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Changes in the morphological and functional indicators of students in response to dosed physical activity

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Abstract

Purpose: to determine the features of changes in the morphological and functional indicators of students in response to a dosed physical load.

Material & Methods: practically healthy students of 18±0.7 years of I-II courses of study (n=40) who did not regularly go in for sports in the past and present took part in the study. They were divided into test groups according to the following principle: group 1 (n=20) included students involved in playing sports (sports games and their elements); group 2 (n=20) included students involved in acyclic/cyclic types of physical culture and sports activities (types of athletics). Research methods: theoretical methods of pedagogical research; testing; hardware methods; mathematical and statistical.

Results: the features of adaptation of the functional systems of the body of students to regular physical culture and sports classes by different types of motor activity of a predominant orientation were determined: gaming (sports games and their elements, mini-sports games); cyclic (types of athletics). It was revealed that as a result of regular classes according to training programs, both in terms of types of physical culture and sports, predominantly cyclic / acyclic (types of athletics), and game types (sports games and their elements), there is an improvement in the level of working capacity and endurance of students already in a two-month period. The reactions of the students' organism in response to the dosed physical activity of the Martin-Kushlevsky test at the end of the study allow us to assert an increase in the level of functioning and reserves of the cardiovascular system of the subjects as characteristics of the adaptation of the morphological and functional structures of the body to programmed regular physical exercises. However, when comparing the indicators of the studied groups, no significant differences were found. Consequently, the influence of predominantly different types of training loads is similar. This helps to deepen the understanding of the influence of academic physical education classes on the body of students. Consequently, the main determinant of increasing the level of adaptation to physical activity among students is the regularity of classes, while observing the pedagogical and specific sports principles of their construction. At the same time, the main goal of such classes should be to increase the level of general endurance as a characteristic of the level of physical health.

Conclusions: morphological and functional changes in the body of students in the amount provided for by the program of physical education of higher education do not depend on the predominant nature of motor activity. As a result of the two-month training program, an improvement in the functional state of the students' body was revealed. However, this does not apply to the integral indicators of the functioning of the cardiovascular system. To improve the morphological and functional indicators of students, it is necessary to increase the time of regular physical education classes, regardless of the nature of motor activity.

Анотація

Андрій Єфременко, Світлана П'ятисоцька, Кшиштоф Прусік, Віктор Павленко, Владислав Рожков. Зміни морфофункціональних показників здобувачів освіти у відповідь на дозоване фізичне навантаження. Мета: визначити особливості змін морфофункціональних показників здобувачів освіти у відповідь на дозоване фізичне навантаження. Матеріал і методи: у дослідженні брали участь практично здорові здобувачі вищої освіти 18±0,7 років I-II курсів навчання (n=40), які не займалися регулярно спортом у минулому та

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теперішньому часі. Вони були розділені на тестові групи за принципом: до групи 1 (n=20), увійшли здобувачі освіти, які займалися ігровими видами спорту (спортивні ігри та їх елементи); до групи 2 (n=20), увійшли здобувачі освіти, які займалися ациклічними/циклічними видами (види легкої атлетики) фізкультурно-спортивної діяльності. **Методи дослідження:** теоретичні методи педагогічного дослідження; тестування; апаратні методи; математико-статистичні. **Результати:** визначено особливості пристосування функціональних систем організму здобувачів освіти до регулярних фізкультурно-спортивних занять різними видами рухової активності переважної спрямованості: ігрової (спортивні ігри та їх елементи, міні-спортивні ігри); циклічної (види легкої атлетики). Виявлено, що в результаті регулярних занять за програмами тренувань як з видів фізкультурно-спортивної переважно циклічно/ациклічного характеру (види легкої атлетики), так і ігрових видів (спортивні ігри та їх елементи) спостерігається покращення рівня працездатності та витривалості здобувачів освіти вже у двомісячний термін. Реакції організму здобувачів освіти у відповідь на дозоване фізичне навантаження проби Мартіне-Кушелєвського наприкінці дослідження дозволяють стверджувати про підвищення рівня функціонування та резервів серцево-судинної системи випробуваних як характеристики адаптації морфофункціональних структур організму до програмованих регулярних занять фізичними вправами. Проте, при порівнянні показників досліджуваних груп не виявлено значних відмінностей. Відтак, вплив переважно різних за характером видів тренувальних навантажень схожим. Це сприяє поглибленню розуміння відносно впливу академічних занять з фізичного виховання на організм здобувачів вищої освіти. Відтак, головним детермінантом підвищення рівня адаптації до фізичних навантажень у здобувачів освіти є регулярність занять, за умов дотримання педагогічних та специфічних спортивних принципів їх побудови. При цьому, головною метою таких занять має бути підвищення рівня загальної витривалості як характеристики рівня фізичного здоров'я. **Висновки:** морфофункціональні зміни організму здобувачів освіти в обсязі, передбаченому програмою з фізичного виховання закладу вищої освіти, не залежать від переважного характеру рухової діяльності. В результаті двомісячної програми занять виявлено покращення функціонального стану організму здобувачів освіти. Однак, це не стосується інтегральних показників функціонування-серцево-судинної системи. Для покращення морфофункціональних показників здобувачів освіти необхідно збільшити час регулярних аудиторних занять з фізичного виховання, незалежно від характеру рухової діяльності.

Introduction

Emotional imbalance, the negative impact of urbanization and environmental instability, the aggressively growing informatization of social processes, contribute to the deformation of the students' health. This leads to a decrease in the reserve capacity of the functional systems of the body of young people. The risk of new diseases and the exacerbation of existing diseases increases. A characteristic feature of student youth is the presence of significant life potential. However, it is students who are a kind of «target» of the branched structure of the negative factors of modern society. This is due to the formation of a worldview against the backdrop of the temptations of a student lifestyle, as well as social pressure in

the environment (Griban et al., 2020; Gorna et al., 2020).

A characteristic feature of modern educational institutions is the ever-increasing hypokinesia. Its result is a decrease in the physical and mental performance of students. This leads to a decrease in the ability of the body's functional systems to withstand significant amounts of training loads and excessive social activity (Burner et al., 2019). From a pedagogical point of view, there is a decrease in the level of manifestation of physical abilities, from a biological point of view – a decrease in energy potential, from a psychological point of view – psycho-emotional overstrain (Komarov et al., 2019).

An important task of the process of physical education in higher educational institutions is the development of modern programs of physical rights of a health-improving nature. Such programs should be based on the dosed use of physical activity. This is achieved by performing various movements in modes and volumes that exceed the minimum recommended values. It is necessary to form programs of rational motor activity. Use physical exercise not as a way of active recreation. It is necessary to create a set of effective measures to improve health, increase the functional and adaptive capabilities of students' bodies (Kondakov et al., 2018; Wrench, 2019).

Recently, there has been a continued interest in the formation of a modern structure of the health-improving educational environment of higher education. Its basis is a rational motor mode in academic classes in physical education. It is the key to high student performance (Gonzalez-Valero et al., 2019). However, there is a trend towards a decrease in the level of students' health. This is due to a decrease in the level of physical activity (Doroshenko et al., 2021). Currently, the attention of researchers is riveted to identifying the level of physical fitness and the state of health of students (Petruk & Grygus, 2019). The rest of the researchers focused on studying interests in the formation of physical activity of the physical culture and sports type (Thorburn et al., 2019). A number of works actualizes the issue of the influence of certain types of physical activity on the functional state and physical fitness of students (Kuna et al., 2018; Wang et al., 2019; Golovin et al., 2020; Gurner & Reineke, 2020). However, the attention of researchers is focused on ascertaining the fact of the deterioration in the health of young people (Guijarro-Romero et al., 2020) and its correction with dosed physical activity (Zavalishina et al., 2021). Such studies form an idea of the state of physical culture of students. This creates conditions for the formation of effective academic programs of health-improving physical exercises.

The question of the influence of certain types of motor activity on the morphological and functional adaptations of the student's body systems remains uncertain. The solution of this issue will improve the morphological and functional indicators of the students' organism. Therefore, the *hypothesis* of the study is: revealing the peculiarities of the reaction of the students' organism to the occupation by the types of motor activity of the overwhelming direction.

The purpose of the study is to determine the features of changes in the morphological and functional indicators of students in response to dosed physical activity.

Material and Methods of the research

Participants. The study involved students 18±0,7 years of I-II courses. Requirements for the subjects: no malformations; are included in the main group in physical education classes; male gender; are not related to regular sports in the past and

present. Those who met the specified conditions were invited to participate in the study. The sample included 40 young men (n=40). The sample was not representative enough, because with a confidence level of 95% of the total number of men enrolled in I-II courses (n=80), its size should be 62 people. However, not all students agreed to participate in the study. This is a limitation of the current work. As an incentive, it was proposed that teachers give additional points when assessing students in the academic discipline "Physical Education". All subjects were informed about the purpose and program of the study and signed an informed consent form to participate in the study. The procedure for conducting the study complied with the provisions of the Declaration of Helsinki.

Methods. To determine the state of development of the problem, theoretical methods of pedagogical research were used. To determine the state of the cardiovascular system, a certified device PAK "Omega-M" (St. Petersburg, RF) was used. The study was conducted by a qualified assistant. He had experience with the instrument for 1.3 years. The indicators were recorded according to the methodological recommendations given in the user manual (Manual, 2019). The parameters were recorded twice: before and after the Martinet-Kushelevsky dosed exercise test. The test was carried out according to the standard procedure (Jaworski, 2021). The state of the respiratory system was determined by measuring the vital capacity of the lungs (VC). The measurement was carried out according to the standard procedure using a portable dry spirometer (M&B, China). Body weight was determined using electronic scales Tefal PP1503V0 (China). Working capacity was determined by the method of bicycle ergometry. The PWC₁₇₀ test was carried out on an Ergoselect 4 bicycle ergometer (Ergoline GmbH, Germany). The test was carried out according to the standard methodology described in the literature (Turner, 2018). To determine the level of general endurance, a 1000-meter run on a standard 400-meter stadium track was used. The time was recorded using a manual electronic stopwatch JUNSD (JS-7061V) (China) with an accuracy of 0,001 s.

Testing/measurement. Indicators of VC, body weight, PWC₁₇₀, 1000 m run were recorded twice: at the beginning and at the end of the study.

Preliminary testing of the level of endurance (100 m run) and working capacity (test PWC₁₇₀) was carried out for two days a week before the start of the study (Monday and Wednesday). Previously, the subjects had two days of rest.

Testing was carried out in the morning hours from 8 to 10. Participants were advised not to eat food and stimulants for 12 hours before testing. On the first (Monday) day, a bicycle ergometer test was performed; after a day of rest (Wednesday), a 1000 m run was held. At the end of 16 lessons, after two days of rest, repeated testing was carried out according to the same scheme. However, on the first (Monday) day, the Martinet-Kushelevsky test was performed with the fixation of indicators using the hardware-software complex Omega-M. It preceded the ergometer testing.

Procedure. The participants were divided into test groups according to the principle: group 1 (n=20) – students involved in team sports (sports games and their elements); group 2 (n=20) – students involved in acyclic / cyclic sports (types of athletics). The division into groups took place in order to determine the benefits of practicing different types of motor activity for the morphological and functional adaptation of the students' organism. In accordance with the requirements of the work program for the academic discipline "Physical Education", programs for physical exercises have been developed (Table 1).

The frequency of classes is 2 times a week (n=16 lessons). The frequency and duration of the programs correspond to the time allotted for the study of the program modules «athletics» and «sports games». During the exercise program, the subjects asked not to engage in additional extracurricular organized physical activity. The duration of the lessons is 120 min. Physical exercises lessons had a traditional structure: preparatory part (20 min), main part (90 min), final part (10 min). The preparatory and final parts were identical in both groups of subjects. The main part had a predominant focus (70% of the total time of the main part of the lesson): game types (group 1), athletics types (group 2). Such a construction of the process of physical education of the subjects was agreed with the educational part of the educational institution. Thanks to this, it was possible to swap the modules of the program in the curriculum. So, in group 1, instead of studying the types of athletics in the first semester, it was planned to study sports games from the second semester.

Statistical analysis. Experimental data were processed by methods of mathematical statistics. Descriptive statistics are calculated, the normality of data distribution is determined according to the Kolmogorov-Smirnov criterion. It was revealed that the experimental indicators differed from the normal distribution. To compare the results of the experiment,

Table 1
Experimental programs for physical exercises

Classes	Sports games (group 1)	*	Types of athletics (group 2)	*
1-4	Learning the elements of basketball	50	Short and medium distance running:	
	2x2 game on one ring	25	Running from the start	35
	Double-sided basketball game	25	Running in a straight line and in a turn	65
5-8	Learning the elements of football	50	Throwing the ball from a running start:	
	Mini football game	25	Simulation exercises	10
	Double sided soccer game	25	Throwing from a place	35
9-12	Learning the elements of volleyball	50	Run-up throw	55
	Playing mini volleyball (pioneer ball)	10	Long jump:	
	Double sided volleyball game	40	Simulation exercises	10
13-16	Learning the elements of handball	50	jumping exercises	55
	Performing game combinations in attack and defense	15	Jumping on a shortened and full run	35
	Double-sided handball game	35	Relay run:	
			Simulation exercises	15
			Passing the baton in pairs	50
			Passing the baton in the team	35

Explanation: * – % of the total time of the lesson

the Mann-Whitney U-test was used. Calculations were made using the computer program IBM SPSS Statistics 20 (USA). The difference between the compared indicators at the level of significance was considered reliable $p < 0,05$.

Results of the research

The results of the study are presented in tables 2 and 3.

Comparing the initial indicators of students in group 1 and group 2, it was found that they did not differ significantly

Table 2
Indicators of hardware-software complex "Omega-M" of students in response to dosed physical activity, $\bar{X} \pm S$

Indicator	Measurement	Group 1 (n=20)	Group 2 (n=20)
A, %	I	63,8±13,3	65,5±14,0
	II	**89,1±9,9	71,6±16,8
B, %	I	78,2±7,9	77,5±7,5
	II	*87,5±6,1	**89,9±11,6
C, %	I	58,3±12,7	57,5±13,0
	II	**79,9±10,5	*69,9±11,6
D, %	I	58,0±7,7	58,9±6,9
	II	**85,6±10,9	*69,9±14,1
Health, %	I	66,3±7,5	68,4±8,1
	II	**91,1±8,9	*80,5±13,6
B ₁ , %	I	77,2±8,4	78,0±7,7
	II	**89,6±6,1	*88,5±15,7
B ₂ , %	I	63,2±11,8	64,1±11,0
	II	**91,6±9,9	**89,4±13,5
HR, beats per min. ⁻¹	I	70,1±10,9	70,3±11,5
	II	72,4±9,7	71,9±8,4
SDNN, ms	I	86,7±20,1	87,3±21,5
	II	88,9±22,5	89,4±20,3

Note: A – level of adaptation; B – vegetative regulation; C – central regulation; D – psycho-emotional state; Health – integral indicator of health; B₁ – level of regulation; B₂ – reserves of regulation; HR – heart rate; SDNN – standard deviation of N–N intervals; I – indicators before the functional test; II – indicators after the functional test; significance of differences according to the Mann-Whitney U-test when comparing values for groups according to the mean values of the sample: * – $p < 0,01-0,05$, ** – $p < 0,001$.

Table 3
Indicators of the physical condition of students during the study, $\bar{X} \pm S$

Indicator	Measurement	Group 1 (n=20)	Group 2 (n=20)
VC, l	I	3,4±0,5	3,4±0,5
	II	**3,9±0,3	**4,0±0,2
Body weight, kg	I	80,0±2,7	81,2±3,3
	II	79,9±3,2	78,1±4,0
PWC _{170'} (W·min·kg ⁻¹)	I	980,5±50,5	1010,2±44,8
	II	**1222,6±33,4	**1348,4±29,7
Біг на 1000 м, с	I	220,5±17,3	222,4±19,5
	II	215,6±13,7	*210,8±22,1

Note: VC – vital capacity of the lungs; I – indicators at the beginning of the study; II – indicators at the end of the study; Significance of differences according to the Mann-Whitney U-test when comparing values for groups according to the averages of the sample: * – $p < 0,01-0,05$, ** – $p < 0,001$.

in all characteristics ($p > 0,05$). This indicates a rational distribution of the subjects in the test groups.

At the end of the study, the level of adaptation (A) in subjects in group 2 increased, but not significantly ($p > 0,05$). Heart rate after the third minute of recovery at the end of the functional test in both groups did not differ significantly ($p > 0,05$).

The SDNN indicator also did not change significantly at the end of the study ($p > 0,05$). All other indicators significantly improved ($p < 0,001-0,05$) in response to dosed test physical activity in both groups.

Table 3 shows the dynamics of indicators that comprehensively characterize the adaptive processes of the body of students.

The body weight of both groups studied had no significant changes ($p > 0,05$). The same applies to the results of the 1000 m run in the subjects of group 1. Other indicators significantly changed in both groups from the beginning to the end of the study.

Comparing the initial indicators of students of groups 1 and 2, it was revealed that they significantly differed in the following characteristics ($p < 0,01-0,05$): level of adaptation (A); psycho-emotional state (D); PWC_{170'}. Consequently, characteristic differences were revealed regarding the influence of classes on different programs of motor activity on some indicators of morphological and functional indicators of students.

Discussion

To assess the characteristics of the morphological and functional adaptations of the body of students regularly engaged in physical culture and sports recreational motor activity, two groups of indicators were selected. The first group of indicators was recorded by hardware and allowed for an express assessment of the functional state of the cardiovascular system of students. They reflect the features of morphological and functional changes in response to dosed physical activity.

The conducted studies have shown that short-term fixed physical load affects the indicators characterizing the adaptive capabilities of the functional systems of the students' body. The initial characteristics of the subjects were characterized by the normotonic type of autonomic regulation in terms of A, B, C, D, H. After the Martinet-Kushelevsky test, the reaction of the organism of the participants in groups 1 and 2 was characterized by the predominant activity of the parasympathetic division of the autonomic nervous system in the regulation of heart rate. Indicators B₁ and B₂ characterize the current voltage level of control systems and the reserves of these systems. The dynamics of these characteristics in both groups of subjects is similar. This indicates an increase in reserves and regulation in response to dosed physical activity. The subjects of both groups showed timely normalization of the heart rate after the third minute of rest after the test load. The values of the SDNN indicator reflect the general variability: its low values indicate the predominance of low-frequency components in the regulation; high reflect the dominant influence of the parasympathetic link. The dynamics of this indicator in both groups did not change. This indicates a similar effect of classes according to different programs of physical exercises on the functional state of the cardiovascular system. The insignificant effect is associated with the short duration of the use of exercise programs.

The next group of indicators determines the features of

the adaptation of the life support systems of the students' organism. It contains labile characteristics that characterize the performance and endurance of the individual.

The action of the selected physical activity programs is effective in terms of a significant improvement in most indicators in both groups of subjects. The only exception is body weight. However, the interpretation of this indicator is limited within the framework of the current study, because the analysis of changes in body composition was not carried out. Consequently, physical activity according to the proposed programs did not have a significant effect on the correction of the weight of the subjects. It should be noted that the level of endurance in group 1 improved according to the results of the 1000 m run, but is less pronounced than in group 2. Clearly, higher values of the level of regulation (A) and psycho-emotional state (D) in students of group 1. After all, playing activities involve multiple changes in the load in different bioenergetic zones. This improves regulation. Play is emotional in nature. This is expressed in its greater influence on the psycho-emotional state compared to the routine nature of most athletics exercises. Higher performance of group 2 students in the PWC170 test characterizes the benefits of athletics for increasing the level of working capacity. The obtained intergroup differences at the end of the study confirm the peculiarities of the influence of classes of different motor activities on the morphological and functional indicators of students.

In accordance with the hypothesis of the study, test procedures and indicators for determining the instantaneous reaction and medium-term adaptation of the morphological and functional structures of the students' body were selected. For the current experimental sample, there was no significant difference in the effects of predominantly different types of training loads, according to the results of the body's response to a dosed physical load. The obtained data complement the idea of the characteristics of the adaptation of the cardiovascular system, as well as the morphological and functional adaptations of the body of student youth to physical activity (Kondakov et al., 2018; Brezdeniuk et al., 2021; Hryshko et al., 2021; Petrachkov & Yarmak, 2021). We believe that it is the increase in the regularity of classes, and not their predominant focus, that is the factor contributing to the improvement of morphological and functional indicators, the increase in the adaptation of the life support systems of the students' body and the increase in the overall level of physical activity. At the same time, the methods of performing a fixed training load (acyclic / cyclic types of motor activity) have some advantage in relation to increasing physical endurance. Such programs should be built taking into account the principles of physical education.

Conclusions

It has been established that two-month classroom lessons on the programs of physical exercises of the game and suppressive orientation contribute to the change in the morphological and functional indicators of students. This is expressed in the dynamics of indicators of the physical condition and the body's response to dosed physical activity. The special thing is that, against the background of dynamic improvement in the indicators of regulation, no pronounced changes in the integral indicators of the cardiovascular system of the subjects were found. Consequently, the duration and volume of the load in both programs of physical exercises were insufficient to create significant adaptations of the cardiovascular system of the subjects. We believe that an increase in the number of physical education classes will optimize the amount of load and create a more pronounced effect on the state of the cardiovascular system of students. This will also increase the variability of the physical education program against the background of a decrease in the period of training in certain types of physical activity. After all, positive changes in the indicators of the body of students on the presented programs were revealed. They were similar for both groups of 1st and 2nd year students, regardless of the predominant direction of physical activity. However, regarding the increase in working capacity and endurance, exercises of a cyclic / acyclic nature have an advantage. In turn, sports games contribute to a greater improvement in regulation and psycho-emotional state. This should be taken into account when programming health and conditioning physical education classes in the classroom. The presented results have practical application in the direction of improving the program material for the academic discipline «Physical Education» in higher education institutions. The data obtained expand the understanding of the importance of regular physical activity as a guarantee of the formation of students' physical health. Taking into account the current results, it is planned to develop a comprehensive program of physical culture and health work with students of a special medical group.

Author Contributions

A – research design/planning; B – data collection/entry; C – data analysis/statistics; D – data interpretation; E – manuscript preparation; F – literature analysis/search; G – fundraising.

Andrii Yefremenko: B, D, E, F, G; Svitlana Piatysotska: C, D, G; Krzysztof Prusik: A, D; Viktor Pavlenko: E, F, G; Vladyslav Rozhkov: B, F, G

Conflicts of Interest

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Some life skills of female wheelchair basketball players

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Abstract

Purpose: the current study aimed to know the level of life skills of female wheelchair basketball players and statistical differences in the life skills of female wheelchair basketball players according to team affiliation.

Material & Methods: the study was conducted on female wheelchair basketball players, where the study sample amounted to 30 players. The life skills scale prepared by Al-Sutri (2007), which contains four dimensions, was adopted; the skill of communication, the skill of teamwork and cooperation, the skill of taking personal responsibility, and the skill of physical and technical.

Results: the results showed that the mean values of the life skills dimensions ranged between (3.40 and 4.18), and the mean value of the total score of the scale amounted to (3.80), which indicates there were a high degree of life skills. And there were no significant differences between female wheelchair basketball players according to team affiliation in the life skills.

Conclusions: it was found that the level of life skills of female wheelchair basketball players is high. It is very important to develop special sports programs that enhance the life skills of persons (male/female) with disabilities, considering the type and severity of the disability.

Анотація

Мостефа Аяд і Мулуд Кеніуа. Деякі життєві навички баскетболісток на візках. Мета: дане дослідження спрямоване на вивчення рівня життєвих навичок баскетболісток-візочниць та статистичних відмінностей у життєвих навичках баскетболісток-візочниць залежно від взаємодії в команді. **Матеріал та методи:** дослідження проводилося на баскетболістках-візочницях, вибірка складала 30 спортсменок. Було прийнято шкалу життєвих навичок, підготовлену Al-Sutri (2007), яка містить чотири виміри: вміння спілкуватися, вміння працювати в команді та співпрацювати, вміння брати на себе особисту відповідальність, фізичні та технічні вміння. **Результати:** отримані результати продемонстрували, що середні значення параметрів життєвих навичок перебували в діапазоні від (3,40 до 4,18), а середнє значення загального балу за шкалою становило (3,80), що вказує на високий рівень життєвих навичок. При цьому суттєвих відмінностей між баскетболістками-візочницями залежно від взаємодії у команді у життєвих навичках виявлено не було. **Висновки:** встановлено, що рівень життєвих навичок у баскетболісток-візочниць високий. Отримані результати дослідження продемонстрували необхідність розробити спеціальні спортивні програми, які покращують життєві навички людей з особливими фізичними потребами (чоловіки/жінки) з урахуванням типу та групи інвалідності.

Introduction

Human societies include many disabled people, young or old, male or female, due to diseases, wars, natural and human disasters and poor social conditions (Sikorska & Gerc, 2018). This category of people is destined to be in a state of physical, sensory or mental deficiency due to hereditary or acquired injuries, which makes them unable even to carry out daily tasks without dependence on others, and this category is the category of people with special needs (Martin, 2005).

In the current era, the interest of societies in people with special needs has increased, based on the principle of equal opportunities, and education, sports and recreational activities have become for all (Sinason, 1992). **Motor disabilities category (fe-**

male and male) has a lot of attention and benefit from various sport programs through care and rehabilitation so that they can live according to their potentials and abilities (Malm et al, 2019).

Wheelchair basketball, which has attracted many people with motor disabilities, whether male or female, is considered a movement sport of great functional and psychological benefit, and all body systems participate in its performance (De Witte et al, 2016). And after women's wheelchair basketball was just a recreational and therapeutic sport, it has now become a competitive sport of a high level, the goal of which is to achieve high achievements and great results and win various local, national and international championships (DePauw & Gavron, 2005).

Life skills are an imperative for all members of society, especially for the disabled, because of the requirements that individuals need to conform to themselves and the society in which they live, which helps them solve daily problems and interact with everyday situations (Böhler et al, 2008; Singla et al, 2020). Several studies (Goudas, et al, 2006. Celenk, 2021; Martin, 2012; Holloway, & Long, 2019) in the field of motor disability have recommended the necessity of practicing sports activity and preparing training programs that suit the characteristics of this category, which helps in developing the skills that help them to meet life requirements.

There is a lack of previous studies that dealt with the life skills of women with motor disabilities who engage in various recreational and competitive sports activities. That is why the importance of the current study, which aims to know the level of life skills of female wheelchair basketball players and statistical differences in the life skills of female wheelchair basketball players according to team affiliation.

Material and Methods of the research

Participants:

The study was conducted on female wheelchair basketball players, where the study sample amounted to 30 players, who play in the Mustapha Ben Boulard Club (Ouargla), the Hodna Club (M'sila), and the Intisar Bashar Club (Bashar). These clubs are active in the National Wheelchair Basketball Championship. The exploratory study also consisted of 12 female wheelchair basketball players. All sample members agreed orally and in writing to participate in the study.

Statistical analysis:

The Statistical Package for the Social Sciences (IBM SPSS) version 26 was used to get the results (Pearson cor-

relation coefficient, Cronbach's alpha coefficient, split half, Spearman Brown, mean, standard deviation, one-way ANOVA).

The measure:

The life skills scale prepared by Al-Sutri (2007), which contains four dimensions, was adopted; the skill of communication dimension (9 items), the skill of teamwork and cooperation dimension (6 items), the skill of taking personal responsibility dimension (8 items), and the skill of physical and technical dimension (14 items). The formulation of the scale items was positive, and the answer was evaluated on a five Likert type scale (always= 5, often= 4, sometimes= 3, rarely= 2, never= 1. The range of scores are shown in the table 1.

Table 1
Shows the range of scores

Level of scores	very high	high	average	Low	very low
Range of scores	05-4.2	4.19-3.4	3.39-2.6	2.59-1.8	1.79-1

To verify the validity of the scale, the researchers calculated the internal consistency of the scale (construction validity), by calculating the correlation coefficients (Pearson's method) between each statement and the total score of the scale (Table 2).

Table 2 showed the degree of correlation of each item in the life skills scale with the total score of the scale, which shows that the scale items are related to the total score of the scale, which means that there was a statistically significant correlation. The life skills scale was characterized by high validity. Table 3 showed that the value of Cronbach's alpha coefficient was equal to (.84), and the value of the split-half coefficient (Spearman-Brown) was (.80). Results of the table 3 showed that the reliability coefficients of the scale were a function.

Table 3
Reliability coefficients of the life skills scale

Scale	Items	Cronbach's alpha	split half Sperman Brown
the life skills	37	.84	.80

Results of the research

1 - The level of life skills of female wheelchair basketball players is high.

Table 2
Shows the Pearson correlation coefficient of the life skills scale items with the total score

Items	correlation coefficient	Items	correlation coefficient	Items	correlation coefficient	Items	correlation coefficient
01	.241	11	.394	21	.342	31	.599
02	.337	12	.471	22	.205	32	.527
03	.419	13	.509	23	.055	33	.373
04	.488	14	.340	24	.344	34	.300
05	.239	15	.244	25	.471	35	.279
06	.448	16	.323	26	.256	36	.386
07	.308	17	.284	27	.405	37	.434
08	.319	18	.053	28	.549		
09	.258	19	.134	29	.464		
10	.102	20	.557	30	.269		

Table 4
Shows the means and standard deviations of the life skills scale dimensions

Dimensions	M	SD	Level of scores
The skill of communication	4.12	.485	high
The skill of teamwork and cooperation	4.18	.517	high
The skill of taking personal responsibility	3.50	.687	high
The physical and technical skill	3.40	.716	high
Total	3.80	.515	high

M = Mean; SD = Standard deviation

Through the results of Table (4), it was found that the mean values of the life skills dimensions ranged between (3.40 and 4.18), and the mean value of the total score of the scale amounted to (3.80), which indicates there were a high degree of life skills.

2 - Statistical differences in the life skills of female wheelchair basketball players according to team affiliation.

Table 5
Analysis of variance (one-way ANOVA) to test the significant differences in the life skills

Variance source	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	1.218	2	.406	1.615	.210
Within Groups	6.540	28	.252		
Total	7.759	30			

In table 5, analysis of variance (one-way ANOVA) was used to test the significant differences in the life skills of female wheelchair basketball players according to team affiliation. F value reached (1.615), when the degree of freedom was (2) between the groups, and the level of significance was (0.05). Consequently, there were no significant differences between female wheelchair basketball players according to team affiliation in the life skills.

Discussion

The life skills of female wheelchair basketball players were high. The reason is the positive participation in various sports activities, regular and continuous training, and various organized competitions throughout the sports season. What gave the female players some life skills such as the skill of social communication, cooperation, teamwork among members of one team, taking responsibility within the team, as well as acquiring some physical and technical qualities. Greve and Sъяenbach (2021) indicated that life skills are among the

most important skills acquired when playing basketball on wheelchairs, whether for men or women. Wheelchair basketball players are characterized by cooperation, and communication between team members, in addition to psychological skills in the form of mutual trust between players, and a sense of responsibility to achieve the desired goal (Celenk, 2021). The main goal of physical activity is to acquire some physical and technical qualities (Goudas et al, 2006).

Despite the harsh climatic conditions (the desert environment) and the culture of society that sees women as inferior to men, the female wheelchair basketball players still practice their sports activities (Nauright, 2012; Limoochi and Le Clair, 2011).

It was found that there are no statistically significant differences between female wheelchair basketball players according to their affiliation with sports teams. The reason is that the expectations of the players towards life skills and their abilities towards performance had the same positive feelings (Gerling et al, 2014; Hutzler et al, 2016). The players from the same sports specialization have one goal, which is to achieve victories and highlight some personal traits such as self-confidence and self-realization (Richardson et al, 2017). In addition, all sports teams belong to the same environment (Walseth, 2008; Tamminen & Gaudreau, 2014).

Conclusions

Through the previous results, it was found that the level of life skills of female wheelchair basketball players is high and there are no statistically significant differences in life skills according to their affiliation with sports teams. It is very important to develop special sports programs that enhance the life skills of persons (male/female) with disabilities, taking into account the type and severity of the disability, employing life skills in sports activities programs by linking what a disabled person takes and what he/she faces in his/her daily life situations, and opening special sports centers and clubs for people with disabilities (female / male) so that they can practice various sports on a regular basis.

Author Contributions

Mostefa Ayad; study design/planning, data collection/entry. Mouloud Kenioua; data analysis/statistics, data interpretation, manuscript preparation, literature analysis/search.

Conflicts of Interest

The authors declare no conflict of interest.

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Effects of a Reathletization protocol after ACL ligamentoplasty on performance of Algerian professional soccer player: A case study

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 параметри

Abstract

Purpose: this study checks the effects of the reathletization protocol following anterior cruciate ligament (ACL) reconstruction in each of the anthropometric parameters, muscle strength and aerobic capacity.

Material & Methods: we present a 12-weeks case-study account for an Algerian professional soccer player participated in this study (age: 21 years, height: 1.71 m, weight: 62.5 kg, body mass index: 21.37 and %body fat: 9.17%).

Results: the authors have comparing the results recorded in measurements and tests before and after 12-weeks of reathletization protocol applied to the professional soccer player, which was intended. First: anthropometric parameters; weight increased by (+3.6 kg, +5.76%) and body mass index by (+1.23, +5.75%). % body fat had decreased by (-1.8 kg, - 19.62%). Their thigh perimeter at 10 and 15 cm from the patella had increased respectively ((injured side; at 10 cm (+4 cm, 9.75%) and at 15 cm (3cm, 6.83%)), ((healthy side; at 10 cm (+2.5 cm, 5.61%) and at 15 cm (2.5 cm, 5%)). Second: muscle strength tests increased in; Prone plank test (1.14 min, 52.77%). Countermovement jump (14.68 cm, 45.66%). Single-leg jump (healthy side; 0.57 cm, 39.04%), (healthy side; 0.1 cm, 4.76%) and Two legs jump increased by (0.43 cm, 22.63%). Third: aerobic capacity; intermittent fitness test increased in: IFT; (2.5 km/h, 14.28%) and maximal O₂ consumption (5.65 mL/min/kg, 11.85%). Heart rate measurements decreased in maximum HR (10 bpm, 5.26%), and resting HR (10 bpm, 16.66%).

Conclusions: after 12-weeks of reathletization protocol, the statistics values indicated a greater significant improvement in the performances of the soccer player. A study with larger population should be undertaken.

Keywords: return to sport, Injury, physical and anthropometric parameters.

Анотація

Хоуар Абделатіф, Касем Абдельхаді, Гуемріче Насредін, Зауї Абделькадер, Чиха Фуад, Зерф Мохамед. Вплив реатлетизації за протоколом після лігаментопластики передньої хрестоподібної зв'язки на працездатність алжирського професійного футболіста: тематичне дослідження. **Мета:** у цьому дослідженні перевіряється вплив реатлетизації за протоколом після реконструкції передньої хрестоподібної зв'язки (ПКС) на кожен з антропометричних параметрів, силові та аеробні показники. **Матеріал та методи:** подано звіт про 12-тижневе тематичне дослідження алжирського професійного футболіста, який брав участь у цьому дослідженні (вік: 21 рік, зріст: 1,71 м, вага: 62,5 кг, індекс маси тіла: 21,37 і % жиру: 9,17%). **Результати:** автори порівняли результати вимірювань та тестів професійного футболіста до та після 12-тижневого застосування реатлетизації за протоколом. По-перше, збільшилися результати в антропометричних параметрах: вага збільшилася на (+3,6 кг, +5,76%), а індекс маси тіла на (+1,23, +5,75%), відсоток жиру в організмі зменшився на (-1,8 кг, - 19,62%), збільшилися параметри стегна на 10 і 15 см від колінної чашечки відповідно – ушкоджена сторона: на 10 см (+4 см, 9,75%) та на 15 см (3 см, 6,83%), здорова сторона – на 10 см (+2,5 см, 5,61%) та на 15 см (2,5 см, 5%). По-друге, збільшилися результати в силових тестах: планка лежачи (1,14 хв, 52,77%), стрибок з контррухом (14,68 см, 45,66%), стрибок на одній

нозі (ушкоджена сторона: 0,57 см, 39,04%), (здорова сторона: 0,1 см, 4,76%) та стрибок на двох ногах збільшився на (0,43 см, 22,63%). По-третє: зміни аеробних можливостей, інтерв'яльний фітнес-тест (ІФТ) збільшився на (2,5 км/год, 14,28%) та максимальне споживання O_2 (5,65 мл/хв/кг, 11,85%) Показники роботи серця знижувалися при максимальній ЧСС (10 ударів на хвилину, 5,26%) та ЧСС у спокої (10 ударів за хвилину, 16,66%). **Висновки:** після 12 тижнів реабілітації за протоколом статистичні дані свідчать про значне покращення результатів футболіста. Надалі слід провести дослідження з більшою вибіркою.

Introduction

Soccer offers multiple physiological and psychosocial benefits, but unfortunately the risk of injury is also high (Laruskain et al., 2018). In professional soccer, injuries have a significant impact on athletic performance, the economy, and player health (Zouhal et al., 2021).

The ultimate goal of professional soccer clubs is to win games, titles and trophies. Avoiding injuries is critical to the team's success; a low number of injuries allows coaches to have the most complete roster (usually about 25 players from which to choose the 11-member team) for training and matches (Ekstrand et al., 2021). In fact, others (Haggglund et al., 2013)(Eirale et al., 2013)(Arnason et al., 2004) have already shown that injuries negatively affect performance and that a lower injury rate is related to success in national and international matches. Hence, avoiding injuries is of utmost importance (van Mechelen et al., 1992).

In professional soccer, lower extremities are the most common body part prone to injury (84.1%) (Zouhal et al., 2021). Anterior cruciate ligament (ACL) sprains (Duval, Lehance, et al., 2017) and rupture are the most frequent knee injury incurred during participation in sports and especially in football (Alizadeh et al., 2022).

Rupture of the anterior cruciate ligament (ACL) is usually due to a forced movement beyond the ligament's ability to resist, sudden stops or changes in direction (Picard et al., 2021) jumping and landing (Ampatzis et al., 2021). It is rightly considered as the most common serious knee injury associated with sports activity (Rodineau, 2014). One of the reasons for a ligamentous knee injury and repetitive trauma in the joint is a decreased static and dynamic postural control of the lower limb (Grueva-Pancheva & Stambolieva, 2021).

ACL rupture is one of the most serious injuries associated with participation in football (soccer), (Montalvo et al., 2019) and sometimes career threatening injury for the male professional football player. ACL injury can have serious consequences for activity level and quality of life (Montalvo et al., 2019).

Reconstruction of anterior cruciate ligaments (ligamentoplasty) causes anthropometric and muscular deficits in all athletes (Puig et al., 2010) as well as a decrease in physical performance, according to (Laboute et al., 2013) the deficit in isokinetic muscle strength on the quadriceps ranges according to the different studies from 23 to 40% at 6 months and from 15 to 20% at 12 months after the intervention. Many athletes with ACL-injuries have experienced changes in their body composition, such as weight gain (Montalvo et al., 2019) and increased body-mass and fat, as well as imbalances between healthy and injured-sides (Laboute et al., 2013).

The return to sport (RTS) continuum is based on a progression defined by three objectives: return to (participation,

sport and performance)(Albano et al., 2021) (Onofrio et al., 2020).

To date, the process of returning to sport after ACL reconstruction is largely time-based, requiring a progressive rehabilitation phase (Kostrub et al., 2020) and defining goals that are the same and achievable (Albano et al., 2021).

Reathletization is an integral part of the rehabilitation of athletes who has suffered the effects of de-training. in order to make him/her physically and mentally fit for a return to competition as soon as possible (Duval, Lehance, et al., 2017). Such a reathletization program requires time, equipment and a specific follow-up (Picard et al., 2021).

Haggglund et al. report that a reathletization program conducted by fitness trainers with soccer players results in a 66% decrease in the risk of new injuries the next season (Haggglund et al., 2007).

In Africa, no study has addressed the problem of soccer injuries either in terms of statistics or in terms of proposed reathletization programs.

Therefore the purpose of this study was to propose a reathletization protocol for an Algerian professional soccer player who has undergone ACL surgery to allow him to return to sports performance and reduce the risk of re-injury. The second objective is to estimate the effect of this protocol in improving the muscular strength and aerobic capacity of the player, as well as the effectiveness of this protocol in reducing the imbalance of strength and muscular volume between the healthy and injured sides.

Material and Methods of the research

Participants

A forward soccer player (Age 21 years) sustained a non-contact injury to his left knee. (Total ACL rupture). He underwent an ACLR surgery. His characteristics are presented in (Table 1).

Participant Player Consent Statement:

"I am indicating my consent to participate in the research. I understand that the data collected from my participation will be used primarily in a scientific article and I agree to its use in this way".

Table 1
Demographic characteristics of study sample

Age	Height (cm)	Weight (kg)	BMI	% body fat	Level
21	1.71	62.5	21.37	9.17%	Professional

Note: BMI: Body Mass Index

Study protocol

The return of a soccer player from an ACL injury can be a long and difficult process, which is the case in our study, although the player may have recovered in medical terms after 6-months of ACL surgery (i.e. improvements in flexibility, range of motion, functional strength, pain, neuromuscular control, inflammation), preparation for competition requires restoration of strength, power, speed, agility, and aero-anaerobic endurance to exposed levels in soccer. The return from injury is a process that requires additional work on the part of the injured player to regain competitive ability. The player has expressed his willingness to start our reathletization protocol during the period of (02/10/2021 to 25/12/2021), according to the methodology divided into four important phases and organized according to the capabilities of team-work and the level of the player, which are as follows: Phase

I, Functional Strengthening: (Improvement of strength levels in specific contraction pattern regimes). Phase II, Freedom of Movement: (Stretching: restoring length for optimal range of motion). Phase III, Muscle Balance: (Processing agonist/antagonist force relationships (regulating and braking movement)). Phase IV, Motor Support: (Motor skill training/physical integrity). For more details on the reathletization protocol, see (Fig. 1).

Anthropometric measurements & physical tests

Skin folds

Harpenden skinfolds caliper (Model C-136 England) were used to assess the thickness of the skin folds of the biceps, triceps, subscapular area, and suprailiac area, following the method described by Weiner et al. All skin folds were assessed twice and averaged. If the two measurements of a skinfold differed by >1.0 mm, the skinfold was measured a third time and the average of the three values was calculated (Van Der Wijden et al., 2013). The percentage of body fat was estimated by using the method of Durnin and Womersley (Joshi et al., 2008)

Thigh perimeter.

Thigh perimeter was measured by experienced football fitness coach with a medical tape measure at 10 cm and 15 cm from the top of the patella of each limb. The difference and % in the values thereby recorded before and after the reathletization protocol was calculated (Laboute et al., 2013).

Heart rate measurement.

The maximum HR was recorded immediately after the

30-15 IFT, and the resting HR was recorded immediately after awakening using a portable heart rate monitor (Polar® Team2 Pro, Kempele, Finland).

The single-leg (hopping) long jump.

Three maximal long jumps on the healthy limb and on the injured limb were performed turn by turn. The first jump began with the healthy limb. After each jump, the patient returned to the starting line, changed sides (or legs) and carried out another trial. The figures recorded for each limb were measured in centimeters. The mean figure was then calculated for the three jumps with the healthy limb and the three jumps with the injured limb. Expressed in percentage, the mean difference in jump length between the healthy side and the injured side provides simple quantification of the strength deficit on the injured side (Laboute et al., 2013).

Two legs jump.

Standing Long Jump, A LJ test was used in this study to test the anterior non rebounding jumping ability (explosive strength capabilities of the leg musculature) (Minerva Medica, n.d.). Player performed 1-maximal bilateral anterior jump with arm swing. Jump distance was measured from the starting line to the point at which the heel contacted the ground on landing. The validity and reliability of this test were previously reported in literature (Cardinale et al., 2004).

Countermovement jump.

The starting position for the CMJ was a standing position with a straight torso and fully extended knees with feet shoulder width apart (Holsgaard Larsen et al., 2007). Participants

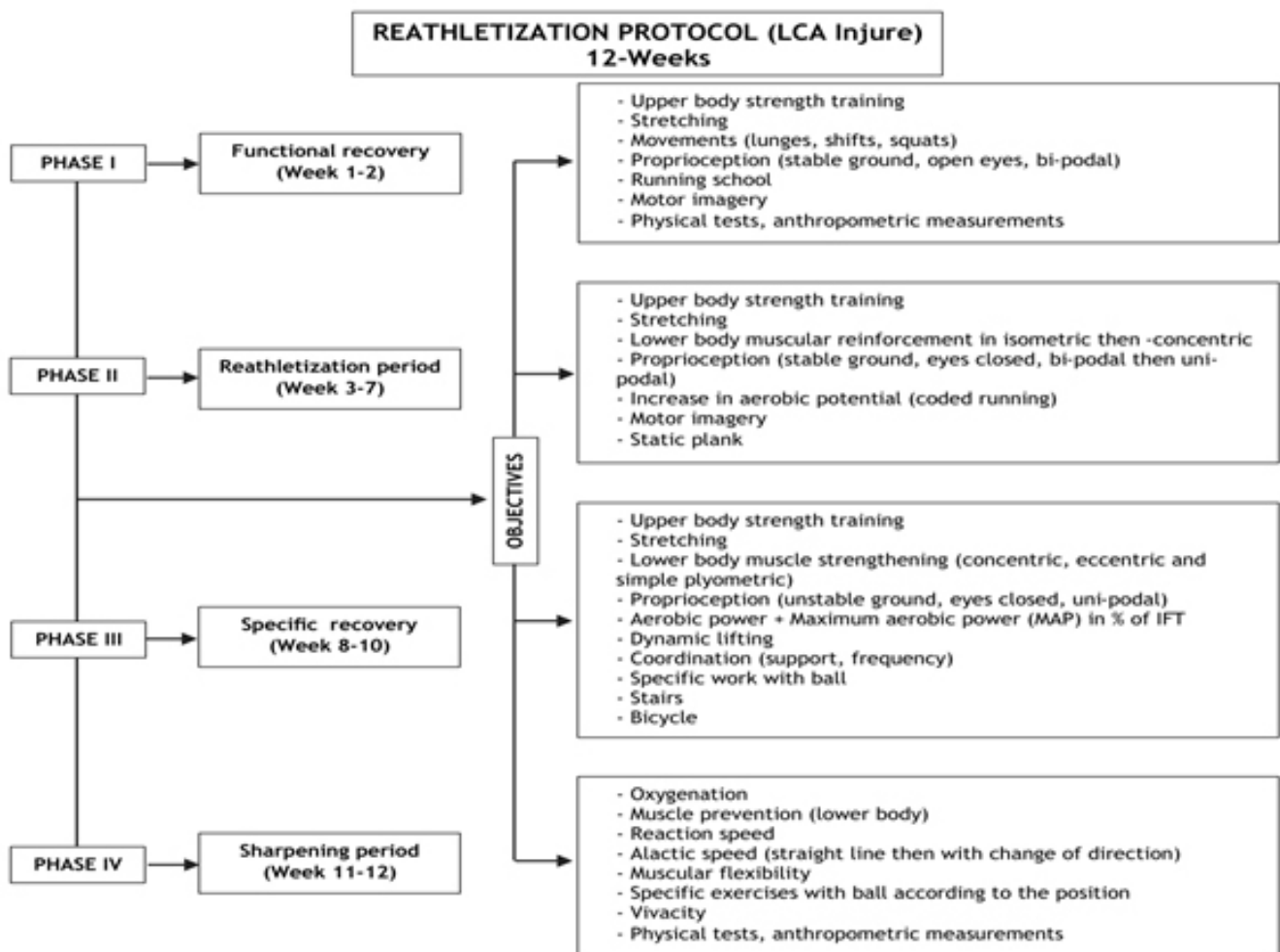


Fig. 1. Show the details of the reathletization protocol

kept their hands on their hips throughout the jump. They were instructed to perform a rapid downward movement (approximately 90° of knee flexion), and afterwards a rapid upward movement to jump as high as possible.

Prone Plank Test.

For the prone plank test, player maintains a prone position in which the body mass was supported by the toes and forearms. Player was instructed to maintain a neutral position of the spine and pelvis and to breathe normally during testing. Elbows were directly below the shoulders, and forearms and fingers were extending forward, while the feet were kept shoulder-width apart. Each test was ended when the player was unable to maintain their posture or their pelvis moved up or down 5 or more centimeters. Each holding time was recorded using a stopwatch. The holding time (seconds) of the prone plank test was used for further analysis. The reproducibility of this test has been confirmed in previous studies (Tong et al., 2014), with reported ICC values of 0.99 (95% confidence interval 0.98–0.99) and (coefficient of variation [CV]) 2.0 6 1.56% (Љbimenko et al., 2019).

The 30-15 IFT.

The 30-15 IFT consists of 30-s shuttle runs interspersed with 15-s passive recovery periods. Velocity is set at 8 km/h-1 for the first 30-s run, and speed is increased by 0.5 km/h every 30-s stage thereafter (well-trained players can start the test at 10 or even 12 km/h to save time). Players are required to run back and forth between two lines set 40 m apart at a pace, which is governed by a prerecorded beep. The prerecorded beep allows the players to adjust their running speed when they enter a 3-m zone placed in the middle and at each extremity of the field. During the 15-s recovery period, players walk in a forward direction towards the closest line (at either the middle or end of the running area, depending on where their previous run had stopped); this line is where they will start the next run stage from. Players are instructed to complete as many stages as possible and the test ends when the players can no longer maintain the required running speed or when they are unable to reach a 3-m zone in time with the audio signal for three consecutive times. The velocity attained

during the last completed stage, determined as the player's VIFT. $VO_2 \text{ max}$ can be estimated from the VIFT according to the following formula: $VO_2 \text{ max } 30-15 \text{ IFT} (\text{ml} \cdot \text{min} \cdot \text{kg}^{-1}) = 28.3 - 2.15 G - 0.741 A - 0.0357 W + 0.0586 A \times \text{VIFT} + 1.03 \text{ VIFT}$, where G stands for gender (female = 2; male = 1), A for age, and W for weight (Buchheit, M, 2015).

Statistical analysis

The statistical treatment of our data was done by using the formula percentage of variation between the pre-tests and the post-tests by the following formula: $((\text{New value} - \text{Old value}) / \text{Old value} \times 100)$. The calculations were performed on Microsoft Excel 2007 licensed (KGFVY-7733B-8WCK9-KTG64-BC7D8).

Results of the research

Table 2 presents the results obtained by the anthropometric measurements done on the professional soccer player before and after the reathletization protocol. We have recorded an evolution in % in weight (kg) increased by (+3.6 kg, +5.76%) and body mass index by (+1.23, +5.75%). % body fat had decreased by (-1.8 kg, -19.62%).

Table 2
Evolution of anthropometric parameters (between beginning and end of protocol: Weight, BMI and %body fat)

Anthropometric parameters	Before	After	Difference	Percent variation
Weight (kg)	62.5	66.1	+3.6	+5.76%
BMI	21.37	22,60	+1.23	+5.75%
%body fat	9.17%	7.37%	-1.8	-19.62%

Table 3 presents the results obtained by the thigh perimeters measurements and horizontal jump done on the professional soccer player before and after the reathletization protocol. We have recorded an evolution in % in his thigh perimeter at 10 and 15 cm from the patella that had increased

Table 3
Evolution of thigh perimeters and horizontal jump. (Difference between beginning and end of protocol for the following parameters: thigh perimeter at 10 cm, 15 cm and single-leg jump)

	Thigh perimeter at 10 cm				Thigh perimeter at 15 cm				Single-leg jump			
	Before	After	D ₁	Percent variation	Before	After	D ₁	Percent variation	Before	After	D ₁	Percent variation
Is	41	45	+4	9.75%	47	50	3	6.83%	1.46	2.03	0.57	39.04%
Hs	44.5	47	+2.5	5.61%	50	52.5	2.5	5%	2.10	2.20	0.1	4.76%
D ₂	7.86%	4.25%	-	-	6%	4.76%	-	-	30.47%	7.72%	-	-

Note: Is: Injured side, Hs: Healthy side, D₁: Difference, D₂: Deficit

Table 4
Evolution of muscle strength in % before and after the reathletization protocol

Tests	Before	After	Difference	Percent variation
Prone Plank Test	min	2'. 16"	3.30	52.77%
CMJ	cm	32.15	46.83	45.66%
Two legs jump	cm	1.90	2.33	22.63%

Note: CMJ: Countermovement Jump.

Table 5
Evolution Evolution of aerobic capacity. (Between beginning and end of protocol for the following parameters: IFT, Vo2 max, maximum-HR and resting HR)

Tests			Before	After	Difference	Percent variation
30-15 IFT	IFT	km/h	17.5	20	2.5	14.28%
	Vo ₂ max	mL/min/kg	47.65	53.30	5.65	11.85%
Heart rate	Maximum HR	bpm	190	180	10	5.26%
	Resting HR		60	50	10	16.66%

Note: IFT: Intermittent Fitness Test, Vo2 max: Maximal O2 consumption, HR: Heart Rate

respectively ((injured side; at 10 cm (+4 cm, 9.75%) and at 15 cm (3cm, 6.83%)), ((healthy side; at 10 cm (+2.5 cm, 5.61%) and at 15 cm (2.5 cm, 5%)). Regarding single-leg jump we have recorded an evolution in % in ((injured side; (0.57cm, 39.04%)), and ((healthy side; (0.1 cm, 4.76%)).

Table 4 presents the results obtained by the muscle strength tests done on the professional soccer player before and after the reathletization protocol. We have recorded an evolution in % in the Prone Plank Test (1.14 min, 52.77%), Countermovement jump test (14.68 cm, 45.66%), and Two legs jump test increased by (0.43 cm, 22.63%).

Table 5 presents the results obtained by the aerobic tests and measurements done on the professional soccer player before and after the reathletization protocol. We have recorded an evolution in % in the 30-15 IFT increased in: IFT (2.5 km/h, 14.28%), and Vo2 max (5.65 mL/min/kg, 11.85%), heart rate measurements decreased in maximum HR (10 bpm, 5.26%) and resting HR (10 bpm, 16.66%). For further clarification on the results of our study, see (Fig. 2).

Discussion

The results of our study confirm the effectiveness of the reathletization protocol and show a significant improvement over the course of the protocol in anthropometric parameters, volume and muscle strength and aerobic capacity. More exactly, the body weight increased by (+3.6 kg, 5.76%), this evolution in body weight had a positive impact on the body mass index, which reached 22.6 after the protocol with a difference of (+1.23, 5.75%). This increase is explained by the muscular hypertrophy because of the various muscular solicitations in particular in the 3rd stage (Specific Recovery). Body fat undergoes a greater decrease (-1.8 mm, -19.62%), this decrease in body fat percentage is due to the running work (coded and uncoded) during most of the reathletization period.

In comparison, the anthropometric values of our player after the reathletization phase are close to the values of high level footballers. Regarding weight (Zouhal et al., 2021) found

Percent variation in anthropometric measurements and physical tests

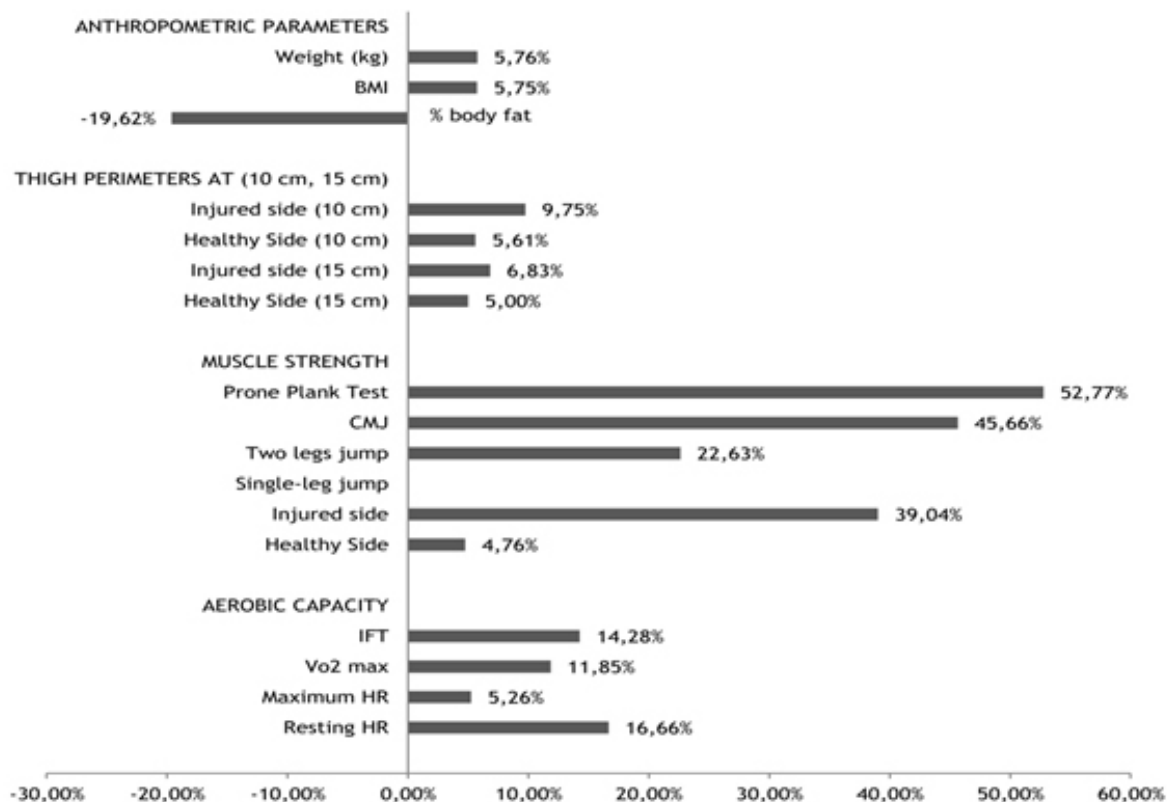


Fig. 2. Show the variation between the beginning and the end of the reathletization protocol in the anthropometric measurements and physical tests

that professional soccer player weighs 69.1-81.3 kg (66.1 kg for our player). Depending on the study, the fat mass of a player is between 7.5 (Owen et al., 2018) and 13.6% (Clemente et al., 2019), (7.37% for our player). The Body Mass Index (BMI) of soccer players is between 22.9 (Ingebrigtsen et al., 2012) and 24.1 kg/m² (de Araujo et al., 2019) (22.6 kg/m² for our player).

More than 80% of professional soccer club physicians surveyed in the study by (Delvaux et al., 2015) considered muscle strength among the most critical criteria for returning to competition after ACL plastic surgery to ensure a safe RTS. A remarkable progression in volume and muscle strength, thigh perimeter at 10 cm increased (4 cm, 9.75%) in the injured side and (2.5 cm, 5.61%) in the healthy side, thigh perimeter at 15 cm also increased by (3 cm, 6.83%) in the injured side and (2.5 cm, 5%) in the healthy side. These gains in muscle volume are greater than that of (Laboute et al., 2013), who achieved 1 cm following a program of rehabilitation and leucine supplementation following ACL surgery. The muscle strength of the injured leg evolved by 39.04%, and the injured leg evolved by 4.76%, this great difference in evolution is due to the great loss of strength after the ACL surgery. Condouret et al. showed the persistence of an average strength deficit of 10% (Duval, Lehance, et al., 2017) to 20% (Delvaux et al., 2015) in the quadriceps and hamstrings. The bilateral deficit of our player is up to 30.47%, this deficit was expected, because the deficit in isokinetic muscle strength on the quadriceps ranges according to the different studies from 23 to 40% at 6 months (Laboute et al., 2013), we see that this great deficit is due to the total cessation of physical activity following ACL reconstruction and the long period and delay in the beginning of the process of reathletization. But through this later, we were able to reduce the bilateral deficit in muscle strength up to 7%, this value allows a more secure RTS, where 36% of doctors tolerate up to 10% of bilateral difference as an essential criterion of RST (Delvaux et al., 2015) and it is essential to decrease these muscular deficits (Paterno et al., 2018), whether it is the strength of the hamstrings (Thomas et al., 2013), which protect the transplant, or of the quadriceps, which is correlated with persistent pain (Cristiani et al., 2020) or recurrence (Schmitt et al., 2015).

The quantified values for our player indicated a greater improvement in the muscular strength performances. The player progressed in terms of general strength after the reathletization protocol, he was able to exceed 3 min of sheathing, and this performance gave him self-confidence to return in competition.

Regarding the vertical jump measured by the basis of the CMJ test, and the horizontal jump measured by the basis of the Two legs jump test, the results obtained in the pre-test show the player's weakness in lower limb strength (Duval, LEHANCE, et al., 2017), and reflect the effect of the cessation of physical activity after the ligamentoplasty, as well as the player's fear of a new ACL rupture during squatting, jumping and landing activities (Schmitt et al., 2015), that's why psychological support is mandatory in this phase (Picard et al., 2021), (Johnson et al., 2016). Plyometric is often included in reath-

letization (Grueva-Pancheva & Stambolieva, 2021), especially in phase 3 allowing the player to make significant progress and reach the values of professional players who have a CMJ performance between 33.6 (Fernando et al., 2016) and 43.3 cm (Arcos et al., 2017).

Shuttle running is an integral part of professional soccer, a long period of inactivity decreases aerobic performances (Duval, LEHANCE, et al., 2017), the IFT test shows the preparation of the patient for a return to competition, the player showed no pain or fear of re-injury during the test, he presented a V_{it} value of 20.5 km/h at the end of the protocol and a VO_2 max value of 53.30 ml/min/kg, these values are acceptable to return to competition, where the VO_2 max of the professional players is between 56.8 (Owen et al., 2018) and 59.4 ml/min/kg (Koundourakis et al., 2014). This VO_2 max value allows the player to sustain high-intensity efforts and to optimize recovery between efforts (Zouhal et al., 2021). The maximum heart-rate and the resting heart rate were influenced by this reathletization protocol, they decreased by 10 pulses/min, reflecting the good physiological responses related to this reathletization protocol.

Conclusions

A progressive protocol after 6 months of ACL surgery allows a complete recovery of the patient and a safer return to competition. A 12-week protocol is adequate for optimal reathletization, and allows: developing strength and aerobic performance, presenting a lower risk of recurrence and reducing bi-lateral deficits.

The results obtained are pertinent to the monitoring of the functional status of football players after ACL ligamentoplasty.

We feel it is important to emphasize the weakness of our sample (one subject) which limits the statistical power of our study. Further studies with a larger number of subjects are still necessary.

Author Contributions

Houar Abdelatif: data collection/entry, data analysis/statistics, data interpretation.

Kacem Abdelhadi: study design/planning, data interpretation.

GuemrichE Nasredine: data interpretation, fundraising.

Zaoui Abdelkader: data collection/entry, literature analysis/search.

Chiha Fouad: data interpretation, fundraising.

Zerf Mohamed: data analysis/statistics, data interpretation, fundraising.

Conflicts of Interest

The authors declare no conflict of interest.

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Effect of running classes on the stress level of combatants

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Abstract

The full-scale war in Ukraine is having a significant psychological and physical impact on combatants. One of the negative consequences of war is combat stress, accompanied by the action of stress factors that negatively affect psychological and physical health, reducing the process of socialization to peaceful life. At the same time, there are not enough studies covering the solution of these issues with the help of adaptive physical culture (APC), which confirms the relevance of the chosen topic.

Purpose: to determine the impact of running classes on combatants who have the consequences of combat stress.

Material & Methods: the research was carried out on the basis of the National Council for Sports Rehabilitation of Defenders of Ukraine in Kyiv. It was attended by 40 combatants. The following methods were used in the course of the study: theoretical analysis and generalization of scientific and methodological literature, pedagogical testing, pedagogical experiment, methods of mathematical statistics.

Results: at the end of the pedagogical experiment, the participants in the hostilities determined the level of stress according to the "Modified method for determining the level of stress by L. Ryder", before and after running classes. Based on the data after the study, it was found that at the initial stage, 77% of combatants had a high level of stress, and 13% had an average level of stress. At stage 2, after the use of APC (within 1 year), the level of stress among combatants was reduced to 50% – medium, 50% – low, which shows the effectiveness of the use of APC (running classes).

Conclusions: a study was conducted with the determination of the level of stress according to the "Modified method of the level of stress according to L. Rieder" and the positive effect of running was shown. Measures are proposed to help reduce the level of stress among combatants.

The dynamics of the results indicates the stability of reducing the level of combat stress with the help of running, which confirms the expediency of organizing the training process for combatants.

Анотація

Наталія Крушинська, Ірина Когут, Сергій Матвеев, Марина Ягієлло. Вплив занять бігом на рівень стресу в учасників бойових дій. Повномасштабна війна в Україні чинить значний психологічний та фізичний вплив на учасників бойових дій (УБД). Одним із негативних наслідків війни є бойовий стрес, який супроводжується дією стрес-факторів, що негативно впливають на психологічне та фізичне здоров'я, яке в подальшому знижує процес соціалізації до мирного життя. Разом з тим, досліджень, що висвітлювали б вирішення цих питань за допомогою адаптивної фізичної культури (АФК) недостатньо, що підтверджує актуальність обраної теми. **Мета:** визначити вплив занять бігом на учасників бойових дій, які мають наслідки бойового стресу. **Матеріал і методи:** дослідження здійснювались на базі Національної ради спортивної реабілітації захисників України в м. Києві. У ньому брали участь 40 учасників бойових дій. Під час проведення дослідження застосовувались наступні методи: теоретичний аналіз і узагальнення наукової та методичної літератури, педагогічне тестування, педагогічний експеримент, методи математичної статистики. **Результати:** по завершенню педагогічного експерименту, в учасників бойових дій визначено рівень стресу за «Модифікованою методикою на визначення рівня стресу Л. Рідера», до занять бігом та після. Виходячи з даних після дослідження встановлено, що на початковому етапі у 77% УБД був високий рівень стресу, а в 13% середній рівень стресу. На 2 етапі після використання АФК (впродовж 1 року) було знижено рівень стресу в УБД до 50% – середній, 50% – низького, що показує про ефективність

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соціалізація до мирного життя

використання АФК (заняття бігом). **Висновки:** проведено дослідження з визначенням рівню стресу за «Модифікованою методикою рівня стресу за Л. Рідера» та показаний позитивний вплив занять бігом. Запропоновані заходи, що сприятимуть зниженню рівня стресу в УБД. Динаміка результатів свідчить про стабільність зниження рівня бойового стресу за допомогою бігу, що підтверджує доцільність організації тренувального процесу для УБД.

Introduction

The full-scale war in Ukraine has a significant psychological and physical impact on the combatants. One of the negative consequences of war is combat stress, accompanied by the action of stress factors that negatively affect psychological and physical health, which further reduces the process of socialization to peaceful life.

According to scientific studies by Druz O. et al. (2016) and Blinov O. (2022), about 80% of combatants were under combat stress, which later transformed into post-traumatic stress disorder (PTSD) of varying severity. 98% of combatants need qualified assistance as a result of combat stress.

An analysis of the literary sources of scientists Blaut O. (2021), Bryndikov Yu. (2018), covering the problem of the recovery of combatants after combat stress, shows that military doctors have traditionally dealt with this problem, among which psychiatrists play a leading role. At the same time, the effectiveness of sports rehabilitation as a means of restoring combatants after combat stress is insufficiently covered in scientific sources.

On May 12, 2018, the President of Ukraine signed a Decree on supporting the development of sports rehabilitation for combatants. According to this document, combatants are involved in sports competitions, training and physical education and sports rehabilitation in order to preserve the social capital of the country.

On February 12, 2022, the Verkhovna Rada of Ukraine adopted the Law of Ukraine "On Amendments to the Law of Ukraine "On Physical Culture and Sports" on the sport of war veterans" (No. 5526). According to this law, according to the proposals of the Ministers of Veterans, a separate area of sport is legally fixed at the state level – the sport of war veterans. The structure of veteran sports organizations will expand, and sports competitions among defenders will be held at the district, regional and international levels.

The sport of war veterans is one of the components of the adaptation of veterans in society and civilian life. Sports competitions for combatants are not only a tool for rehabilitation, but also an opportunity to build high-quality communication among the Defenders, expand the circle of participants in the implementation of veteran policy in communities and reduce combat stress.

The reduction of combat stress with the help of APC and involvement in sports was revealed by scientists Bryndikov Yu., Puzan Ya., Prykhodko I. At the same time, the number of scientific works and events covering recovery from combat stress with the help of sports (including running) is not enough, which confirms the relevance of the chosen topic.

Material and Methods of the research

Members

The study involved combatants in the amount of 40 people who during the year were engaged in APC and preparation

for all-Ukrainian and international competitions. The combatants were informed about all the features of the study and agreed to participate.

Methods

Among the research methods, we used the analysis and generalization of special scientific and methodological literature, documentary sources and materials from the Internet; pedagogical supervision; questioning; Methods of Mathematical Statistics The research program included "Modified Method for Determining the Level of Stress by L. Ryder".

Procedure (organization of the study)

The pedagogical experiment was carried out on the basis of the National Council for Sports Rehabilitation of Defenders of Ukraine. The study involved 40 combatants who were tested. Testing was carried out by the coach at the first training session and a year after APC (running) in preparation for international and all-Ukrainian competitions. Athletes who qualified for the international competitions Invictus Games, Warriors games, and the Marine Corps marathon in the United States took part in the research. All participants were informed about the use of testing materials and gave their consent to their use.

The research program included testing "Modified method for determining the level of stress by L. Reeder" – this is an express diagnostic of the level of stress, which has been used since 1969 and demonstrates the effective determination of indicators of self-assessment of health, stress level and life satisfaction in patients. Thus, combatants can conduct a self-assessment by checking the appropriate box in the questionnaire. "The modified method for determining the level of stress by L. Reeder" is part of the primary study with which you can identify the level of stress at the moment in combatants. The results are interpreted using the assessment criteria of the questionnaire, distributed by scores from 1 to 4. 1) 1–2 – high; 2) 2,01–3 – medium; 3) 3,01–4 – low.

Statistical analysis

In order to process scientific materials, methods of mathematical statistics were used for quantitative analysis of the results obtained. The research results were processed using Excel 2016 (Microsoft, USA).

Results of the research

Analyzing the literary sources of scientists O. Blinova (2022), O. Druz et al. (2016), O. Kravchenko (2022), we can conclude that the level of combat stress is present in 98% of combatants. In order to preserve the social capital of the country among combatants with combat stress, the need to find effective means of restoring these individuals is becoming more active. According to scientists Zlivkov V. and others (2022), Shidelko A. (2022), one of the areas for the recovery of combatants is the use of APC, in particular, preparation for sports competitions in running.

To determine the level of stress among combatants, studies were carried out according to the method of L. Ryder. Testing was carried out in two stages (before the start of APC training and after 1 year of running) (Table 1).

An analysis of the results obtained indicates a high level of stress found in 77% of combatants. The average level of stress is 23% of combatants. A low level of stress was not found during the first stage of the survey of combatants, which indicates the negative consequences of combat stress and the need to restore psychological and physical health with the help of APC, in particular, running (Shidelko, A. (2022)).

Table 1

Level of stress among combatants according to the modified method of L. Ryder (n=40)

Last name, First name	Age	I stage			II stage		
		Total score	Result	Stress level	Total score	Result	Stress level
B. O.	22	12	1,71	high	23	3,28	low
S. G.	25	11	1,57	high	18	2,57	average
K. V.	30	16	2,28	average	23	3,28	low
Ch. P.	32	15	2,14	average	21	3	low
B. M.	32	15	2,14	average	24	3,42	low
S. A.	32	13	1,85	high	19	2,71	average
T. O.	32	11	1,57	high	21	3	low
M. M.	35	13	1,85	high	22	3,14	low
P.P.	35	12	1,71	high	21	3	low
K.V.	36	16	2,28	average	24	3,42	low
Z. O.	36	12	1,71	high	22	3,14	low
K.S.	37	15	2,14	average	21	3	low
N. I.	38	16	2,28	average	21	3	low
P.R.	39	10	1,42	high	20	2,85	average
B. R.	40	14	2	high	17	2,42	average
K. I.	41	11	1,57	high	20	2,85	average
K. T.	41	14	2	high	22	3,14	low
M. M.	42	12	1,71	high	17	2,42	average
G. I.	42	12	1,71	high	25	3,57	low
G. O.	42	9	1,28	high	16	2,28	average
D.V.	42	15	2,14	average	23	3,28	low
Sh. A.	42	13	1,85	high	19	2,71	average
B. Yu.	43	15	2,14	average	23	3,28	low
S. Yu.	43	10	1,42	high	19	2,71	average
K. G.	44	12	1,71	high	17	2,42	average
D.S.	44	13	1,85	high	22	3,14	low
Z. I.	44	13	1,85	high	19	2,71	average
O.V.	45	13	1,85	high	21	3	low
Z. Yu.	47	16	2,28	average	24	3,42	low
D.V.	47	12	1,71	high	17	2,42	average
Sh. V.	49	10	1,42	high	19	2,71	average
R. V.	51	13	1,85	high	24	3,42	low
H.S.	53	12	1,71	high	18	2,57	average
Sh. L.	54	14	2	high	19	2,71	average
B. V.	54	11	1,57	high	18	2,57	average
P.V.	54	14	2	high	22	3,14	low
T.S.	56	13	1,85	high	18	2,57	average
P.V.	56	14	2	high	20	2,85	average
Yu. V.	57	12	1,71	high	19	2,71	average
V. A.	60	9	1,28	high	17	2,42	average

Considering the age indicator, we can generalize those combatants aged 45-60 have a harder time recovering from combat stress (Melnyk, O., 2019). Recovery also depends

on the responsible attitude to the training process of combatants. Athletes who did not systematically attend training are significantly lower than the effectiveness of restoring physical

and psychological health (Krushinskaya N. and others (2021), Matveev S. and others (2022)).

For 1 year, the combatants were engaged in running, preparing for all-Ukrainian and international competitions: Invictus Games, Marathon in New York, which no one wants to run, the run “I respect the soldiers, I run for the Heroes of Ukraine”, “Veteran Ten”, “Military Run UA”, “Veteran Mile in Kosice”, Marine Corps Marathon in the USA, Peace Marathon in Kosice and others (Puzan Ya. and others (2021), Ukrinform. (2021), Presidential Decree (2018), Internet source, 2021). The trainings took place three times a week under the supervision of a trainer, and twice a week the combatants trained individually. To control the physical fitness of the participants in the hostilities, the test developed by the Ministry of Youth and Sports of Ukraine was used – “Annual assessment of the physical fitness of the population” (Decree of the President of Ukraine No. 123/2018 (2018). And to control the decrease or increase in combat stress and manifestations of PTSD, the “Modified method for determining the level of stress by L. Ryder” was used.

After the second stage of the questionnaire on the “Modified methodology for determining the level of stress”, it was found that 50% of combatants have an average level of stress, and 50% have a low level of stress, showing a positive effect of running on recovery from combat stress (Figure 1).

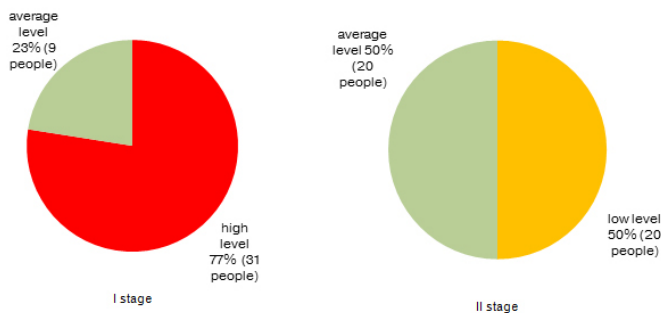


Figure 1. Modified method for determining the level of stress by L. Ryder

So, based on the data obtained after passing the “Modified Method for Determining the Level of Stress by L. Ryder” among combatants, it was found that at the initial stage, out of 40 respondents, 31 respondents had a high level of stress (77%); 9 respondents had an average level of stress (23%), which indicates the negative effects of combat stress. After completing the APC (running) classes, the testing was repeated, which showed the following indicators: in 20 respondents, the level of stress decreased to average (50%), and in 20 to low (50%), which showed the effectiveness of building the training process.

Discussion

The large-scale war in Ukraine led to the negative consequences of combat stress and manifestations of PTSD among

combatants. To reduce and eliminate combat stress, the use of APC (in particular, running classes) is proposed.

The results of the study according to the “Modified method for determining the level of stress by L. Ryder” indicate a positive effect of APC training. In the works of domestic authors (Yu. Bryndikov, 2018; I. Kogut, N. Krushinskaya, S. Matveev, 2021), positive factors of the influence of APC classes on the psychological and physical condition of combatants are noted. Using the L. Rieder test, the presence of negative psychological consequences of the war among combatants and the positive effect of physical activity on improving their psychological and physical health were confirmed (Decree of the President of Ukraine No. 123/2018 (2018); Internet source (2019, October 27; 2022, August 10; 2022, February 15)).

Therefore, it can be assumed that subsequent regular APC classes will reduce the negative level of stress among combatants. The readiness of combatants for systematic APC classes will reduce the level of combat stress and manifestations of PTSD (Kogut I. and others 2021; Prykhodko I., 2021; Internet source (2021, August 1)).

Conclusions

1. An analysis of professional literature shows that 98% of combatants have combat stress, which further negatively affects adaptation to civilian life. Through adaptive physical training, combatants can reduce the level of negative effects of combat stress.

2. Combatants aged 45–60 more difficult to recover from combat stress. At the same time, recovery depends on a responsible attitude to the training process of combatants. Athletes who did not systematically attend training are significantly lower than the effectiveness of restoring physical and psychological health.

3. The results of the studies made it possible to determine that running classes have a positive effect on the level of stress among combatants. At the initial stage, 77% of combatants had a high level of stress, and 13% had an average level of stress. After studies using APC, including running (for 1 year), the level of stress among combatants was reduced to 50% – medium, 50% – low, which indicates the effectiveness of the use of APC funds.

Author Contributions

Nataliia Krushynska – research planning, manuscript preparation;

Iryna Kohut – data interpretation, data analysis;

Sergey Matveev – data collection, literature analysis;

Marina Jagiello – Study design/planning.

Conflicts of Interest

The authors declare no conflict of interest.

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Game stretching as a modern means of developing the flexibility of 5–6-year-old female gymnasts

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Abstract

Purpose: to prove the effectiveness of the technique of game stretching to increase the level of development of flexibility in female gymnasts aged 5-6 years.

Material & Methods: the study involved 30 female athletes aged 5-6 years who are engaged in rhythmic gymnastics. According to the results of the initial testing, a group of female gymnasts was divided into control (n=15) and main (n=15), taking into account the absence of significant differences in the indicators of flexibility tests. Both groups of young gymnasts trained in accordance with the curriculum for the Youth Sports School in rhythmic gymnastics (1999). In the training sessions of female athletes of the main group, a specially developed technique of game stretching was included, aimed at developing flexibility.

Results: the obtained results of the study give grounds to assert that the proposed methodology, by which female gymnasts of the main group (MG) trained, contributed to a more pronounced ($p < 0,05$; $p < 0,01$) increase in the level of flexibility development compared to the results of female athletes control group (CG), who trained according to the traditional flexibility development program. So in tests T1 "Extension in the knee joints" (cm); T2 "Twisting the stick" (cm); T4 "Gymnastic bridge" (points) significant differences in test scores were found with a probability of 99% at $p \leq 0,01$. In tests T3 "Backward bend in lying position" (cm); T5 "Performing splits on the right", (points) and T6 "Performing splits on the left", (points) there were also found significant differences in indicators with a probability of 95% at $p \leq 0,05$ between the main and control groups. However, in the T7 test "Performance of transverse splits" (points), an unreliable difference was obtained between the performance of the gymnasts of the main and control groups ($p > 0,05$), although an improvement in the results in this test was observed in both groups.

Conclusions: the results of the study showed the effectiveness of the method of game stretching to increase the level of development of flexibility in female gymnasts 5-6 years old. The technique contributed to a more pronounced ($p < 0,05$; $p < 0,01$) increase in the level of development of flexibility among female athletes of the main group (MG) compared with the results of female gymnasts in the control group (CG). So, in tests T1 "Extension in the knee joints" (cm); T2 "Twisting the stick" (cm); T4 "Gymnastic bridge" (points) significant differences in test scores were found with a probability of 99% at $p \leq 0,01$. In tests T3 "Backward bend in lying position" (cm); T5 "Performing splits on the right", (points) and T6 "Performing splits on the left", (points) there were also found significant differences in indicators with a probability of 95% at $p \leq 0,05$ between the main and control groups. The results obtained allow us to recommend the developed methodology for use in the training process of young gymnasts at the stage of initial training. And test exercises were applied that are not included in the Curriculum, such as T1 "Extension in the knee joints" (cm); T2 "Twisting the stick" (cm); T3 "Backward bend in lying position" (cm) is quite informative and can be used to control the flexibility of gymnasts at all stages of preparation.

Анотація

Альфія Дейнеко, Катажина Прусик, Інна Красова, Наталія Батієва, Михайло Марченков. Ігровий стретчинг як сучасний засіб розвитку гнучкості гімнасток 5-6 років. **Мета:** довести ефективність методики ігрового стретчингу для підвищення рівня розвитку гнучкості гімнасток 5-6 років. **Матеріал і методи:** у дослідженні прийняли участь 30 спортсменок віком 5-6 років, які займаються художньою гімнастикою. За результатами початкового тестування група гімнасток була розподілена на контрольну (n=15) та основну

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Ключові слова:

гімнастки
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тестування

($n=15$) з урахуванням відсутності достовірних відмінностей у показниках тестів на гнучкість. Обидві групи юних гімнасток тренувались відповідно до Навчальної програми для ДЮСШ, СДЮШОР ШВСМ з художньої гімнастики (1999). У тренувальні заняття спортсменок основної групи було включено спеціально розроблену методику ігрового стретчингу, спрямовану на розвиток гнучкості.

Результати: отримані результати дослідження дають підставу стверджувати, що запропонована методика, за якою тренувалися гімнастки основної групи (ОГ), сприяла більш вираженому ($p < 0,05$; $p < 0,01$) підвищенню рівня розвитку гнучкості, порівняно з результатами спортсменок контрольної групи (КГ), які тренувалися за традиційною програмою розвитку гнучкості. Так в тестах Т1 «Розгинання в колінних суглобах» (см); Т2 «Викручування палиці» (см); Т4 «Гімнастичний міст» (бали) були виявлені достовірні відмінності показників тестування з ймовірністю 99% при $p \leq 0,01$. В тестах Т3 «Прогинання назад в упорі лежачи» (см); Т5 «Виконання шпагату на праву», (бали) і Т6 «Виконання шпагату на ліву», (бали) також були виявлені достовірні відмінності показників з ймовірністю 95% при $p \leq 0,05$ між основною і контрольною групами. Однак у тесті Т7 «Виконання поперечного шпагату», (бали) була отримана не достовірна різниця між показниками гімнасток основної і контрольної групи ($p > 0,05$), хоча покращення результатів у цьому тесті спостерігалось в обох групах. **Висновки:** отримані результати дослідження довели ефективність методики ігрового стретчингу для підвищення рівня розвитку гнучкості гімнасток 5-6 років. Методика сприяла більш вираженому ($p < 0,05$; $p < 0,01$) підвищенню рівня розвитку гнучкості спортсменок основної групи (ОГ), порівняно з результатами гімнасток контрольної групи (КГ). Так в тестах Т1 «Розгинання в колінних суглобах» (см); Т2 «Викручування палиці» (см); Т4 «Гімнастичний міст» (бали) були виявлені достовірні відмінності показників тестування з ймовірністю 99% при $p \leq 0,01$. В тестах Т3 «Прогинання назад в упорі лежачи» (см); Т5 «Виконання шпагату на праву», (бали) і Т6 «Виконання шпагату на ліву», (бали) також були виявлені достовірні відмінності показників з ймовірністю 95% при $p \leq 0,05$ між основною і контрольною групами. Отримані результати дають підставу рекомендувати розроблену методику для використання в навчально-тренувальному процесі юних гімнасток на етапі початкової підготовки. А застосовані тестові вправи, що не входять в Навчальну програму, такі як Т1 «Розгинання в колінних суглобах» (см); Т2 «Викручування палиці» (см); Т3 «Прогинання назад в упорі лежачи» (см) є достатньо інформативними і можуть використовуватися для контролю гнучкості гімнасток на всіх етапах підготовки.

Introduction

Rhythmic gymnastics is one of the most popular Olympic sports around the world. Its specificity is manifested in the need for female athletes to perform a large number of complex coordination movements of a free nature, which are combined into a competitive composition that harmoniously combines technical skills, virtuosity, expressiveness in performing complex body movements in combination with object manipulations accompanied by musical accompaniment. The versatility of the means (dance steps, jumps, turns, balances, waves, inclinations, etc.) allow solving a variety of tasks of the physical, aesthetic, emotional, spiritual development of

female athletes (Montosa et al., 2018; Deyneko & Shevchuk, 2019; Semyzorova & Krasova, 2021; Myroshnychenko, 2006; Rutkauskaitė & Skarbalius, 2012; Vernetta et al., 2017; Sutula, 2018; et al.). Analyzing the current state of rhythmic gymnastics, the authors of Osta et al. (2021) note that in order to be competitive in the international arena, female athletes need to quickly adapt to the development of the sport and changes in competitive rights, which requires mastering a large number of complex and latest technical movements in conditions of high intensity training. An analysis of the competition rules of this Olympic cycle (2022-2024) showed that the compositions of female gymnasts were filled with more dynamic elements, during which it is very important to fix the required amplitude of movement, which is unattainable without an appropriate level of flexibility development. Therefore, the requirements for its manifestation are becoming ever higher, and the issue of its development is more relevant already at the stage of initial training of young female gymnasts. The rhythmic gymnastics curriculum suggests that already at the age of 5-6 years, female athletes should learn a large number of basic exercises, the implementation of which requires a certain level of special physical qualities, including flexibility (Khudozhnaya himnastyka dlya dytyachy-yunats'kykh sportyvnykh shkil, spetsializovanykh shkil olimpiys'koho rezervu, shkil vyshchoyi sportyvnoyi maysternosti, 1999). But the development of flexibility in female athletes aged 5-6 years is a very complex and painful process, both physically and mentally, and with the traditional forcing of the training process, already at this age, you can forever reflect the desire of the child to do gymnastics. Therefore, the search and use of modern, interesting, non-traumatic and effective methods of developing flexibility at the stage of initial training is one of the main areas of work for many specialists around the world. One of these areas is the use of game stretching techniques – specially selected exercises for stretching all muscle groups, carried out in a game form (Nechyporuk et al., 2016). The results of the studies of these specialists indicate that this technique is based on static stretching of the muscles of the body and the joint-binding apparatus of the arms, legs, spine, which contributes to the development of flexibility and has a deep healing effect on the entire body of the child. It is this method that helps the coach improve physical qualities, give emotional coloring and introduce elements of competition into the training process of young gymnasts. However, in the practice of training activities in rhythmic gymnastics, the technique of game stretching as a means of developing flexibility has not found wide application. This is most likely due to the fact that at present there are almost no scientific and methodological developments on its use in rhythmic gymnastics. Consequently, the issues related to the peculiarities of the application of game stretching techniques in the training process of female gymnasts aged 5-6 years are little studied, relevant and of interest to scientific research.

Connection with scientific programs, plans, topics. The study was conducted in accordance with the initiative topic of the scientific research of the Department of Gymnastics, Dance Sports and Choreography of the KhSAPC: “Theoretical and methodological foundations for the development of backbone components of physical culture (sports, fitness and recreation) for 2020-2025, state registration number 0120U101215”.

Purpose of the study: to prove the effectiveness of the technique of game stretching to increase the level of development of flexibility in female gymnasts 5-6 years old.

Material and Methods of the research*Participants*

The study involved 30 female gymnasts 5-6 years old, who train in the initial training group of the first year of study. From young female athletes, two groups were formed: the main (MG) and control (CG) of 15 female gymnasts in each. All female gymnasts and their parents were informed about the nature of the study and gave informed consent to participate in the study and to process the data obtained.

Methods

To achieve the goals set during the study, pedagogical testing, a pedagogical experiment, and methods of mathematical statistics were used. To assess the level of development of the flexibility of athletes aged 5-6, 7 test items were selected, 57% of which are offered by the Curriculum for Youth Sports School in rhythmic gymnastics (1999). So, to determine the mobility (flexibility) in the knee joint, a test exercise was used: "extension in the knee joints", the exercise "twisting the stick" – to determine the mobility (flexibility) in the shoulder joints, tests "bending back in the lying position" and "gymnastic bridge" – to determine the mobility (flexibility) in the spine, and with the help of the tasks "Performing three splits (on the right, left, transverse)" in the hip joints.

Statistical analysis

Statistical analysis of the results obtained was carried out using descriptive statistics indicators using licensed Excel spreadsheet packages and a set of built-in functions. The characteristics of descriptive statistics were determined: the arithmetic mean and the standard deviation. The assessment of the statistical significance of the results of a comparative analysis of the indicators of the main and control groups that were studied was carried out using the non-parametric Rosenbaum test (Q).

Procedure

Based on the results of the initial testing, the group of female gymnasts was divided into the main (n=15) and control (n=15) groups, taking into account the absence of significant differences in the indicators of the proposed tests. The level of development of the flexibility of young female athletes was tested twice – at the beginning (October) and at the end of the training year (May). Both groups of young female gymnasts trained in accordance with the Curriculum for Youth Sports School, in rhythmic gymnastics. However, in the training sessions of female gymnasts of the main group (n=15), a technique was used to develop flexibility, which included means of game stretching. Taking into account the fact that gaming activity is the main component of the educational material of the Program at the stage of initial training, the emphasis in the developed methodology was placed on the integrated development of physical qualities through the game, but with the dominance of exercises for flexibility. Training sessions with the use of game stretching exercises were held 3 times a week for 90 minutes. The duration of the study was 6 months (October-March).

Game stretching is a health-improving technique that is aimed at strengthening the musculoskeletal system with the help of stretching exercises, mostly of a static nature, which helps prevent injury, promotes the formation of correct posture, and corrects its shortcomings.

The developed technique of game stretching, firstly, was adapted to the training process of young female gymnasts, corresponded to their age characteristics and level of preparedness; secondly, it assumed the implementation of gaming opportunities in order to improve and develop the physical

and mental qualities of young female athletes; thirdly, the exercises were imitation in nature and were performed at a slow, calm pace in order to exclude injuries; fourthly, the exercises used in the methodology did not contradict the material of the Curriculum; fifthly, a positive emotional background always reigned in the training sessions.

The developed methodology provided for the use of plot-based game complexes of exercises in the preparatory, main and final parts of each training session. The time devoted to playing stretching exercises depended on the tasks of the lesson and ranged from 25 to 40 minutes. One lesson per week consisted entirely of outdoor games and game stretching exercises. The exercises consisted of imitative actions and images, carried out to the appropriate musical accompaniment of classical or folk music in the form of a story game or complexes of interrelated game situational exercises aimed at developing flexibility in combination with exercises for developing coordination abilities, strength and endurance. At each lesson, a combination of dynamic and static modes of muscle work was mandatory. By stretching and relaxing the muscles rested. The alternation of exercises in their direction was mandatory in order to eliminate fatigue and monotony of classes, as well as to increase the effect of exercises on the body of young female gymnasts. The play complexes included exercises with children's items: balls, hoops, ribbons, maces, which contributed to a more detailed acquaintance of the girls with these items, and also made it possible to interest them and increase motivation for further rhythmic gymnastics. Also, specially designed game exercises in balance, in pairs and on the gymnastic bench were widely used in the methodology. So, in the preparatory part, during the warm-up, game stretching exercises were carried out as a means of preparing muscles and tendons for the implementation of the training program: "Penguin", "Tumbler", "Snake", "Ant", etc. They were usually performed after dynamic exercises, gradually increasing the range of motion and the complexity of the exercises themselves. In the main part of the training session, to develop flexibility and increase the elasticity of muscles and ligaments, such game stretching exercises were used as: "Fish", "Dolphin", "Starfish", "Shell", "Ring", "Bridge", "Mouse", "Tiger", "Frog", "Butterfly", "Firebird", "Gymnast", "Ballerina", "Cobra", "Snail", "Swimmer", "Swing", "Ostrich", "Fox", "Boa", etc., which were associated with the names of animals, birds, flowers and imitative actions. These exercises were performed in series, alternating with program exercises of rhythmic gymnastics or simultaneously with strength exercises. As the exercises were mastered, they became more complicated due to the inclusion of elements of novelty in them, the use of objects (balls, ropes, hoops, maces). Young female athletes were given the opportunity to independently come up with flexibility exercises to the music. It should be noted that the girls enjoyed this opportunity, demonstrating confidence, artistry, ease, freedom and coordination of movements. It should be noted that if the development of flexibility was one of the main tasks of the training session, then the proposed game stretching exercises were performed in the second half of the main part of the session, as a separate independent "block" of the load. In the final part, game stretching exercises were also used as a means of recovery after training loads and prevention of injuries of the musculoskeletal system: "Twig", "Gingerbread Man", "Owl", etc. They were necessarily combined with relaxation exercises.

It should be noted that in the developed methodology, special attention was paid to the feedback between the coach, the female athlete and parents. Thus, individual home-

work assignments were developed and, with the help of their parents, young female athletes completed them, as a result of which they developed the skills of independent activity and responsibility. Home tasks were not episodic, but constituted a certain system of interaction between the coach, parents and gymnasts throughout the study. They included a number of game stretching exercises, closely related to each other in such a way that the next one could be performed only if the previous one was mastered. The homework system provided for mandatory control, on the one hand by the coach, on the other hand, by the parents. The focus of the developed tasks was of four types: on the development of flexibility either in the knee, or shoulder, or in the hip joint, or in the spine. When performing these exercises, the child imagined himself in the form of a snake, a hare, a fox, a frog, a goldfish, and other interesting and well-known characters. So, the system of home tasks was a form of attracting female gymnasts 5-6 years old to regular physical exercises and contributed to self-improvement and assimilation of educational material.

ment and assimilation of educational material.

Thus, the content of the developed methodology using the means of game stretching not only floated on the development of the flexibility of female gymnasts 5-6 years old, but also contributed to the development of the exercises of the classification program for groups of initial training.

Results of the research

At the beginning of the study, testing of the flexibility development of female gymnasts aged 5-6 years of the main and control groups was carried out, the indicators of which are presented in Table 1.

Using the Student's criterion, it was found that the obtained statistical indicators have unreliable differences in the results for all the proposed tests and state an acceptable difference in the initial level of flexibility of female gymnasts in both groups (Table 1).

Table 1
Indicators of the development of flexibility of female gymnasts aged 5-6 at the beginning of the study
($t_{gr.} = 2,05$ at $p < 0,05$)

No i/o	Name of the test	$\bar{X} \pm m$		t_p	P	
		Main group (n=15)	Control group (n=15)			
T1	Flexibility in the knee joint «Extension in the knee joints», cm	2,13±0,30	1,73±0,19	1,13	>0,05	
T2	Flexibility in the shoulder joints «Twisting the stick», cm	51,33±3,42	55,00±2,20	0,90	>0,05	
T3	Flexibility in the spine	“Backward bend in lying position”, cm	43,87±1,52	41,53±2,13	0,89	>0,05
T4		“Gymnastic bridge”, points	4,27±0,35	4,97±0,41	1,30	>0,05
T5	Flexibility in the hip joints «Performance of three splits», points	right	5,30±0,43	4,97±0,28	0,65	>0,05
T6		left	3,63±0,33	4,23±0,32	1,29	>0,05
T7		transverse	3,23±0,35	3,97±0,33	1,52	>0,05

Table 2
Indicators of flexibility development of female gymnasts 5-6 years old at the final stage of research
($t_{gr.} = 2,05$ at $p < 0,05$)

No i/o	Name of the test	$\bar{X} \pm m$		Q (S1+S2)	Qcr	
		Main group (n=15)	Control group (n=15)			
T1	Flexibility in the knee joint «Extension in the knee joints», cm	3,60 ± 0,83	2,76 ± 0,75	9	p < 0,01	
T2	Flexibility in the shoulder joints «Twisting the stick», cm	33,93 ± 4,61	40,33 ± 7,15	9	p < 0,01	
T3	Flexibility in the spine	“Backward bend in lying position”, cm	25,67 ± 4,65	28,00 ± 6,30	6	p < 0,05
T4		“Gymnastic bridge”, points	6,50 ± 1,10	5,97 ± 0,97	9	p < 0,01
T5	Flexibility in the hip joints «Performance of three splits», points	right	7,43 ± 1,37	5,87 ± 1,20	8	p < 0,05
T6		left	5,53 ± 1,27	4,59 ± 0,99	6	p < 0,05
T7		transverse	5,23 ± 1,33	4,73 ± 1,08	4	p > 0,05

At the final stage of the study, after 6 months of training according to the developed methodology using the means of game stretching, a re-testing of the development of flexibility of young female gymnasts of the main and control groups was carried out. The results obtained are presented in table 2.

At the final stage of the study, the evaluation of the effectiveness of the developed methodology was carried out using the non-parametric Rosenbaum criterion, which made it possible to analyze the reliability of differences in the average statistical values of the indicators of the level of development of the flexibility of young athletes from the main and control groups. In fact, the results of all tests revealed reliable changes in the obtained characteristics. So in tests T1 "Extension in the knee joints" (cm); T2 "Twisting the stick" (cm); T4 "Gymnastic bridge" (points) significant differences in test scores were found with a probability of 99% at $p \leq 0,01$. In tests T3 "Backward bend in lying position" (cm); T5 "Performing splits on the right", (points) and T6 "Performing splits on the left", (points) there were also found significant differences in indicators with a probability of 95% at $p \leq 0,05$ between the main and control groups. However, in the T7 test "Performance of transverse splits" (points), an unreliable difference was obtained between the performance of female gymnasts in the main and control groups ($p > 0,05$), although an improvement in the results in this test was observed in both groups. This may be due to the specificity and complexity of the work on flexibility when teaching splits. To improve the result when performing this exercise, specially directed gymnastic means are needed. However, the obtained significant changes in the results of six tests prove the effectiveness of the proposed method using the means of game stretching to increase the flexibility level of female gymnasts 5-6 years old.

Discussion

In the course of the study, results were obtained that confirm and complement the developments of domestic and foreign scientists on topical issues of rhythmic gymnastics. Thus, the theoretical positions formulated in the works of Miroshnichenko (2006), Rutkauskaitė and Skarbalius (2012), Montosa et al. (2018), Deyneko and Shevchuk (2019) that rhythmic gymnastics is a very specific sport, not only technically, but also physically, therefore, it requires a high level of preparedness from female gymnasts. Confirmed data from both Ukrainian and foreign experts (Stadnik et al., 2010; Sosina & Ruda, 2019) that the vast majority of elements, namely jumps, balances, turns and tilts, should be performed with the maximum amplitude, requiring from female gymnasts of the optimal level of development of mobility of the spine, hip and shoulder joints. The results of a study by Sosina and Ruda (2009) showed that female gymnasts should show a high level of flexibility in 95% of bends, 78% of jumps, 60% of balances and 58% of turns. Therefore, without an appropriate manifestation of mobility in the joints, gymnasts will not be able to perform at a high technical level, naturally, virtuously and expressively, a competitive composition and show a sufficient sports result (Sosina & Ruda, 2009; Semyzorova & Krasova, 2021). This position is also confirmed by the studies of Bordalo et al. (2015), Polat and Gunay (2016). In this regard, the natural desire of specialists (Andreeva, 2010; Deyneko & Bilenka, 2021; Semyzorova & Krasova, 2021) to solve the problems of improving the quality and efficiency of the training process in rhythmic gymnastics on the development of flexibility.

Based on scientific research by Miletić et al. (2004), Sosina and Ruda (2009), Andrieva (2010), Bordalo et al. (2015),

Polat and Gunay (2016), Semyzorova and Krasova (2021) confirmed the data that the proper level of flexibility of female athletes is a prerequisite for the effective performance of all basic gymnastic elements – jumps, balances, turns and bends.

An analysis of literature sources (Danish, 2002; Netchyporuk et al., 2016; Deyneko, 2017; Deyneko et al., 2021; Deineko et al., 2022; Quan Bai, 2022) revealed a unanimous opinion of domestic and foreign experts regarding 5-6 years are in the "play period", the game becomes more imaginative, logical and social, creating the prerequisites for consolidating motor skills and developing physical qualities. The results of the conducted studies supplement the data of Sosina and Ruda (2009), Andryeyeva (2010), Bobo-Arce and Mündez-Rial (2013), Bordalo et al. (2015), Polat and Gunay (2016), Semyzorova and Krasova (2021) et al., on the use of flexibility development tools and methods used in rhythmic gymnastics training sessions.

The analysis of foreign scientific literature allows us to state that since the early 1980s, static stretching has been considered an effective method of increasing the range of motion and flexibility, reducing the risk of injury during exercise (Shrier, 2005; Kay et al., 2015; et al., 2017; Konrad et al., 2017). We also agree with Boligon et al. (2015) that the level of development of flexibility directly affects the performance of various movements that provide a higher technical level of female gymnasts and, as a result, improve sports results.

It is important to note that in recent years, new modern types of physical activity have been widely spread all over the world, one of which is stretching. Biletska et al. (2015) consider «Stretching» as a system of specially fixed positions of certain parts of the body, that is, static stretching. Issues of stretching are also discussed by foreign scientists. Thus, numerous studies (Kay et al., 2015; Konrad et al., 2017) indicate that static stretching is widely used in sports practice in order to sharply increase the range of motion of the joint. As you know, flexibility must be developed from the moment of early specialization in all sports, including rhythmic gymnastics. Therefore, such a sparing and effective mode of muscle work, which meets the specifics of game stretching exercises, is quite suitable for developing the flexibility of female gymnasts at the stage of initial training. The analysis of the scientific and methodological literature (Rukhlyvi ihry: z metodykou vykladannya, 2014; Deyneko, 2017; Deyneko et al., 2021; Deineko et al. 2022) confirms the effectiveness of using the game method at the stage of initial training in gymnastic sports

Conclusions

The results of the study showed the effectiveness of the game stretching technique for increasing the level of development of flexibility in female gymnasts aged 5-6 years. The technique contributed to a more pronounced ($p < 0,05$; $p < 0,01$) increase in the level of development of flexibility among athletes of the main group (MG) compared with the results of gymnasts from the control group (CG). So, in tests T1 "Extension in the knee joints" (cm); T2 "Twisting the stick" (cm); T4 "Gymnastic bridge" (points) significant differences in test scores were found with a probability of 99% at $p \leq 0,01$. In tests T3 "Backward bend in lying position" (cm); T5 "Performing splits on the right", (points) and T6 "Performing splits on the left", (points) there were also found significant differences in indicators with a probability of 95% at $p \leq 0,05$ between the main and control groups. The results obtained allow us to recommend the developed methodology for use in the train-

ing process of young female gymnasts at the stage of initial training. And applied test exercises that are not included in the curriculum, such as T1 "Extension in the knee joints" (cm); T2 "Twisting the stick" (cm); T3 "Backward bend in lying position" (cm) is quite informative and can be used to control the flexibility of female gymnasts at all stages of preparation.

Prospects for further research are the introduction of game stretching tools into the educational and training process of the Youth Sports School, clubs and specialized educational institutions for the comprehensive development of physical qualities and further improvement of young female gymnasts at the stage of initial training.

Author Contributions

Alfiia Deineko: collection, data entry, statistics.
Katarzyna Prusik: design, study planning.
Inna Krasova: data interpretation, manuscript preparation.
Nataliya Batieieva: analysis, literature search.
Marchenkov Mikhailo: literature search, fundraising.

Conflicts of Interest

The authors declare no conflict of interest.

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