball players is a combination of education and training with multi-level selection, based on a basketball school (academy);
- a differentiated methodical support for the athletes' training and professional upgrade of basketball coaches through the implemented licensing system;

- the planning of the educational and training process taking into account modern approaches to the psychological characteristics of young basketball players as a priority component;

- a shared vision was expressed regarding the selection of players for the teams entered in the national championships, which should take place taking into account the combination of current skill and the prospects of realizing individual potential;

- the existing need for scientific substantiation of a new style of management, taking into account the peculiarities, needs, motives and interests of the individual, is indicated.

Consistency of experts' opinions was confirmed using Kendall's coefficient of concordance and allows us to state that the expertise took place and the experts' opinions are agreed.

Author Contributions

A – research methodology development; B – data collection; C – statistical analysis; D – manuscript preparation; E – fundraising: Komotska Oksana^{ABCDE}, Sushko Ruslana^{ABCDE}

Conflicts of Interest

The authors declare no conflict of interest.

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Influence of the functional class of Paralympic cross-country sit-skiers on the effectiveness of competitive activity (on the example of the sprint distance)

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Abstract

Purpose: to determine the value of the functional classification and its influence on the result of the competitive activity of Paralympic cross-country sit-skiers.

Material and methods: to solve the problems of the study, the data of 164 Paralympic cross-country sit-skiers were analyzed, including 98 men and 66 women, participants of the Winter Paralympic Games, namely: Sochi 2014 – 47 athletes (24 men and 25 women) PyeongChang 2018 – 61 men and 25 women), Beijing 2022 – 56 athletes (38 men and 18 women) with a functional class LW10-12 and are representatives of the sitting category, performing in the sprint ski race. During the study, the following methods were used: theoretical analysis of scientific and methodological literature and Internet sources, generalization of best practices, analysis of protocols and videos of competitive activity, methods of mathematical statistics.

Results: changes were revealed in relation to representatives of different classes in the final round of the sprint ski race among athletes of the sitting category: Sochi 2014: men – LW10 – 1 and LW12 – 5, women – LW11 – 2 and LW12 – 4; PyeongChang 2018: men – LW11.5 – 1 and LW12 – 5, women – LW11 – 1 and LW12 – 5; Beijing 2022: men LW10 – 2, LW11.5 – 1 and LW12, women – LW10 – 1, LW10.5 – 1, LW11.5 – 1 and LW12 – 3.

Conclusions: it has been proven that one of the topical issues in holding competitions among athletes with disabilities is the classification process aimed at fair competition between athletes, despite their individual functional capabilities; despite this, modern research proves that there are some factors that affect the result of competitive activity, but which are not taken into account by the classification system; the modern classification strategy is aimed at improving this process (percentage system), which helps to increase the competitiveness of representatives of all classes included in the sitting category.

Анотація

Максим Мішин, Людмила Павленко, Mirosława Cieslicka, Олег Камасєв, Лариса Таран Вплив функціонального класу парализників категорії сидячи на результативність змагальної діяльності (на прикладі спринтерської дистанції). **Мета:** визначити значення функціональної класифікації та її вплив на результат змагальної діяльності парализників категорії сидячи. **Матеріал і методи:** для вирішення завдань дослідження було проаналізовано дані 164 парализників, серед яких 98 чоловіків та 66 жінок, учасників зимових Паралімпійських ігор, а саме: Sochi 2014 – 47 атлетів (24 чоловік та 25 жінок) PyeongChang 2018 – 61 атлетів (36 чоловіки та 25 жінок), Beijing 2022 – 56 атлетів (38 чоловік та 18 жінок), що мають функціональний клас LW10-12 та є представниками категорії сидячи, які виступали в спринтерських лижних перегонах. Під час проведення дослідження застосовувались наступні методи: теоретичний аналіз науково-методичної літератури та джерел Інтернету, узагальнення передового досвіду, аналіз протоколів і відеозаписів

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змагальної діяльності, методи математичної статистики. **Результати:** виявлено зміни щодо представників різних класів у фінальному раунді спринтерських лижних перегонів серед спортсменів категорії сидячі: Sochi 2014: чоловіки – LW10 – 1 та LW12 – 5, жінки – LW11 – 2 та LW12 – 4; PyeongChang 2018: чоловіки – LW11.5 – 1 та LW12 – 5, жінки – LW11 – 1 та LW12 – 5; Beijing 2022: чоловіки LW10 – 2, LW11.5 – 1 та LW12, жінки – LW10 – 1, LW10.5 – 1, LW11.5 – 1 та LW12 – 3. **Висновки:** доведено, що одним із актуальних питань в проведенні змагань серед спортсменів з інвалідністю є процес класифікації, що спрямовано на чесну та справедливу конкуренцію між атлетами, не зважаючи на їх індивідуальні функціональні можливості; попри це, сучасні дослідження доводять що існують деякі чинники, які впливають на результат змагальної діяльності, але які не враховує система класифікації; сучасну класифікаційну стратегію спрямовано на вдосконалення цього процесу (система відсотків), що сприяє підвищенню конкурентоспроможності представників всіх класів, які входять до категорії сидячі.

Introduction

Cross-country skiing as a sport has been part of the official program of the Paralympic Winter Games since the very first, held in 1976 in Ornskoldsvik, Sweden (Gastaldi et al, 2016). For competitions among athletes with disabilities, the rules for cross-country skiing were adapted taking into account their functional capabilities. That is why one of the features of the adapted rules is the use of a functional classification, which is a kind of guarantee of fair and fair competition in Paralympic sports and guarantees the competitiveness of an athlete in his starting group (Briskin et al, 2010, p. 48-49). The main task of the classification is to determine the compliance of the athlete's preserved motor abilities with the minimum criteria for admission to competitions and the distribution of athletes into starting groups for participation in competitions (David et al, 2021).

According to the Classification Code of the International Paralympic Committee (IPC), the classification requirements are the rules of the competition and must be strictly observed and have a great influence on the achievement of sporting results in Paralympic sports (Tweedy et al, 2014; Mishyn, 2017; Grashchenkova et al, 2018)

The distribution into functional classes in each sport is determined by a classification system based on the functional capabilities of athletes to perform the main tasks of competitive activity, which are taken into account regardless of their level of skills or preparedness. In Paralympic skiing, in order to increase competition, a handicap classification is used, which allows combining athletes of different functional classes within the same starting group and provides for assigning a coefficient to a certain functional class that affects the real result of athletes (Kohut et al, 2019, p. 11). Therefore, in cross-country skiing, there are only three starting groups: competing athletes standing, sitting and athletes with visual impairments.

To implement equal competition between athletes, a certain system of percentages is maintained. These percentages are determined by the results of the World Cup competitions from previous years (Lajunen et al, 2020). The percentage system applied to paralyzers in the sitting category ranges from 86%, the most severe violations, to 100%, the minimum violations. Such a percentage system allows, based on the processing of the actual time, by multiplying by a certain percentage, to correct the finish time of each athlete and determine his overall place in relation to other athletes.

In this regard, the analysis of the classification criteria used in Paralympic cross-country skiing and their influence on the results of competitive activity are of particular relevance.

Material and Methods of the research

Participants: in order to solve the research problems, the results of Paralympic cross-country sit-skiers, who competed in the sprint at the Paralympic Winter Games Sochi 2014, were analyzed – 47 athletes, of which 24 were men: LW10 – 1; LW11 – 3; LW11.5 – 6; LW12 – 14 (www.paralympic.org/sochi-2014/results/cross-country/mens-1-km-sprint-sitting, 21.10.2022) and 23 women: LW10 – 2; LW10.5 – 4; LW11 – 7; LW11.5 – 2; LW12 – 8 (www.paralympic.org/sochi-2014/results/cross-country/womens-1-km-sprint-sitting, 21.10.2022); Paralympic Winter Games PyeongChang 2018 – 61 athletes, of which 36 men: LW10 – 3; LW10.5 – 3; LW11 – 5; LW11.5 – 5; LW12 – 20 (www.paralympic.org/pyeongchang-2018/results/cross-country/mens-11km-sprint-sitting, 21.10.2022) and 25 women: LW10 – 1; LW10.5 – 6; LW11 – 5; LW11.5 – 4; LW12 – 9 (www.paralympic.org/pyeongchang-2018/results/cross-country/womens-11km-sprint-sitting); Paralympic Winter Games Beijing 2022 – 56 athletes, of which 38 men: LW10 – 4; LW10.5 – 2; LW11 – 4; LW11.5 – 7; LW12 – 21 (www.paralympic.org/beijing-2022/results/cross-country/men-s-sprint-sitting, 21.10.2022) and 18 women: LW10 – 2; LW10.5 – 5; LW11 – 2; LW11.5 – 1; LW12 – 8 (www.paralympic.org/beijing-2022/results/cross-country/women-s-sprint-sitting). In total, the results of 164 Paralympic cross-country sit-skiers were analyzed, including 98 men and 66 women..

Methods

During the study, the following methods were used: theoretical analysis of scientific and methodological literature and Internet sources, generalization of best practices, analysis of protocols and videos of competitive activities, methods of mathematical statistics.

Procedure

The research was conducted in several stages. At the first stage, the analysis and generalization of the scientific and methodological literature was carried out, which made it possible to study the state of the problem under study. At the second stage, the protocols and videos of the Winter Paralympic Games were analyzed. At the third stage, a comparative analysis of the obtained data was carried out, the results obtained were summarized, and the conclusions of the study were drawn.

Statistical analysis

To process the research data, the methods of mathematical statistics of the quantitative analysis of the results obtained were used. The results of the study were processed using the statistical package Excel 2016 (Microsoft, USA).

Results of the research

Data on the use of the percentage system at the Paralympic Winter Games over the past decade is presented in Table 1. An analysis of the classification system for Paralympic cross-country sit-skiers used at the Paralympic Winter Games revealed some changes in recent years. So, at Paralympic Winter Games PyeongChang 2018, compared to Sochi 2014, changes occurred in the LW11.5 class from 97% to 96%. But despite the decrease in the percentage in the competitive sprint discipline (distance length \approx 1.1 km), the handicap of LW11.5

Table 1

Application of handicap classification depending on the functional class of athletes of cross-country skiing men's and women's sprint – sitting

Functional class	Gender		Paralympic Winter Games		
			Sochi 2014	PyeongChang 2018	Beijing 2022
LW10	Men's	The current percentages, %	86	86	86
		Time handicap, s	0	0	0
	Women's	The current percentages, %	86	86	86
		Time handicap, s	0	0	0
LW10.5	Men's	The current percentages, %	90	90	87
		Time handicap, s	-	9	2
	Women's	The current percentages, %	90	90	87
		Time handicap, s	8	11	2
LW11	Men's	The current percentages, %	94	94	93
		Time handicap, s	12	18	12
	Women's	The current percentages, %	94	94	93
		Time handicap, s	15	21	14
LW11.5	Men's	The current percentages, %	97	96	96
		Time handicap, s	16	22	16
	Women's	The current percentages, %	97	96	96
		Time handicap, s	-	25	19
LW12	Men's	The current percentages, %	100	100	100
		Time handicap, s	20	29	22
	Women's	The current percentages, %	100	100	100
		Time handicap, s	25	34	26

Table 2

The number of athletes cross-country skiing men's sprint – sitting

Paralympic Games	Round	Functional classified					Athletes
		LW 10	LW 10.5	LW 11	LW 11.5	LW 12	
Sochi 2014 Paralympic Winter Games	Qualification	1	-	3	6	14	24
	Semi-final	1	-	1	2	8	12
	Final	1	-	-	-	5	6
PyeongChang 2018 Paralympic Winter Games	Qualification	3	3	5	5	20	36
	Semi-final	2	1	1	2	6	12
	Final	-	-	-	1	5	6
Beijing 2022 Paralympic Winter Games	Qualification	4	2	4	7	21	38
	Semi-final	2	1	1	4	4	12
	Final	2	-	-	1	3	6

class athletes increased from 16 s to 22 s to LW10 (0 s) class athletes, who are considered to be the starting point, due to severe functionality impairments.

It is also worth noting that, despite the preservation of percentages in other classes at the Games in Sochi 2014 and PyeongChang 2018, there was an increase in the time handicap in relation to the athletes of the LW10 class. In LW10.5 women, the handicap increased by 3 s, from 8 to 11 s; in LW11 class women from 15 s to 21 s, in LW11 class men from 12 s to 18 s and LW 11.5 from 16 s to 22 s, which was 6 s. The time handicap changed the most in the LW12 class, both for men and women, by 9 s, from 20 s to 29 s and from 25 s to 34 s, respectively.

In comparing the Paralympic Winter Games PyeongChang 2018 and Beijing 2022, the percentage changes occurred in two classes at once: in LW10.5, it was reduced from 90% to 87%, which led to a minimum difference with the LW10 class and amounted to only 1%; in the LW11 class from 94% to 93%. It is these changes that have increased the chances of winning the LW10.5-11 class at the Beijing 2022 Games compared to

previous ones. Paraathletes of the LW10.5 class received a significant advantage. Their time handicap was only +2 s over the LW10 class, while women's handicap at PyeongChang 2018 was +11 s, Sochi 2014 was +8 s, and men's at PyeongChang 2018 was +9 s. For LW11 athletes, the time handicap decreased by 6 s, from 18 s to 12 s, exactly the same as it was in Sochi 2014, and for LW11 athletes by 7 s, from 21 s to 14 s, which is also less by 1 s compared with Sochi 2014. At the same time, despite maintaining the percentage at 96%, representatives of the LW11.5 class received a temporary advantage of -6 s compared to previous games. So, for men, the handicap decreased from 22 s to 16 s, and for women from 25 s to 19 s. The same thing happened with the LW12 class athletes. For men, the time behind LW10 athletes decreased by 7 s compared to PyeongChang 2018, and amounted to 22 s, but this is 2 s more than Sochi 2014, and for women the lag was 26 s, which is 8 s less than the handicap 2018 and 1s more than in 2014.

Data on representatives of the functional classes LW10-12, who took part in the Paralympic Winter Games 2014-2022, are presented in Tables 2, 3.

Table 3

The number of athletes cross-country skiing women's sprint – sitting

Paralympic Games	Round	Functional classified					Athletes
		LW 10	LW 10.5	LW 11	LW 11.5	LW 12	
Sochi 2014 Paralympic Winter Games	Qualification	2	4	7	2	8	23
	Semi-final	1	1	4	-	6	12
	Final	-	-	2	-	4	6
PyeongChang 2018 Paralympic Winter Games	Qualification	1	6	5	4	9	25
	Semi-final	1	2	2	1	6	12
	Final	-	-	1	-	5	6
Beijing 2022 Paralympic Winter Games	Qualification	2	5	2	1	8	18
	Semi-final	1	4	2	1	4	12
	Final	1	1	-	1	3	6

Analyzing the Sochi 2014 data, it was found that in the sprint distance, which is held throughout the day and consists of 3 rounds: qualification – all Paralympic cross-country sit-skiers take part; semi-finals – athletes who, according to the results of the qualification, are in the top 12, perform; final – athletes who took 1-3 places in the semi-finals get into, among the athletes of the sitting category, 47 Paralympic cross-country sit-skiers took part.

Thus, among men, 24 athletes competed in the qualifying round, of which representatives of the LW10 class accounted for 4%, LW11 – 13%, LW11.5 – 25% and LW12 – 58%. There were no LW10.5 male athletes in Sochi 2014. According to the results of qualification in the next round of the competition, athletes were represented: LW10 – 8%, LW11 – 8%, LW11.5 – 17% and LW12 – 67%. It was found that according to the results of qualification in the semi-finals, the representation of athletes of the LW10 (8%) and LW12 (67%) classes increased, and at the same time, the representation of athletes of the LW11 (8%) and LW11.5 (17%) classes decreased. This trend was also revealed in the final, where, it is worth noting, only representatives of two classes took part: LW10 and LW12, the percentage of which was 17% and 83%, respectively. At the same time, the winners of the competition were: LW12 – I-II place, LW10 – III place.

When analyzing the ratio of the number of athletes in each round of the competition, it was determined that in men, 100% of the LW10 class athletes, 57% of the LW12 class and 33% of the LW11 and LW11.5 classes (Figure 1) got into the semifinals according to the qualification results.

From the semi-finals, only representatives of two classes LW10 – 100% and LW12 – 63% got to the final stage, and compared to the total number of athletes who took part in the qualification – 100% and 36%, respectively.

Among women of the category sitting at the sprint distance, 23 female Paralympic cross-country sit-skiers participated (Table 3). In qualification, unlike men, there were representatives of all classes: LW10 – 9%, LW10.5 – 17%, LW11 – 30%, LW11.5 – 9% and LW12 – 35%. Skiers of 4 classes entered the second round of the competition, who got into the top 12: LW10 – 8%, LW10.5 – 8%, LW11 – 34%, LW12 – 50%, and the representation of athletes in the LW11 and LW12 classes increased, and LW10 and LW10.5 decreased. In the final, as in men, there were representatives of only 2 classes LW11 (34%) and LW12 (66%). I and III places were won by representatives of the functional class LW12, the second place was taken by a female cross-country sit-skier LW11.

As for the representation of athletes of different classes in competitive rounds, a somewhat similar situation was found here, as in men. Thus, representatives of four classes got into the top 12: LW10 – 50%, LW10.5 – 25%, LW11 – 57% and LW12 – 75%, of which only athletes of two classes got into the top 6: LW11 – 50% and LW12 – 67%, which of the total number of female cross-country sit-skiers of these classes amounted to 29% and 50%, respectively (Figure 2).

The dominance of higher functional classes was also revealed at the next Paralympic Winter Games PyeongChang 2018. So, in men, 36 athletes took part in the qualifying round of the competition, including representatives of the functional class LW10 and LW10.5 – 8%, LW11 and LW11.5, LW12 – 56% (Table 2). Athletes of all classes got into the semi-finals, and among the top 12 there were 8% of cross-country sit-skiers athletes of the LW10.5 and LW11 classes, 17% of the LW10 and LW11.5 classes each, 50% were athletes of the LW12 class, the percentage of which increased to 83% in the final. the rest were representatives of the LW11.5 class – 17%. It should be

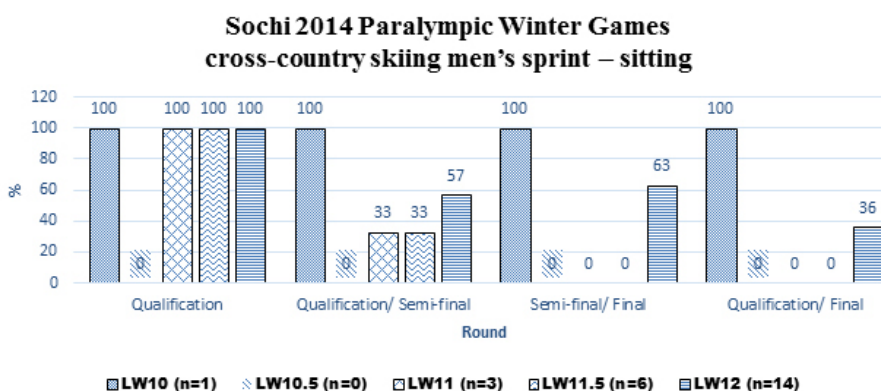


Fig. 1. Percentage of the number of men in each round of the sprint competition at the Paralympic Winter Games Sochi 2014

Sochi 2014 Paralympic Winter Games cross-country skiing women's sprint – sitting

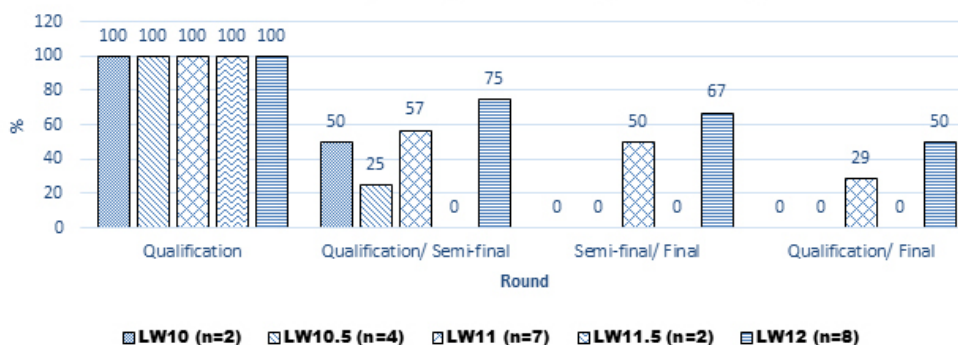


Fig. 2. Percentage of women in each round of the sprint competition at the Paralympic Winter Games Sochi 2014

PyeongChang 2018 Paralympic Winter Games cross-country skiing men's sprint – sitting

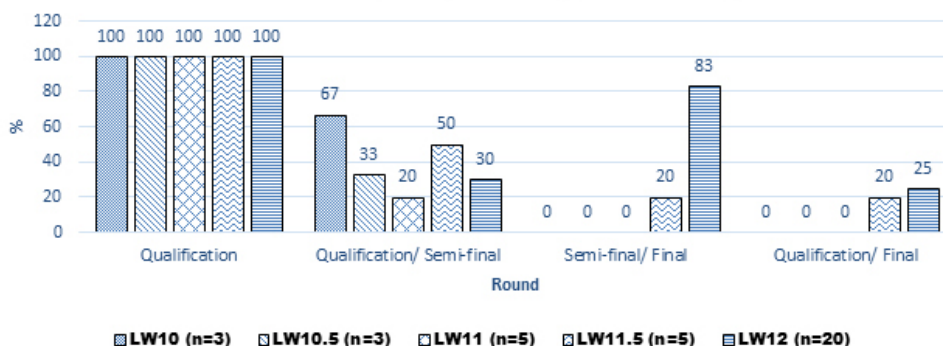


Fig. 3. Percentage of men in each round of sprint competition at Paralympic Winter Games PyeongChang 2018

PyeongChang 2018 Paralympic Winter Games cross-country skiing women's sprint – sitting

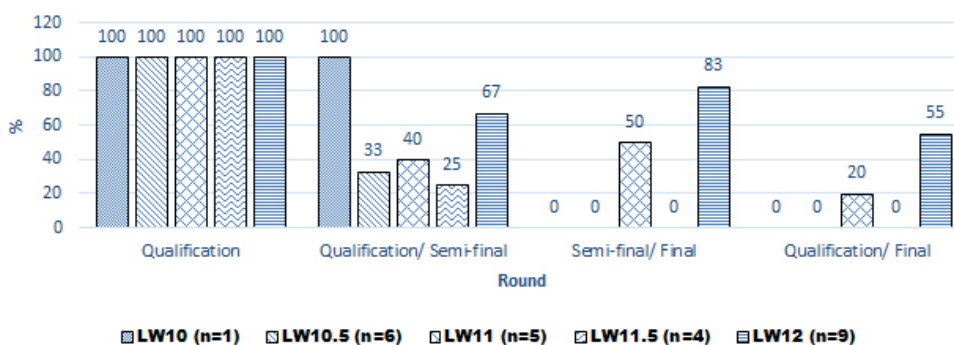


Fig. 4. Percentage of women in each round of sprint competition at Paralympic Winter Games PyeongChang 2018

noted that all prize-winning places were won by athletes of the LW12 class.

Analysis of the percentage of representatives of the same class in the competitive rounds showed that 20% of the representatives of the LW11 class, 30% of the LW12 class athletes, 33% of the LW10.5 class, 50% of the LW11.5 class, 67% of the LW10 class got into the semifinals (Figure 3).

But in the final, as in previous games, there were representatives of only two functional classes. So, 20% of LW11.5 class athletes and 83% of LW12 class athletes got into the top 6 cross-country sit-skiers athletes from the representatives of the

semifinals. As for the representatives of these two classes, out of the total number of athletes participating in the Paralympic Winter Games PyeongChang 2018, 20% of the LW11.5 class athletes remained, and 25% of the LW12 class.

Analysis of data from the 2018 women's PyeongChang sprint cross-country skiing showed a similar pattern for men. According to the qualifying competitions, in which 25 athletes took part: LW10 – 1, LW10.5 – 6, LW11 – 5, LW11.5 – 4, LW12 – 9, which amounted to 4%, 24%, 20%, 16% and 36%, representatives of all functional classes got into the semifinals, the percentage representation of which was: LW10 – 8%,

LW10.5 – 17%, LW11 – 17%, LW11.5 – 8% and LW12 – 50%. According to the results of the semi-finals, only the representatives of LW11 – 17% and LW12 – 83% got to the final (table 3). As in the previous Paralympic Winter Games, I and III places were won by cross-country female sit-skiers of the functional class LW12, the second place was taken by a representative of the LW11 class.

Data on the transition of representatives of each functional class to the next round of the competition is presented in Figure 4.

So, according to the results of the qualification, 100% of LW10 class female athletes, 67% of LW12 class, 40% of LW11 class, 33% of LW10.5 class representatives and 25% of LW11.5 class representatives went to the semifinals. At the same time, according to the results of the semi-finals, only the female athletes of two classes, namely 83% of the LW12 class cross-country female sit-skiers and 50% of the LW11 class, made it to the final. As for the percentage representation of female athletes from the total number of them in the qualification, in the final it was equal to LW11 – 20%, and in the LW12 class – 55%.

At the Paralympic Winter Games Beijing 2022, 38 athletes took part in the sprint distance (Table 2). In the qualifying competitions among men, representatives of the functional classes were represented as follows: LW10 – 11%, LW10.5 – 5%, LW11 – 11%, LW11.5 – 18% and LW12 – 55%. Among the 12 athletes who made it to the semi-finals, representatives of all classes were also identified, namely: LW10 – 18%, LW10.5 – 8%, LW11 – 8%, LW11.5 – 33% and LW12 – 33%. Compared to Paralympic Winter Games Sochi 2014 and PyeongChang

2018, representatives of three classes got into the main final of the competition: 17% – LW11.5, 33% – LW10, 50% – LW12. But it is worth noting that, despite the fact that representatives of the LW12 class made up half of the finals, they all ended up outside the top three. The 1st and 2nd places were won by representatives of the LW10 functional class, the bronze medalist of the Games was the LW11.5 class cross-country sit-skier.

According to the analysis of representatives of different classes in the final rounds of the competition, it was determined that 57% of the LW11.5 class athletes, 50% of the LW10 and LW10.5 class athletes, 29% of the LW11 class and 19% of the LW12 class got into the semifinals (Figure 5).

Among these cross-country sit-skiers, 100% of LW10, 75% of LW12 and 25% of LW11.5 qualified for the finals. As for the representatives of functional classes from the total number of athletes who took part in the competition, 50% of the athletes of the LW10 class and 14% of the LW11.5 and LW12 classes made it to the final.

18 female cross-country sit-skiers took part in the women's competitions at the Paralympic Winter Games Beijing 2022 (Table 3). 11% of the LW10 class, 28% of the LW10.5 class, 11% of the LW11 class, 6% of the LW11.5 class and 44% of the LW12 class were represented in the qualification. According to the results of the qualifying competitions, athletes of all functional classes made it to the semi-finals and were represented by the following composition: 9% of the athletes of the LW10 and LW11.5 classes, 33% of the LW10.5 and LW12 classes and 16% of the LW11 class. Female cross-country sit-skiers of 4 functional classes reached the final: LW10, 10.5, 11.5 and 12,

Beijing 2022 Paralympic Winter Games cross-country skiing men's sprint – sitting

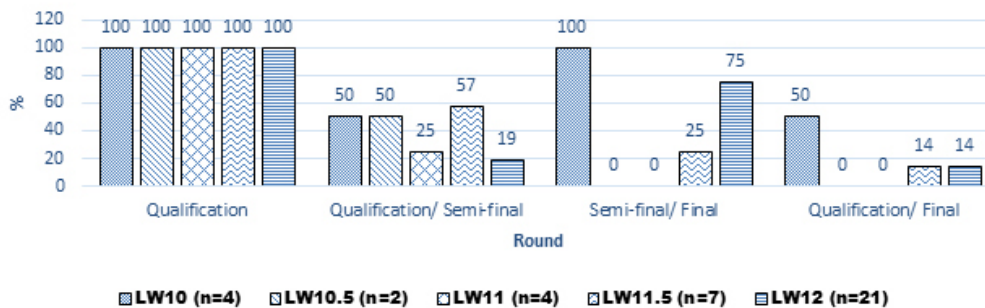


Fig. 5. Percentage of men in each round of the sprint competition at the Paralympic Winter Games Beijing 2022

Beijing 2022 Paralympic Winter Games cross-country skiing women's sprint – sitting

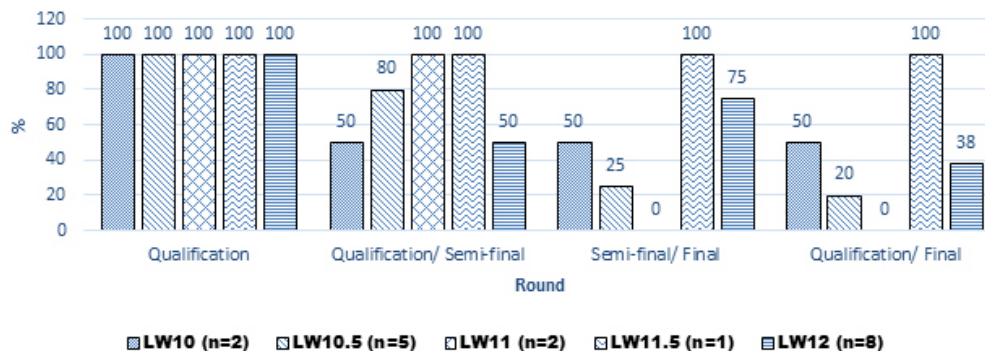


Fig. 6. Percentage of women in each round of the sprint competition at the Paralympic Winter Games Beijing 2022

but the representation of athletes in the LW12 class was 50%. It should be noted that the 1st place was won by a female athlete of the LW10 class, the 2nd place was taken by a representative of the LW12 class, and the 3rd place was taken by a female athlete of the LW10.5 class.

Considering the percentage of athletes who made it to the semi-finals, 50% of the athletes of the functional class LW10 and LW12, 80% of the athletes of the LW10.5 class and 100% of the representatives of the LW11 and LW11.5 classes were determined (Figure 6).

25% of LW10.5 class, 50% of LW10 class, 75% of LW12 class and 100% of LW11.5 class from the semi-finals competed in the final. Of the total number of female athletes who took part in the Paralympic Winter Games Beijing 2022 Cross-country skiing women's sprint – sitting, 20% of the female athletes of the functional class LW10.5, 38% of the functional class LW12, 50% of the female athletes of the LW11.5 class reached the final.

Discussion

This study was aimed at determining the influence of the functional class on the effectiveness of the competitive activity of athletes united in the sitting category, and the objectivity of the classification process at the present stage of development of the Paralympic ski race.

An analysis of modern scientific sources has determined that today, for athletes with disabilities, the problem of classification remains one of the most important and rather ambiguous. Classifiers face difficulties in classifying athletes with several hundred different types and degrees of disability, and sometimes reducing or exaggerating the degree of existing disability during the classification procedure. Despite the evolution of Paralympic Classification systems from early systems based on medical indications to systems currently in use, the classification process has faced objections and protests from both athletes and coaches. Experts note the need for a classification system for specific sports, and the methods used in them must be supported by scientific data developed on the basis of interdisciplinary scientific research, that is, based on evidence and evidence-based data focused on the relationship between the functional impairment of athletes and key factors determining sports results (Connick et al, 2018; Pastor et al, 2019).

Questions about the perfection of the classification process also arise in Paralympic cross-country skiing. The modern classification system distributes athletes included in the sitting category into 5 classes: LW10, LW10.5, LW11, LW11.5, LW12, with lower limb dysfunction, but different ranges of capabilities associated with trunk control (Gastaldi et al, 2016). It was to test the ability to hold the body that the Test-Table-Test was developed. This is a functional test, which is performed in a sitting position and consists of four tasks: 1) torso tilt forward by 45°; 2) torso tilt back by 45°; 3) lifting the ball over your head; 4) the maximum rotation of the body to the right-left, the results of which determine the class among athletes of the sitting category (Pernot, 2012). However, modern researchers draw attention to an additional disadvantage of the classification process, which is associated with the posture in which the athlete sits. Experts identify four sitting postures «normal», «long sit», «kneeing», and «knee-high» (Rapp et al, 2016). Although trunk stability can be improved by strengthening the trunk muscles, athletes with a severe impairment, such as those in the LW10 class, cannot improve balance control while sitting. To overcome weakened muscle control and improve trunk stability,

they adopt a sitting position with knees higher than the hips – «knee-high», which allows for low amplitude and limited trunk movement. In contrast, the «kneeing» position, with the hips above the knees, is commonly used by athletes with good torso control to take advantage of increased torso ranges and control of force direction (Gastaldi et al, 2012; Rosso et al, 2019; Ohlsson et al, 2022). The use of the «knee-high» position by the LW10 class athletes puts them in unequal conditions with the LW12 class, who use the «kneeing» position, which has a performance of 15% or more, and according to the classification system, the percentage of LW12 class athletes is 100%, and LW10 class – 86%, i.e., the difference is 14% (Lajunen, 2020). This is also confirmed by our research. So, according to the results of athletes in the sprint distance at Paralympic Winter Games Sochi 2014 and PyeongChang 2018, among 6 winners in men, 5 were representatives of the LW12 class, and in women 4 representatives of the LW12 class and 2 – LW11.

However, the IPC continuously pursues a classification strategy that promotes fair competition through a clear, transparent and fair sport functional classification process and contributes to the sporting achievement of Paralympic athletes (IPC Athlete Classification Code, 2015). The results of this strategy are that the dominance of LW12 athletes has changed at the Paralympic Winter Games Beijing 2022. So, in the men's final there were 3 representatives of the LW12 class, but the winners were the athletes of the LW10 (2) and LW11.5 classes. For women, 3 representatives of the LW12 class were also represented in the final, but the female athlete of the LW10 class became the champion, representatives of the LW12 and LW10.5 classes, respectively, won II and III places.

In our opinion, we should also note other factors that may affect the results of the competition in different ways, but which are not currently taken into account by the classification system. Cross-country skiing is a sport with variable competition conditions (Taran, 2017). The defining characteristic of the competition is the variability of the profile of tracks and conditions, which puts forward specific requirements for competitive activity, and, consequently, for the preparedness of athletes (Platonov, 2020, p. 19). Athletes of heavier classes (LW10-10.5) are very sensitive to the presence of large elevation changes and the presence of protracted slides on the track, which affects the performance of even the most successful athletes (Bernardi et al, 2012). At the same time, excessive stress experienced by athletes increases the risk of shoulder injury due to subacromial oppression (Sasadai et al, 2022). It should be noted that on the basis of many years of experience, in addition to complex relief segments, it is possible to determine some more factors that affect the final result of competitive activity, such as snowfall, wind, low temperature (Kamaev et al, 2020; Pavlenko et al, 2021). But we clearly understand that it is very, very difficult to take into account these factors in the qualification process. Most participants in the Paralympic competitions believe that no classification system can be perfect, it needs to be understood the basic provisions on which it is based.

Conclusions

The conducted research proved that one of the topical modern issues in holding competitions among athletes with disabilities is the classification process aimed at building fair and fair competition between athletes, despite their individual functional capabilities. The improvement of the classification system is influenced by the IPC improvement strategy and research focused on the relationship between athlete functional

impairment and key determinants of athletic performance.

The main provision of the system of classification of Paralympic cross-country sit-skiers is the stability of the torso. Determining the range of body control possibilities refers the athlete to one of the functional classes: LW10, LW10.5, LW11, LW11.5, LW12. Despite this, modern research proves that there are some factors that affect the result of competitive activity, but which are not taken into account by the classification system.

Data analysis of Paralympic Winter Games Sochi 2014, PyeongChang 2018, Beijing 2022 determined the change in the percentage system in classes LW11.5 from 97% to 96% (2018), LW10.5 from 90% to 87%, LW11 from 94% to 93% (2022), which contributed to an increase in the competitiveness of representatives of these classes.

Analysis of the results of cross-country sit-skiers in the sprint at the Paralympic Winter Games revealed changes in the attitude of representatives of different classes in the final rounds of the competition. So, in Sochi 2014 among men in the finals, classes LW10 – 1 and LW12 – 5 were represented, which amounted to 100% and 36%, respectively, of the total number of athletes in these classes, and for women LW11 – 2 (29%) and LW12 – 4 (50%). In PyeongChang 2018, in the final among

men, the classes LW11.5 – 1 (20%) and LW12 – 5 (25%) were represented, among women – LW11 – 1 (20%) and LW12 – 5 (55%). In Beijing 2022, in the final among men, the classes LW10 – 2 (50%), LW11.5 – 1 (14%) and LW12 – 3 (14%) were represented, among women – LW10 – 1 (50%), LW10.5 – 1 (20%), LW11.5 – 1 (100%) and LW12 – 3 (38%).

Author Contributions

Maksym Mishyn – study design/planning, statistical analysis, manuscript preparation;

Liudmyla Pavlenko – data collection, data analysis, data interpretation, fundraising;

Oleg Kamaiev – data analysis, data interpretation;

Larysa Taran - data entry, analysis/literature search.

Conflicts of Interest

The authors declare no conflict of interest.

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Analysis of the dynamics of physical development of cadets as a result of the application of crossfit equipment

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Abstract

Purpose: to investigate the impact of classes in the program of physical training of cadets of military institutions of higher education at the stage of primary training with the use of crossfit tools on the physical development of cadets.

Material & Methods: was organized and conducted. anthropometric study and calculation of indices of physical development of cadets. The study was conducted in the sanitary section of the National Academy of Ground Forces named after Hetman Petro Sahaidachny by medical personnel 30 minutes after the ascent.

Results: it was determined that conducting training sessions using crossfit equipment has a positive effect on strengthening the musculoskeletal system of cadets and improving their muscular system (especially the muscles of the back, legs and shoulder girdle). During the study of body weight, there were positive changes in the direction of weight reduction by 3.62 kg ($t=2.52$; $p<0.05$) at the end of the experiment; the average value of VL in EG improved compared to the initial data by 245.48 ml ($p<0.001$), and in EC – by 78.22 ml ($p<0.05$); the difference between the dynamometry indicators of the left and right hand of the EG at the first and fifth stages of the study was 3.18 kgc and had positive significant changes ($t=3.18$; $p<0.01$), the difference between the dynamometry indicators of the left and right hand of the CG was 2.19 kgf and had positive unreliable changes ($t=1.85$; $p>0.05$). As a result of the pedagogical experiment, it was determined that the dynamometry indicators of the right and left hands of EG and CG cadets at the end of the experiment differ significantly ($p<0.01$), which indicates the effectiveness of the physical training program. The chest circumference of the cadets at the beginning and at the end of the experiment has reliably stable results and is only 2.04 cm ($p>0.05$) and are reliable. As for the Quetelet index, there were positive changes towards improvement, namely: at the beginning of the experiment it was 4.85 g/cm ($t=0.69$; $p>0.05$), at the end – 25.80 g/cm ($t=4.09$; $p<0.001$), which emphasizes the positive impact of exercise and crossfit.

Conclusions: it has been proven that the application of a physical training program at the stage of primary training with the use of crossfit equipment ensures the positive development and strengthening of the musculoskeletal system of cadets, the improvement of their muscular system. Under the influence of systematic crossfit classes, the VL increases, the circumferences of the chest and shoulders increase, the volume of the waist decreases, and body weight stabilizes. These circumstances have a positive effect on the work capacity of cadets, improve their physical health, improve their well-being and increase their work efficiency.

Анотація

Артур Одеров, Сергій Романчук, Орест Лесько, Олег Ольховий, Віктор Романчук, Олег Небожук, Іван Пилипчук, Андрій Полтавець. Аналіз динаміки фізичного розвитку курсантів за результатами застосування засобів кросфіту. **Мета:** дослідити вплив занять за програмою фізичної підготовки курсантів військових закладів вищої освіти на етапі первинного навчання із застосуванням засобів кросфіту на фізичний розвиток курсантів. **Матеріали і методи:** було організовано

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fphysical qualities
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Ключові слова:

ффізичні якості
курсанти
кросфіт
фізичний розвиток
експеримент
військовий заклад вищої освіти

та проведено. антропометричне дослідження та розрахунок індексів фізичного розвитку курсантів. Дослідження проводилося у санітарній частині Національної академії сухопутних військ імені гетьмана Петра Сагайдачного працівниками медичної служби через 30 хвилин після підйому. **Результати:** визначено, що проведення тренувальних занять із застосуванням засобів кросфіту позитивно впливає на зміцнення опорно-рухового апарату курсантів та удосконалення їх м'язової системи (особливо м'язів спини, ніг та плечового поясу). У процесі дослідження маси тіла відбулися позитивні зміни у бік зменшення ваги на 3.62 кг ($t=2.52$; $p<0.05$) наприкінці експерименту; середнє значення ЖЄЛ у ЕГ покращилося порівняно з вихідними даними на 245.48 мл ($p<0.001$), а в ЕК – на 78.22 мл ($p<0.05$); різниця між показниками динамометрії лівої та правої руки ЕГ на першому і п'ятому етапах дослідження становила 3.18 кгс та має позитивні достовірні зміни ($t=3.18$; $p<0.01$), різниця між показниками динамометрії лівої та правої руки КГ становила 2.19 кгс та мала позитивні недостовірні зміни ($t=1.85$; $p>0.05$). У результаті педагогічного експерименту визначено, що показники динамометрії правої та лівої рук курсантів ЕГ та КГ наприкінці експерименту достовірно відрізняються ($p<0.01$), що свідчить про ефективність програми фізичної підготовки. Щодо індексу Кетле, то відбулися позитивні зміни у бік покращення, а саме: на початку експерименту він становив 4.85 г/см ($t=0.69$; $p>0.05$), наприкінці – 25.80 г/см ($t=4.09$; $p<0.001$), що підкреслює позитивний вплив занять фізичними вправами та кросфітом. **Висновки:** доведено, що застосуванням програми фізичної підготовки на етапі первинного навчання із застосуванням засобів кросфіту забезпечено позитивний розвиток та зміцнення опорно-рухового апарату курсантів, удосконалення їх м'язової системи. Під впливом систематичних занять кросфітом збільшується ЖЄЛ, збільшуються окружності грудної клітки, зменшується об'єм талії, стабілізується маса тіла. Наведені обставини позитивно впливають на працездатність курсантів, покращують стан фізичного здоров'я, сприяють покращенню самопочуття та підвищенню ефективності роботи.

Introduction

To date, the Armed Forces of Ukraine have taken a significant step towards the gradual transition to the training of military specialists according to the standards of the armed forces of the leading NATO countries. The main difference of which is the non-implementation of organizational and personnel, military-technical and ideological changes, rethinking and justification of the process of formation of military-professional readiness of servicemen (Afonin V.M. et al., 2017; Oderov A. et al. 2022).

The most important element of the professional readiness of servicemen to perform the assigned tasks is their physical readiness, namely, the specific physical condition that allows the serviceman to fulfill the modern requirements of combat, which are conducted on the territory of our state and combat tasks in accordance with the assignment (Levchuk V.O., 2014; Fedak S., 2013).

At the same time, despite purposeful positive changes in the modernization of weapons and military equipment, the research of many scientists has proven that the performance of tasks in the combat zone is accompanied by significant physical stress (Starchuk O.O. et al., 2016; Fedak S., 2015; Neschadym M.I., 1998).

Recently, in Ukraine, there has been a steady trend to-

wards the deterioration of the physical health of young people (about 76%), which in turn has a negative effect on the intensification of the educational process, a decrease in physical activity, the imperfection of physical education, etc. (Petrova A. et al., 2022). It should be noted that today crossfit is steadily gaining momentum and popularity among modern youth. Thus, we believe that the introduction of CrossFit as an innovation for military institutions of higher education in the system of physical training is appropriate, as it will contribute to increasing the interest of cadets in physical education, increase motor activity and, as a result, improve the level of physical health of future defenders.

Regarding the use and application of crossfit in the practice of physical education, special physical training and sports with cadets of military institutions of higher education, we affirm that the list of issues of the work program of the educational discipline (a mandatory component of the program) provides for the study and improvement of exercises by means of crossfit.

Thus, the experience of conducting combat operations by military personnel on the territory of Ukraine proves that during the execution of combat missions to destroy the Russian enemy, raid actions are usually used, therefore, the success of combat missions largely depends on the physical readiness of military personnel (Collection of standards for combat training of the Ground Forces of the Armed Forces of Ukraine, 2002; Krasota, 2007; Loiko O.M., et al., 2013). All these events gave us the opportunity to propose, develop and test the effectiveness of the physical training program for cadets of military institutions of higher education for the first two years of study using Crossfit equipment, which, in turn, will ensure and accelerate the adaptation of cadets to the conditions of professional activity, increase the level of general physical fitness with an emphasis on the development of strength and endurance, will improve the physical development and functional state of cadets, increase the body's resistance to the adverse factors of military and professional training, develop moral and willpower and professionally important psychological qualities, form motivation for independent training in physical training and sports (Kyrpenko V., et al., 2015).

The purpose of the study: to analyze and investigate the impact of classes on the physical training program of cadets of military institutions of higher education at the stage of primary education with the use of Crossfit tools on the physical state of health.

Material and Methods of the research

The study was organized and conducted at the National Army Academy in the period from 2019 to 2021. It was conducted in five stages: the first stage - the beginning of primary military training - the beginning of the 1st semester (initial data); the second stage - the beginning of the first semester - the end of the first semester; the third stage - the beginning of the second - the end of the II semester; the fourth stage - the beginning of the third - the end of the III semester; the fifth stage - the beginning of the fourth - the end of the IV semester. The indicators that the cadets showed at the end of the research stage were taken for the analysis. For the reliability of the study, we formed experimental ($n=94$) and control ($n=94$) groups aged 17-24 using the method of equal pairs.

The following crossfit exercises were applied to the content of the program at the first stage: walking with forward and backward lunges; running with high knee lift; pulling up with a grip to the middle; jumping on one leg in motion; bending and

stretching of the arms in a lying position (hands at shoulder width): raising the legs, bent at the knees to the chest from the position of hanging on the crossbar; flexion and extension of the trunk; keeping the body in a horizontal position (bar) resting on the elbows; jumping up from a squat position.

The content of the program at the second and third stages - bending and extending the arms in a lying position with the palms apart in the lower position; pulling up on the crossbar with a narrow grip; jumping out of a full squat forward; keeping the body in a horizontal position (plank) while resting on the hands, burpee; squatting on two legs; running 60 m; lunge on one leg forward; simultaneous lifting of legs and trunk; touching the toes of the feet with the fingers from the position of lying on the back; flexion and extension of the trunk; jumping over a gymnastic bench with a high knee lift; kettlebell deadlift (16/24 kg) to the chin; raising straight legs lying on the back; swing a kettlebell (16/24 kg) with two hands above the head; flexion and extension of the trunk while holding the meatball on the chest; jumping on and off the bollard; jumping rope; 30 m run; holding a 5 kg meatball for 20 seconds; 1 km run; performing exercises as part of the crew, based on the transfer of the partner 400 m.

In the fourth and fifth stages - carrying a log 200 m, squatting with a log, lifting a log up from one shoulder and lowering it to the other, pulling a rope, jumping in and out of a trench, running in full equipment 800 m; overcoming a ditch 2 m wide, a labyrinth, a 2-meter fence; transfer of 10 ammunition boxes filled with sand 600 m; running 1500 m, bending and extending the arms in a supine position.

All participants of our study gave their informed consent to participate in the experiment. Research was conducted and performed in accordance with the ethical standards of the Declaration of Helsinki.

The research methods consisted in the organization and analysis of indicators of height, mass, body mass index, dynamometry of the right and left hands, static dynamometry, Ketele indices, vital and strength indices, index of static strength of the cadets in order to determine the sufficient level of the functional state of the cadets and readiness to perform tasks according to destination. The study was conducted in the sanitary section of the National Army Academy by medical personnel 30 minutes after liftoff. A height meter, medical scales, manual dynamometer, standing dynamometer, spirometer, centimeter tape were used.

The study was conducted in compliance with the requirements of the unified methodology of anthropometric studies (Marfell-Jones M. et. al., 2012). To assess the physical development of the participants, the indices were calculated:

The Quetelet weight-height index was used to determine the correspondence of body weight to height indicators, which was calculated according to the formula:

$IR = m/h$ (where m is the cadet's weight in grams; h – cadet's height in centimeters) and evaluated according to the weight-height index rating scale (Pichugin MF. et. al., 2010).

Life index (hereafter \dot{Z}) determined by the formula: $\dot{Z} = GEL (ml) \setminus weight (kg)$. 50-60 ml/kg is considered average for young men. This indicator characterizes the work of the cadets' respiratory system.

The strength of the hands and individual muscle groups was studied by the dynamometry indicators of the left and right hands.

The dynamometry of the deadlift was determined using the strength index (the strength index = deadlift (kgf) \ weight (kg) x 100). The average indicator of standing strength for men

is 200-220%.

The methods of mathematical statistics were used in order to prove the regularities discovered in the research process. Mathematical and statistical calculations were carried out using computer programs, in particular "Excel", "SPSS", "STATISTICA 7" in the operating system "Windows Vista".

The application of the methods described above made it possible to organize a study, to check the indicators of EG and CG cadets, to prove the effectiveness of the implementation of the physical training program for cadets of military institutions of higher education at the stage of primary training with the use of crossfit equipment.

Results of the research

In order to study the influence of classes in the program of physical training of cadets at the stage of primary training with the use of crossfit tools on the physical development of cadets, we analyzed the obtained indicators.

In particular, the analysis of the growth indicators of EG and CG cadets allows us to note their increase during the entire pedagogical experiment, however, no significant difference was recorded ($p > 0.05$). In addition, the average value of the height of the cadets EG and CG does not reliably differ from each other during the entire period of the experiment ($p > 0.05$).

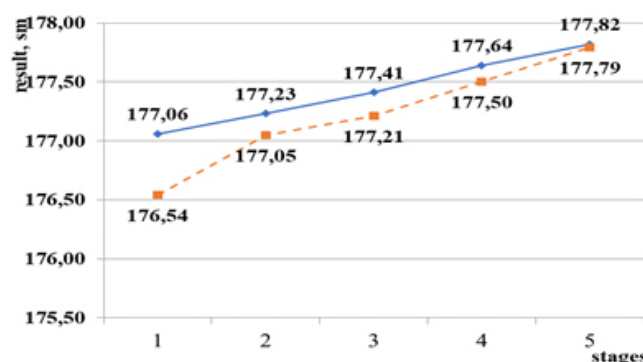


Fig. 1. Growth dynamics of EG and CG cadets during the experiment

— results of cadets of the CG;
- - - the results of the cadets of the EG.

Comparative analysis showed a significant difference in indicators only at the second stage (by 0.18 cm; $t=0.14$; $p > 0.05$) and on the fifth - 0.07 cm; $t=0.03$ $p > 0.05$ (). At the remaining stages, an unreliable difference in indicators was found.

A comparative analysis of body weight (fig. 2) showed that a significant difference between EG and CG indicators is observed only at the third stage of the study and is 2.83 kg ($t=2.20$; $p < 0.05$) and at the fourth stage - 2.89 kg ($t=2.28$; $p < 0.05$).

The difference between the cadets' body weight at the beginning and at the end of the experiment is only 2.08 kg ($p > 0,05$) and has seasonal fluctuations in range 1.64-2.40 kg.

The comparative analysis of the vital capacity of the lungs (fig. 3) showed the existence of a significant difference between the indicators of EG and CG only on the fourth (157.30 ml; $t=2.82$; $p < 0.01$) and at the fifth stages of the research (164.71 ml; ($t=2.92$; $p < 0.01$). At the remaining stages of the study, an unreliable difference in indicators was found.

The study of vital capacity of the lungs determined that during the experiment its indicators in EG cadets in the III and

IV semesters reliably improved ($p < 0.001$), and in CG there is no significant difference ($p > 0.05$).

At the end of the experiment, the average value vital capacity of the lungs in EG improved compared to the initial data on 245.48 ml ($p < 0.001$), and in EG – on 78.22 ml ($p < 0.05$), which emphasizes the positive impact of physical exercises and sports.

A comparative analysis of the dynamometry of the left hand showed (fig. 4) that a significant difference between the indicators of EG and CG is observed only at the fifth stage of the study and is 2.79 kgf ($t = 2.35$; $p < 0.05$).

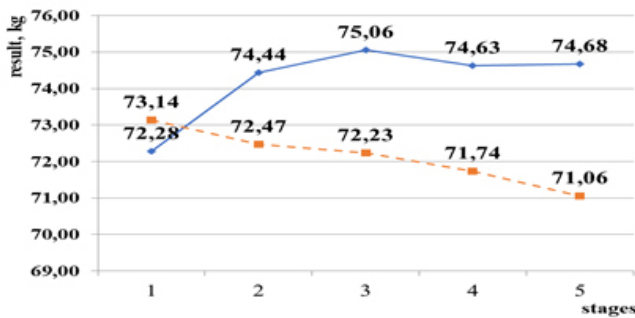


Fig. 2. Body mass dynamics of EG and CG cadets during the experiment

— results of cadets of the CG;
 - - - the results of the cadets of the EG.

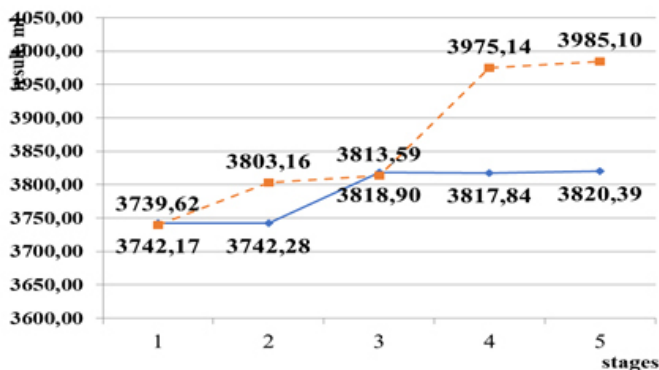


Fig. 3. Dynamics of the vital capacity of the lungs of EG and CG cadets during the experiment

— results of cadets of the CG;
 - - - the results of the cadets of the EG.

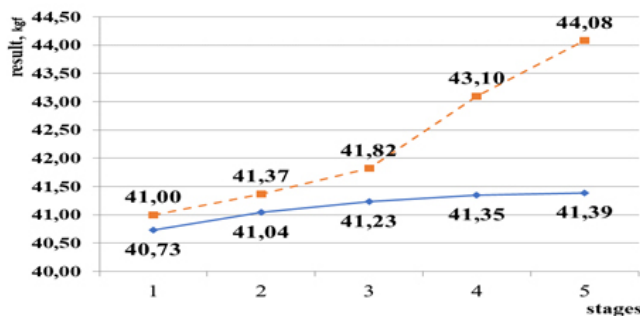


Fig. 4. Dynamics of left hand dynamometry indicators of EG and CG cadets during the experiment

— results of cadets of the CG;
 - - - the results of the cadets of the EG.

Our arm strength studies have proven the positive impact of crossfit training on arm strength development. A significant difference in the values of the indicators of CG and EG cadets is observed in the IV semester - the dynamometry indicators of the right hand of EG and CG cadets at the end of the experiment reliably differ by 2.38 41, ($p < 0.05$). The values of the muscle strength indicators of the right hand of EG cadets in the IV semester are significantly better than at the beginning of the experiment by 3.18 kgf ($p < 0.01$). As a result of the pedagogical experiment, it was determined that the dynamometry indicators of the right and left hands of EG and CG cadets at the end of the experiment are reliably different ($p < 0.01$), which testifies to the effectiveness of the program of physical training of cadets of military institutions of higher education at the stage of primary training with the use of crossfit tools.

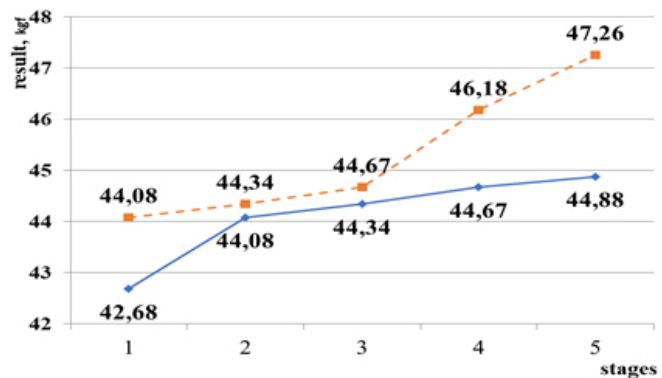


Fig. 5. Dynamics of dynamometry indicators of the right hand of EG and CG cadets during the experiment

— results of cadets of the CG;
 - - - the results of the cadets of the EG.

The dynamics of static dynamometry indicators (fig. 6) of EG and CG cadets has a progressive character throughout the experiment: in the IV semester, the average value of the indicator of back strength development in CG is significantly higher than the indicator at the beginning of the experiment by 2.26 kgf ($p < 0.05$), in EG - by 5.30 kgf ($p < 0.01$), which determines the effectiveness of the program of physical training of cadets of military institutions of higher education at the stage of primary training with the use of crossfit tools.

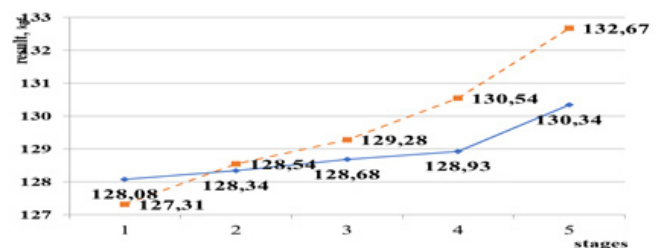


Fig. 6. Dynamics of static dynamometry indicators of EG and CG cadets during the experiment

— results of cadets of the CG;
 - - - the results of the cadets of the EG.

A comparative analysis of Kettle's weight-height index showed (fig. 7) a significant difference only at the fourth stage of the study and is 17.41 g/cm ($t = 2.72$; $p < 0.01$) and at the fifth stage - 25.80 g/cm ($t = 4.09$; $p < 0.001$). At the I-III stages, an unreliable difference between the indicators was found.

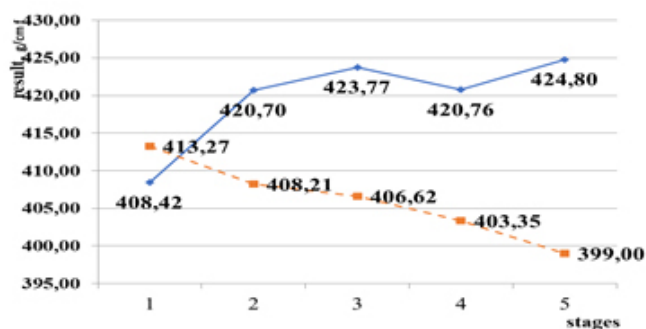


Fig. 7. Dynamics of indicators of the Quetelet index of EG and CG cadets during the experiment

— results of cadets of the CG;
 - - - the results of the cadets of the EG.

The dynamics of the Quetelet index of EG cadets is reliably stable ($p > 0.05$) at all stages except the 5th where $p < 0.01$. In CG cadets, the average value of the Quetelet Index reliably increases during the experiment by 16.04 g/cm ($p < 0.01$).

The comparative analysis of the vital index showed (Fig. 8) that the significant difference between EG and CG indicators is only at the fourth stage of the study - 4.88 ml/kg ($t = 3.97$; $p < 0.001$) and at the fifth stage of the study - 5.89 ml/kg ($t = 4.86$; $p < 0.001$).

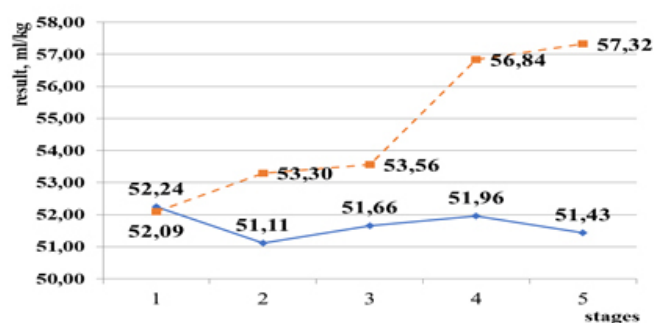


Fig. 8. Dynamics of the vital index of cadets EG and CG during the experiment

— results of cadets of the CG;
 - - - the results of the cadets of the EG.

The study of this indicator in EG and CG cadets allows us to note that before the start of the experiment in 1-2 semesters of study, they are reliably equal ($p > 0.05$), and in the 3rd-4th semesters, the indicators of the vital index of the cadets of the EG significantly exceed those of the CG by 4.88 ml/kg ($p < 0.001$) and 5.89 ml/kg ($p < 0.001$) in accordance. The dynamics of life index indicators of EG and CG cadets is positive. In EG, the reliability of the difference between the indicators at the beginning and at the end of the experiment is 5.23 ml/kg ($p < 0.001$), which indicates an increase in the functional capabilities of the cadets' respiratory system during crossfit classes at the initial training stage.

A comparative analysis of the static strength index showed (fig. 9) that the difference between the indicators of EG and CG at the 1st stage is 6.25 % ($t = 0.79$, $p > 0.05$), at the II stage - differ by 7.22 % ($t = 1.67$; $p > 0.05$), at the third stage, an unreliable difference was found ($t = 2.58$; $p < 0.01$), at the IV stage of the study - 12.09 % ($t = 2.70$; $p < 0.01$), at the V stage - 19.83 % ($t = 3.79$; $p < 0.01$).

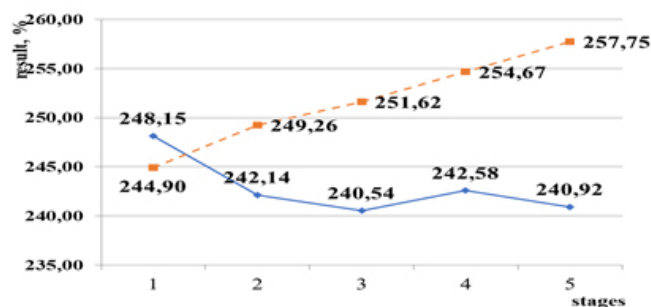


Fig. 9. Dynamics of changes in the static strength index of EG and CG cadets during the experiment period, (%)

— results of cadets of the CG;
 - - - the results of the cadets of the EG.

The study of the static strength index made it possible to determine that the indicators of EG and CG cadets at the beginning of the experiment were at the "below average" level. For CG cadets in the I-II semesters, the value of the static strength index is estimated as "below the average", and in the III-IV semesters - as "average". The indicators of EG cadets in the I-III semesters are at the average level, and in the IV semester - at the "above average" level for men.

Discussion

In scientific works of leading scientists of the field (Bazilevich NO., et al., 2017; Korchagin M. et al., 2020; Oderov A. et al., 2019) it is noted that the modern conditions of conducting military operations require a high level of development of general physical qualities and applied physical skills from a serviceman. Special attention is paid to the formation of general and special endurance of military personnel (Romanchuk S.V. et al., 2021).

Klymovych V., Oderov A. Romanchuk S. et al. prove that the performance of military duty by military personnel takes place in equipment, in certain climatic conditions, even in populated areas. All this requires systematic classes with weights, exercises with oxygen starvation, physical exercises in military equipment and similar in structure to the conditions of military service.

Increasing the level of physical training of military personnel allows them to more effectively perform the combat tasks assigned to them. The armies of many countries pay great attention to the development and implementation of various physical training programs. One of the leading places among them is occupied by programs that include crossfit elements (Grier T. et al., 2013; O'Connor, F.G. et al., 2017; Poston, W.S. et al., 2017).

In scientific works Grier, T., Canham-Chervak, M., McNulty, V., Jones, B.H., O'Connor, F.G., Deuster, P.A., Barrett, J., Kane, S.F. studied the impact of such programs on the injury rate of US Army servicemen and their physical fitness. The increase in the risk of injury practically does not differ between those who practiced according to a special program and those who did not use elements of CrossFit in their training. At the same time, the risk of injury was significantly lower among those who trained with weights.

Scientists N. Bazilevich, O. Tonkonog, O. Romanyuk, claim that crossfit products provide an opportunity to continue exercising for a long period of time, strengthen and improve the

overall physical endurance of the body, improve the work of the cardiovascular and respiratory systems, increase and improve the level of muscle strength, strengthen the joints, optimize weight, improve flexibility and acquire an athletic figure. Crossfit includes training in various formats, functional gymnastics, balance training, and various cyclical exercises. Functional multisport (crossfit) involves such methods of sports training as continuous, interval and competitive (Stepanova I. et.al., 2018; Pylypchak I., 2017).

Poston, W.S.C., Haddock, CK., Heinrich, KM., Jahnke, SA., Jitnarin, N. emphasize that high interval training has a number of advantages over traditional programs of physical training of military personnel. Rather than biasing the training toward maximal fitness, such as aerobic endurance, these workouts are designed to increase overall fitness. Other challenges associated with traditional approaches include: the relevance of fitness tests to current combat requirements; the perception that military physical education is aimed at passing tests for service suitability; combat training requires more than just aerobic endurance. All this determines the perspective of using training with crossfit elements.

Scientists O'Hara RB., Serres J., Traver KL., Vojta C., Eveland E. conducted a comparative analysis of non-traditional training programs for Air Force personnel. Data from the literature confirm the effectiveness of strength training with weights on the lower extremities, crossfit training, kettlebell training, and agility training. It was concluded that further study of these types of training is necessary.

Our comparative analysis of the dynamics of physical development of cadets confirmed the research of scientists Gaponenko H., Romaniuk O., Kovalchuk O. et.al. (2018), that crossfit is a training system that includes elements of weightlifting and athletics, bodybuilding, fitness, classical gymnastics, kettlebells and other sports, is an intense, diverse, interesting, useful training and has a positive effect on the work capacity of cadets, improves the state of physical health contribute to improving well-being and increasing work efficiency.

Available works (A.Petrova et.al, 2022) prove the effectiveness of the use of crossfit, testify to the improvement of the physical fitness of schoolchildren and the level of physical health of high school students «below average». In terms of age, there is mainly an improvement in the results of boys in both the main and control groups. It was established that after the introduction of the CrossFit variable module, the level of physical health of the boys of the main groups studied increased by 1 point and began to equalize - 3 points, which corresponds to the «average» level. The exception is the 2017 data. boys who did not show an improvement in the indicators on the rating scale and they are equal to 3 points before the experiment, which corresponds to the «average» level of physical health. The results of the young men of the control groups, reflecting the level of physical health, remained unchanged compared to the initial data. Thus, the conducted studies testify to the positive impact of our CrossFit exercises on the level of physical health of 16-17-year-old students, which makes it possible to recommend to teachers to include the developed version of the «Crossfit» module in the educational process of physical education of high school students.

Research Okhrimenko I.M., Hrebeniuk M.O., Borovyk M.O., Kuzenko Y.I., Korak Y.O. was devoted to assessing the impact of crossfit classes on the health of cadets. At the end of the experiment, it was established that the level of physical health of cadets who attended Crossfit classes was significantly higher than that of cadets who were engaged in a standard

physical training program. The most pronounced effect was found on the functional capabilities of the cardiovascular, respiratory and muscular systems, stabilization of the body weight of the cadets of the experimental groups.

We have confirmed the results of scientific works Stepanova I., Dutko T., Zhorova O. and Yagodzinsky VP, Geiko OA, Zarchanskyi OA. regarding the possibility of increasing the effectiveness of the training process by using a system of non-specialized highly intensive training, namely crossfit. It has been established that this system has a positive effect on the level of physical fitness of servicemen, strengthens their motivation for physical culture and sports activities, promotes the mastery of certain knowledge of modern approaches to the organization of physical training, skills and abilities of independent training and leading a healthy lifestyle.

In our opinion, the use of crossfit exercises during the organization and conduct of forms of physical training will ensure high-quality and professional training of cadets, especially during preparation for participation in hostilities, conducting combat exercises in accordance with the appointment and the position held in the future.

Conclusions

Thus, the study of indicators of physical development of EG and CG cadets determined that conducting crossfit training sessions has a positive effect on strengthening the musculoskeletal system of cadets and improving their muscular system (especially the muscles of the back, legs and shoulder girdle). Under the influence of systematic crossfit classes, the vital capacity of the lungs increases, the circumferences of the chest and shoulders increase, the volume of the waist decreases, and body weight stabilizes. These circumstances have a positive effect on the work capacity of cadets, improve their physical health, improve their well-being and increase their work efficiency.

The value of the static strength index of EG and CG cadets increases significantly throughout the entire training period, however, the difference between the results at the beginning and at the end of the experiment in CG is 7.75 % ($p < 0.05$), and in EG – 23.93% ($p < 0.001$), which indicates a significant advantage of the physical training program for cadets of military institutions of higher education at the stage of primary training with the use of crossfit equipment over the existing physical training program for the development of back muscles in cadets at the stage of primary training.

The application of the program of physical training of cadets of military institutions of higher education at the stage of primary training with the use of crossfit equipment ensured the maintenance of a sufficient level of functional condition of cadets of military institutions of higher education for the performance of professional (combat) tasks.

Prospects for further research in this direction. In the next message, our research will be directed to the study of the functional state and dynamics of the level of physical health of the cadets of the experimental and control groups at the stage of primary training.

Author Contributions

Artur Oderov, Serhii Romanchuk – data collection/entry, data analysis/statistics, data interpretation;

Andrii Poltaets, Victor Romanchuk – study design/planning, data interpretation;

Oleh Olkhovyi – data analysis/statistics, data interpreta-

tion, fundraising;

Oleh Nebozhuk – data interpretation, fundraising;
Orest Lesko – data collection/entry, literature
analysis/search;
Ivan Pylypchak – data interpretation, fundraising.

Conflicts of Interest

The authors declare no conflict of interest.

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