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PHYSIOLOGY

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FEATURES OF SEASONAL BIORHYTHMS ASSOCIATED WITH THE CARDIOVASCULAR SYSTEM FUNCTION IN FIRST-YEAR STUDENTS

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Annotation. Despite a significant amount of empirical data on the influence of circadian rhythms on the functional systems of the human body, the role of seasonal rhythms has not been studied enough, in our opinion. The purpose of this work was to identify the features of seasonal biorhythms associated with functions of the cardiovascular system of first-year students. The results obtained show significant seasonal fluctuations of the cardiovascular system's indicators, which indicates a need to consider these indicators in the arrangement of the educational process for the studied group.
Keywords: biorhythms, zeitgebers, adaptive potential.

Introduction. At the current moment, big chronological data has been gathered on the features of the rhythmic organization of the physiological systems of the human and animal body. The physiological systems of mammals (nervous, cardiovascular, respiratory, digestive, excretory, reproductive) are characterized by a presence of a great number of circadian, ultradian and infradian biorhythms interacting with each other [1]. The most studied ones are the circadian (comes from the Latin: circa – approximately, and dies – day), physiological, biochemical and behavioral rhythms. It is known, that the main circadian oscillator that sets biorhythms to organs and functional systems of the body, including structures of the central nervous system, is located in the suprachiasmatic nucleus [2].

A modern man often does not consider many rhythm-based factors of nature, such as sunlight, circadian, seasonal and other zeitgebers, although the endogenic biorhythm program is embedded in the genetic code. Desynchronization of biorhythms and external geophysical and social rhythm-based factors may lead to dysfunctions of regulatory physiological mechanisms of the body, consequently – to disorders and pathological dysfunctions [3].

The purpose of this study: to reveal the features of seasonal biorhythms associated with the cardiovascular system's function in first-year students.

Methods and organization. The study of seasonal biorhythms has its own complications due to the fact that it is very difficult to organize standard measurements of the functional state and set strict time frames for them.

The studies included 44 male students aged 18-20 years, who studied in the Samara University in 2020-2022. The control testing took place during the first year of study (2020-2021), the experimental testing – during the second year (2021-2022). The authors have chosen the common testing methods: heart rate monitoring and blood pressure measurement (sBP – systolic blood pressure, mm of Hg; dBP – diastolic blood pressure, mm of Hg).

Evaluation of the cardiovascular system's reducing properties was made with the Rufier Functional Test, which was calculated according to the formula:

$$RT = \frac{4 \times (P1 + P2 + P3) - 200}{10},$$

where *P1* – heart rate (HR) at rest for 15 s; *P2* – HR for 15 s after physical activity (30 squats for 1 minute); *P3* – HR for 15 s of the first minute of recovery.

Evaluation of the heart reducing properties: RT<0 – excellent work of the heart; 0 to 5.0 – very good work of the heart; 5.1-10.0 – good; 10.1-15.0 – moderate; >15 – poor.

The autonomic tone assessment was carried out with the Kerdo index (KI) according to the formula:

$$KI = \left(1 - \frac{dBP}{HR}\right) \times 100,$$

where *dBP* – diastolic blood pressure, mm of Hg; *HR* – heart rate, beats/min.

The KI assessment: KI>0 – the sympathetic influence prevails, KI<0 – the parasympathetic influence prevails.

The integral indicator of the adaptive potential (AP) was calculated with the Baevskij's formula:

$$AP = 0.011 \times HR + 0.012 \times sBP + 0.008 \times dBP + 0.14 \times age - 0.009 \times m_{body} - 0.009 \times H_{body} - 0.27,$$

where *HR* – heart rate, beats/min; *sBP* – systolic blood pressure, mm of Hg; *dBP* – diastolic blood pressure, mm of Hg; m_{body} – body mass, kg; H_{body} – body height, cm; *age*, years.

The results are interpreted as follows: AP less than 2 – satisfactory adaptation level; 2.1 to 3.0 – adaptation strain; 4.1 and higher – adaptation failure [4].

The results were statistically processed with the SigmaPlot 12.5 software package. The arithmetic mean indicators of HR, RT and AP are presented as arithmetic means (M) ± standard errors of mean (δ). With the SigmaPlot 12.5 software, we evaluated the distribution law of examined indicators with the Shapiro-Wilk test. Since values of most registered indicators did not correspond with the law, the next statistical data processing used the ANOVA Post-hoc test (Bonferroni T-test). The significance level was identified with the Student's T-test during the winter (1), spring (2), summer (3) seasons of the first year and the autumn (4) season of the second year. Values were deemed as critical if $p \leq 0{,}05$.

Results and discussion. While analyzing dynamics of biorhythmic characteristics in students, we took into the account the fact that the exam period is connected to the season change (winter and spring exams), which is why in order to reduce errors in measurements we registered the indicators during the period between exams in daytime at the specified time intervals (10:00-14:00): winter (January-February), spring (April-May), summer – after summer exams (from mid-June to July), autumn (October-November) seasons [5].

The data obtained is presented in the table below.

HR is a very variable indicator that is sensitive to external and internal factors. The revealed tachycardia has become the most common type of functional deviation, especially during our first examination. The decrease in the tachycardia values by the end of the year shows a tendency for normalizing the heart activity, and, in our opinion, it occurred due to internal factors (fig. 1).

Table

Dynamics of the cardiovascular system's indicators in first-year students during different seasons of the year

Seasons		Winter		Spring		Summer		Autumn	
Parameters		M	δ	M	δ	M	δ	M	δ
HR, beats/min	Control	89.97	11.76	84.75	9.31	81.66	12.00	75.07	7.22
	Experim.	90.31	10.3	85.3	8.24	82.56	12.00	75.44	6.07
sBP, mm of Hg	Control	132.89	8.25	129.72	8.84	127.06	9.60	123.79	5.92
	Experim.	129.5	5.34	126.7	7.21	126.0	6.61	123.8	3.2
dBP, mm of Hg	Control	80.56	7.01	76.30	4.41	72.10	7.59	75.26	4.96
	Experim.	78.16	6.91	74.45	4.33	71.08	5.52	74.26	4.22
PP, mm of Hg	Control	13.93	3.78	12.25	3.69	11.65	4.06	9.62	4.03
	Experim.	12.22	3.88	11.06	3.23	10.85	3.86	8.52	3.83
KI, c.u.	Control	8.65	11.05	7.95	10.77	9.86	10.51	-1.26	8.96
	Experim.	7.22	9.05	6.99	8.98	7.54	9.71	-1.54	3.25
AP, c.u.	Control	0.93	0.22	0.62	0.38	0.69	0.25	0.64	0.13
	Experim.	1.47	0.30	0.55	0.19	0.50	0.17	0.44	1.00

Note: HR – heart rate; sBP – systolic blood pressure; dBP – diastolic blood pressure; PP – pulse pressure; KI – Kerdo index; AP – adaptive potential

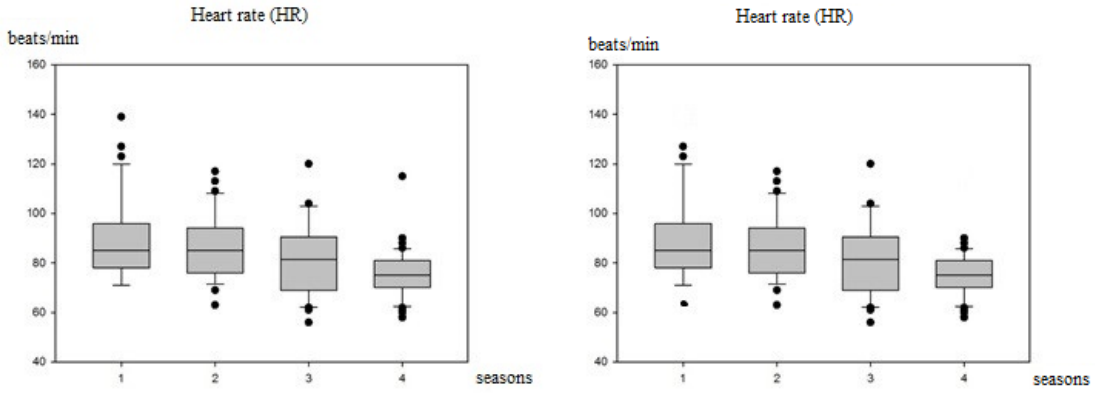

Fig. 1. Heart rate dynamics in students during different seasons ($p<0.01$)

The examined students had higher values of blood pressure during the winter season, which was characterized by the systolic and diastolic hypertension. By the first exam period of the 2nd year, the blood pressure indicators of most students were within the standard values.

The Kerdo index is considered as an important characteristic describing the state of the cardiovascular system. It is also traditionally used as an indicator of the ratio of the sympathetic and parasympathetic nervous system tone. Since the heart work and vascular tone depend on autonomic regulating sympathetic and parasympathetic influences, the Kerdo index was used for a seasonal evaluation of the cardiovascular system. Negative values show a prevalence of the parasympathetic influence on blood circulation, positive values – prevalence of the sympathetic influence [6].

The conducted research revealed that the autonomic balance in all groups during winter-spring and spring-autumn periods shifted towards sympathetic activity (KI increased), and during summer-autumn period – towards parasympathetic activity ($p<0.01$) (fig. 2).

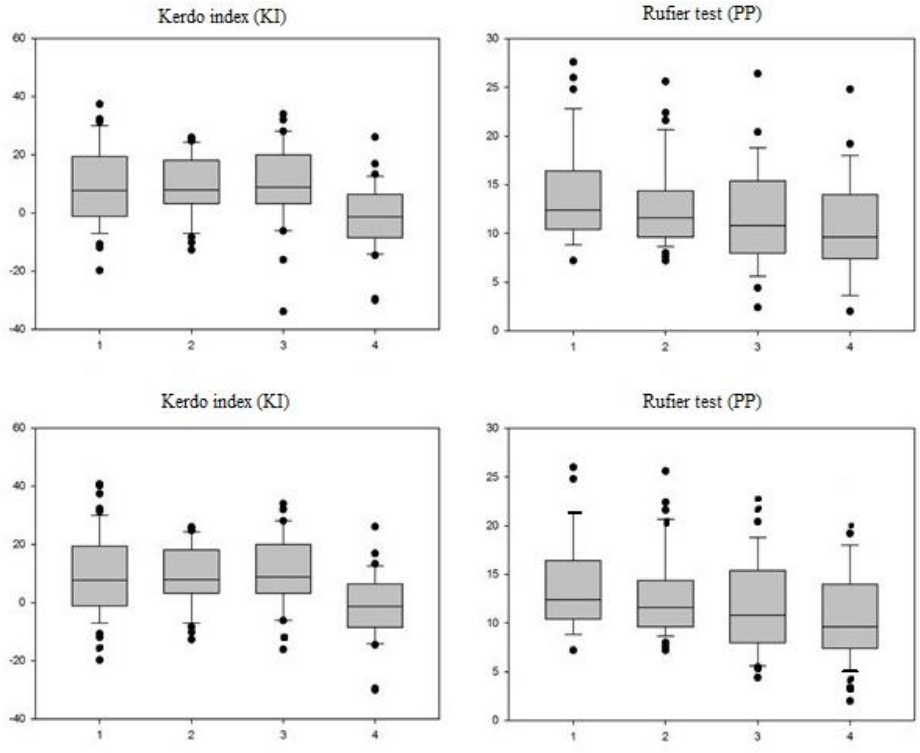

Fig. 2. Kerdo index and pulse pressure dynamics (M±δ) in students during different seasons
Note: above – control measurement results, below – experimental measurement results

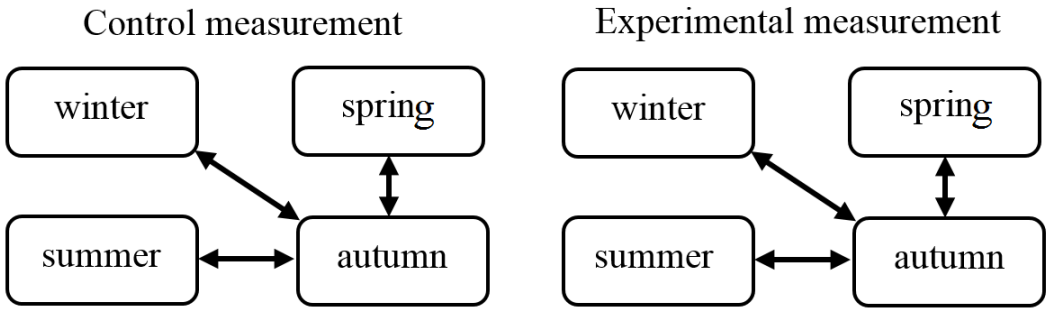

Fig. 3 Correlations between the Kerdo index indicators according to the Student's T-test in the control and experimental measurements

Note: bold lines – pronounced direct connections (r=0.35–0.69)

We have also found significant correlations ($p<0.01$) in sBP and dBP between seasons according to the Student's T-test, which is shown in the figure 3.

Functional strain of the cardiovascular system revealed after the Rufier test is shown in other indicators, the adaptive capabilities of students in particular. The comprehensive criterion reflecting these capabilities (AP) is based on the systemic approach and, in our case, it was calculated as an integrative indicator that includes age and morphofunctional features of the students. These features are shown in the table above and they demonstrate that a student's body does not experience complications associated with adaptation to the learning process.

Conclusion. The experiment that took 2 years with a fairly homogenous group of students allowed identifying significant seasonal fluctuations of the cardiovascular system indicators, which shows the need to take them into account in the educational process organization for the studied group.

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DEVELOPMENT OF THE ADL (ACTIVITIES OF DAILY LIVING) THERAPY METHODS FOR IMPROVING STRENGTH OF WEAKENED MUSCLE GROUPS AND OPTIMIZING MUSCLE BALANCE IN ATHLETES

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Annotation. Normally, specific sports training is directed towards development of strength and strength-speed capabilities of muscles contributing to performance of competitive exercises. Often, not enough attention is paid to a development of the autochthonous core muscles of athletes. Therefore, a creation of special methods aimed at optimizing muscle balance and improving the said muscles is a relevant task for strenghtening the musculoskeletal system of athletes and prevention of sports injury. The purpose of the study was to develop the ADL (Activities of Daily Living) therapy methods for improving strength of lagging muscle groups and optimizing muscle balance in athletes. The study involved 27 elite athletes (17 women, 10 men). We have conducted research of strength characteristics of the muscle groups before and after applying the developed methods. Prevention-Park, the ADL therapy intellectual system with biofeedback, was used in mechanotherapy for developing strength of lagging muscle groups and optimizing muscle balance. The experimental test results with the Prevention-Park system have revealed a significant improvement of the core muscles among athletes, which was more pronounced in women. According to the study's findings, the authors have identified main tasks of the ADL mechanotherapy for athletes: increase of functional capabilities of the musculoskeletal system, consisting in optimizing the muscle balance of various muscle groups, increasing the speed and strength abilities of muscles, the development of lagging muscle groups; prevention of overstrain and fatigue of athletes, including in the middle altitude conditions; formation of a balanced muscular spine corset.
Keywords: musculoskeletal system, neuromuscular system, muscle balance, muscle strength, muscle corset, ADL (Activities of Daily Living) therapy, biofeedback.

Introduction. The musculoskeletal and neuromuscular systems, contributing to performance of movements, are maximally involved and limit effectiveness in all sports [1-2]. Coordinated work of the spine muscle corset allow performing needed movements and preserve stability [1-2]. The acquired motor abilities of elite athletes or the motor dynamic stereotype is a sign of phased dynamic variability of the muscle corset [3].

Normally, specific sports training is aimed at improving strength and speed-strength qualities of muscles that contribute to performance of competitive exercises. Frequently, not enough attention is paid to a development of the autochthonous core muscles of athletes. Therefore, they can be developed insufficiently or unevenly and asymmetrically. Disorder of interaction between muscles that stabilize spine with muscles that perform movements is a spine muscle imbalance [3]. Such disorder causes problems for normal function of the locomotion system, since the muscles responsible for movement are normally stronger than the muscles responsible for stability, consequently – the neuromuscular imbalance of the spine and instability in the spinal motion segment. The neuromuscular imbalance disorders is shown in athletes clinically in the form of pain, burning sensation, fatigue, movement limitation in separate segments of the spine, which leads to a decreased training process intensity and prevents from reaching the peak of athletic form [4].

The ADL (Activities of Daily Living) therapy term is used for describing exercises developed for solving daily tasks. Due to concentration on a chosen joint and special sets

of movement, the training does not require significant time costs and has a long-term effect, which corresponds to the most modern trends in sports medicine during medical rehabilitation [5].

Therefore, a creation of special methods aimed at optimizing muscle balance and improving the said muscles is a relevant task for strengthening the musculoskeletal system of athletes and prevention of sports injury.

The purpose of the study – to develop the ADL (Activities of Daily Living) therapy methods for improving strength of weakened muscle groups and optimizing muscle balance in athletes.

Methods and organization. The development and testing of the ADL therapy methods was carried out during the preparatory period in Yug Sport, the organization located in Kislovodsk on the Maloe Sedlo mountain (1240 m) during training camps for elite athletes (the preparatory period). The study involved 27 elite athletes (17 women, 10 men). We have conducted research of strength characteristics of the muscle groups before and after applying the developed methods.

During the study, the athletes were at stage of the preparatory and transition periods of the training process. All subjects gave an informed consent to participate in the study in accordance with the WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects (2013), as well as a permission to process their personal data.

The authors identified strength characteristics of different muscle groups with "Dr. Wolff "Back-Check" (Germany, Physiomed), the diagnostic biofeedback system that conducts an assessment of target-oriented movements to measure peak strength during isometric contraction of muscle groups from the back, core, upper and lower limbs. The result was measured in kilograms. The diagnostic frame of the system has 2 sensors for identifying position in case of bending (fig. 1). Following measurements were carried out: back extension, back flexion, core shifting to the left, core shifting to the right, press, row, arm pulling backwards, leg pulling backwards, leg adduction, hip extension.

Fig. 1. The "Dr. Wolff "Back-Check" diagnostic system

The experts note that this system is a convenient and informative tool for assessing the "muscle corset" state in patients with pathology and healthy athletes [6-7].

After each test, we calculated the functional asymmetry coefficient (Cfa) according to the formula used by a number of authors [8-9]:

$$Cfa = \frac{N_r - N_l}{N_r + N_l} \times 100\% \qquad (1)$$

where N_r – right body half indicator, N_l – left body half indicator.

The statistical data processing was made with the Statistica 13.0 software. The authors calculated descriptive statistics indicators (mean value, mean square deviation). All data was tabulated. The comparison was made with the non-parametric Wilcoxon test for analyzing dynamics in changing parameters, as well as the Kruskal-Wallis test for identifying differences between athletes of different sports.

The mechanotherapy was carried out with Prevention-Park, the ADL therapy intellectual system with biofeedback. The set allows conducting ADL exercises. The devices have electronic control panels, LED displays that show in real time all main training parameters. It can also read therapeutic smart cards of patients.

Results and discussion.

The ADL therapy method for developing strength of lagging muscle groups and optimizing muscle balance in athletes

Back-Therapy-Center, the training device set with biofeedback by Dr. WOLFF Sports & Prevention GmbH, was used for the ADL therapy. Duration of the mechanotherapy course was 10-14 days, the exercises were done every day, the amplitude is selected individually, and a number of repeats – from 30 with an addition of 5-10 seconds every day. Description and the method of performing the exercises is presented below.

1) Lateral core shifting to the left/right while standing (Lateral-Shifting) (fig. 2).

Fig. 2. Lateral (frontal) core shifting to the right and to the left while standing (Lateral-Shifting 936)

Lateral (frontal) core shifting to the left

An athlete stands on a special "tilted" ledge on the device's platform, slightly leaning, the left arm is lowered down, the right is bent at the elbow. While resting their left shoulder against the foam cushion of the device fixed at shoulder

height, and with their right hip against the cushioning device (a measuring sensor with a cushioning pad), the athlete makes a frontal core shift to the left, with their right hip pushing on the cushioning device on the right, fixing the pressure exerted by the athlete's leg.

Lateral (frontal) core shifting to the right An athlete stands on a special "tilted" ledge on the device's platform, slightly leaning, the right arm is lowered down, the left is bent at the elbow. While resting their right shoulder against the foam cushion of the training device fixed at shoulder height, and with their left hip against the cushioning device (a measuring sensor with a cushioning pad), the athlete makes a frontal core shift to the right, with their left hip pushing on the cushioning device on the left, fixing the pressure exerted by the athlete's leg.

2) Transversus abdominis training (Transversus-trainer – a training device for deep transversus abdominis while lying) (fig. 3).

An athlete lies down (takes a horizontal position) on the device's bench, lifts their legs and bends their knees at 90-degree angle, then with both hands holds the short horizontal handles protruding above the head, located shoulder-width apart in the device's supports, resting their hands on them, and with their back to the bench, the athlete arches their back (lower back) alternately, so that it rises up and lowers down. Movements are registered by the cushioning device protruding from a hole in the bench at the lower back level.

3) Body stabilization while standing (Standing stabilization – training of weakened deep muscles that hold the spine in vertical position) (fig. 4).

An athlete stands on the device's rack vertically and rests their back against the backrest, spreading the legs shoulder-width apart, while stretching the arms and hands forward. The athlete must fix the standing position and try not to move. The slightest movements (rack shifting) are recorded and transmitted to the monitor by a cushioning device located in the hole in the backrest. The monitor is located in front of the athlete's eyes, so that they can adjust their balance. For a more advanced level, it is possible to hold dumbbells at arm's length during training.

4) Training of the multifidus muscles of the back (multifidus-trainer – segmentary stabilization while sitting) (fig. 5).

Fig. 3. The transversus abdominis training (Transversus-trainer 916)

Fig. 4. Performing the body stabilization exercise while standing (Standing stabilization 926)

Fig. 5. Training of the multifidus muscles (Multifidus-trainer 906)

An athlete sits on the device's seat, resting their knees against a special support with the device's softening cushion, and their back placed against the backrest of the seat. The legs are bent at the knees at 90-degree angle, the back is straight. The athlete, holding on to the handles attached to the cables, alternately performs rows with both hands. A softening device built into the opening of the seat captures the shifts of the back movement and transmits it to the display located in front of the athlete.

5) Rotations while standing (standing rotation – training with the core rotations to the left and right while standing) (fig. 6).

An athlete stands straight on the platform, legs shoulder width apart. The front sides of both legs are fixed between two supports, one of which has the built-in motion-locking cushioning device. The grip module (combined handle), consisting of two vertical handles, two shoulder supports and an elongated monitor broadcasting the athlete's movements, is held.

Rotations to the left are carried out in the following position: the athlete stands straight on the platform, legs shoulder width apart. The front sides of both legs are fixed between two supports, the left hip rests against the cushioning device on the left, the grip module (combined handle) is held from the rack on the right, the athlete performs lifts, making alternate movements of the body to the left at an angle of 90°.

Rotations to the right are carried out in the following position: the athlete stands straight on the platform, legs shoulder width apart. The front sides of both legs are fixed between two supports, the right hip rests against the cushioning device on the right, the grip module (combined handle) is held from the rack on the left, then the athlete performs lifts, making alternate body movements to the right at an angle of 90°.

Fig. 6. Rotations while standing (Standing rotation 946)

Results of the ADL therapy's experimental testing of elite athletes with the Prevention-Park biofeedback device

The testing results have revealed that the developed mechanotherapy course on the ADL therapy system with biofeedback for developing strength of lagging muscle groups and optimizing muscle balance in female athletes contributed to an increased strength of muscle groups responsible for following movements: back extension, back flexion, seated rows, lateral core shifting (table 1).

After the mechanotherapy course, male athletes have an increased strength of muscles responsible to lateral core shifting (table 2).

Table 1

Indicators of strength (and its asymmetry) of different muscle groups in female athletes after the mechanotherapy course on L adapters for developing strength of weakened muscle groups and optimizing muscle balance, M±δ

№	Indicators	Before	After	p<
1	Back extension, kg	52.5±18.9	58.0±18.7	0.01
2	Back flexion, kg	34.0±14.7	39.1±16.0	0.02
3	Cfa flexion / extension	0.21±0.17	0.21±0.10	-
4	Upper back, horizontal press, kg	86.2±26.2	88.1±18.4	-
5	Upper back, seated row, kg	58.8±12.4	63.2±13.6	0.01
6	Core shifting to the left, kg	43.0±16.2	57.6±17.8	0.003
7	Pulling left shoulder backwards, kg	32.9±12.4	38.7±14.5	-
8	Pulling left leg backwards, kg	33.5±7.7	37.6±12.7	-
9	Left leg adduction, kg	36.1±11.4	36.6±12.6	-
10	Left hip extension, kg	44.0±11.9	48.4±15.0	-
11	Core shifting to the right, kg	41.3±16.1	54.3±17.9	0.006
12	Pulling right shoulder backwards, kg	32.7±11.4	37.9±10.4	-
13	Pulling right leg backwards, kg	38.9±13.1	39.3±15.4	-
14	Right leg adduction, kg	37.8±12.8	37.8±11.9	-
15	Right hip extension, kg	45.4±16.8	48.1±16.9	-
16	Cfa core shifting	0.02±0.12	0.03±0.10	-
17	Cfa pulling shoulder backwards	-0.001±0.08	-0.004±0.10	-
18	Cfa pulling leg backwards	-0.06±0.12	-0.008±0.14	-
19	Cfa leg pulling	-0.02±0.09	-0.02±0.06	-
20	Cfa hip extention	-0.003±0.11	0.02±0.13	-

Note: Cfa flexion / extension – strength coefficient of back flexion / extension; K core shifting – functional asymmetry coefficient in tilting to the left / right; Cfa pulling shoulder backwards – functional asymmetry coefficient in pulling right / left shoulder backwards; Cfa pulling leg backwards – functional asymmetry coefficient in pulling right / left leg backwards; Cfa leg adduction – functional asymmetry coefficient in right / left leg adduction; p< – according to the non-parametric Kruskal-Wallis test between all groups

Table 2

Indicators of strength (and its asymmetry) of different muscle groups in male athletes after the mechanotherapy course on L adapters for developing strength of weakened muscle groups and optimizing muscle balance, M±δ

№	Indicators	Before	After	p<
1	Back extension, kg	74.5±22.1	77.8±19.4	-
2	Back flexion, kg	47.0±8.2	54.5±13.3	-
3	Cfa flexion / extension	0.21±0.17	0.17±0.11	-
4	Upper back, horizontal press, kg	122.7±51.5	122.8±51.6	-
5	Upper back, seated row, kg	93.0±32.3	91.1±33.9	-
6	Core shifting to the left, kg	55.6±20.0	74.1±27.8	0.01
7	Pulling left shoulder backwards, kg	48.5±42.3	47.5±32.2	-
8	Pulling left leg backwards, kg	39.3±13.1	38.5±11.3	-
9	Left leg adduction, kg	51.1±18.5	48.0±17.5	-
10	Left hip extension, kg	51.2±36.4	44.8±18.1	-
11	Core shifting to the right, kg	55.7±21.2	74.4±35.8	0.04

Table 2 (continued)

12	Pulling right shoulder backwards, kg	55.6±43.5	51.0±31.1	-
13	Pulling right leg backwards, kg	43.5±14.8	42.4±13.5	-
14	Right leg adduction, kg	51.7±18.8	51.0±18.6	-
15	Right hip extension, kg	43.5±23.9	42.7±19.0	-
16	Cfa core shifting	0.01±0.10	0.02±0.09	-
17	Cfa pulling shoulder backwards	-0.08±0.11	-0.04±0.12	-
18	Cfa pulling leg backwards	-0.05±0.05	-0.04±0.06	-
19	Cfa leg pulling	-0.02±0.11	-0.03±0.07	-
20	Cfa hip extention	0.06±0.10	0.03±0.08	-

Note: Cfa flexion / extension – strength coefficient of back flexion / extension; K core shifting – functional asymmetry coefficient in tilting to the left / right; Cfa pulling shoulder backwards – functional asymmetry coefficient in pulling right / left shoulder backwards; Cfa pulling leg backwards – functional asymmetry coefficient in pulling right / left leg backwards; Cfa leg adduction – functional asymmetry coefficient in right / left leg adduction; p< – according to the non-parametric Kruskal-Wallis test between all groups

According to the results, the main tasks of ADL mechanotherapy in athletes were:

- Increasing the functional capabilities of the musculoskeletal system, consisting in optimizing the muscle balance of various muscle groups, increasing the speed-strength abilities of muscles, developing lagging muscle groups;
- Prevention of overstrain and fatigue of the musculoskeletal system of athletes, including training in the middle altitude conditions;
- Formation of a balanced spine muscle corset.

Indications for ADL mechanotherapy in athletes are:

- the need to improve the functional capabilities of the athletes' musculoskeletal system;
- muscle imbalance, insufficient level of development of separate muscle groups.

Contraindications for ADL mechanotherapy in athletes are:

- acute injuries,
- painful conditions.

Conclusion. Therefore, the course of specially developed mechanotherapy sets on Prevention-Park, the intelligent ADL therapy system with biofeedback, for the developing strength of weakened muscle groups and optimizing of muscle balance in athletes significantly contributed to the development of core muscles, which was more pronounced in women.

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POSSIBILITIES OF USING HYPERBARIC OXYGEN THERAPY FOR RECOVERY OF THE FUNCTIONAL STATE OF ATHLETES AFTER COVID-19

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Annotation. The purpose of the work was to conduct a literature data analysis on possibilities of using hyperbaric oxygen therapy for athletes after COVID-19. The authors conducted a theoretical analysis of domestic and foreign sources. We have revealed, that this method is successfully applied during pandemic for rehabilitation of patients who had coronavirus. The method is also used in sports practice for recovery of an athlete' functional state during the preparative and contest season and for improvement of their performance. There are practically no studies on recovery of the functional state of athletes after COVID-19, who resumed training. Therefore, there is a need to develop a method of implementing hyperbaric oxygen therapy for this category of patients, which would allow increasing their functional and adaptive capabilities when resuming the training process, including training in middle altitude.
Keywords: hyperbaric oxygen therapy, athletes, COVID-19, rehabilitation, recovery, functional state, adaptation, hypoxia, middle altitude.

Introduction. Development and application of methods that allow effective recovery of the functional state and increase of performance of athletes after SARS-coV-2 (COVID-19) is a relevant issue of sports medicine. It is known that the coronavirus infection affects almost all organs and systems: the upper and lower respiratory tracts, the cardiovascular system, the digestive tract, the nervous system, as well as blood-forming organs. Systemic hypoxia serves as a result of COVID's negative effect. In some cases, post-COVID syndrome may occur, including more than 85 different symptoms. The most frequent are: asthenia, cognitive and psychoemotional disorders, slow recovery of the functional capabilities of the respiratory and cardiovascular systems, reduced tolerance to physical activity. It may occur regardless the COVID's severity: latent, low, moderate, high and critical [1-2]. There is a suggestion that athletes are not included in the high severity risk group, however there is no reliable data on the disease's consequences. There is practically no information on changes in tolerance to physical and sports activity [3].

In the field of sports medicine, Russian and foreign colleagues developed medical guidelines of systematic recovery to training after coronavirus with safe mode for athletes [4-5]. A number of scientists consider the disease's severity when developing the said guidelines (they have suggested a division into four clinical groups with inclusion of a list of diagnostic studies and an approximate time period of limiting physical activity for athletes) [6-7]. Thus, an issue of searching effective methods for restoring the functional state of athletes after COVID-19 is of great relevance. The fact that return of athletes to the training process might be carried out in middle altitude, where their body can face barometric hypoxia, should also be considered [8-9].

Hyperbaric oxygen therapy might become an effective method of recovering athletes after COVID-19.

Methods and organization. The authors have conducted and analysis of literature sources of domestic and foreign authors, included in eLibrary, PubMed, Web of Science, Scopus scientific databases. Following keywords in Russian and English were used in the search for publications: спортсмены, реабилитация, ГБО, sport after COVID-19, elite athletes, hyperbaric oxygenation.

Results and discussion. Hyperbaric oxygen therapy is a method of oxygen saturation under pressure higher than the atmospheric in a hypobaric chamber. The principle of the

method is as follows: when breathing under increased pressure, an increase of liquid medium (blood, lymph, tissue fluid etc.) that occupy approximately 70% of body mass occurs. It leads to an increased oxygen content in fluids and tissues of a body, and is a basis for a physiological effect. Under the influence of this method, following processes take place: formation of non-specific and specific adaptation reactions as a response to changes of external and internal environment, which leads to functional and metabolic reconstruction on various levels, as well as normalization of bioenergy-based processes in damaged tissues and organs due to the influence on mitochondrial oxidation. An increased oxygen content in plasma, as well as an increase in oxygen-carrying capacity of blood under the influence of high pressure creates preconditions for eliminating hypoxia. A pronounced detoxification effect occurs due to the effect caused on microsomal oxidation [10]. Favorable effects of the therapy justify a broad application in clinical practice and for therapeutic purposes to treat different pathological states [11]. In sports practice, hypobaric oxygen therapy is used as an additional way for treating muscle injuries [12-14].

During pandemic, this method is used in clinical practice for rehabilitation of patients after coronavirus. Some researchers have noted that after sessions in a hypobaric chamber systemic hypoxia reduces, blood circulation improves and severity of inflammation processes decreases [15-17]. A.N. Polikarpochkin and others were observing patients after COVID-19 who were diagnosed with "Virus pneumonia caused by COVID-19" and had lung damage percentage from 20 to 40%. The test subjects passed the therapy course. The researchers noted that "hyperbaric oxygen therapy can be applied for patients after COVID-19, since in hyperoxic conditions various body systems are shifted to lower and more economic level of functioning – breathing is less frequent, heart rate decreases, cardiac output reduce and erythrocyte content in blood reduces". They have also found that as a result of the course, positive changes of the body's functional capabilities occur. It is shown in increased blood oxygen saturation, improved functional state and level of physical performance. The therapy also solves the primary task to ensure timely delivery of oxygen to cells and tissues, primarily brain cells. Taking the conducted research into account, the authors recommend considering the hyperbaric oxygen therapy as an effective way to recover the functional state of athletes after virus pneumonia. The main sanogenetic factors in this case are excess oxygen, its replacing effect and its reflexive effect on the functions and systems of the body [18-19]. Respectively, application of the therapy is also advisable in sports practice for recovering the functional state of athletes after coronavirus.

There are also studies, the purpose of which is aimed towards examining the therapy's influence on restoring the functional state of athletes after training and competitive loads, as well as on increasing sports performance.

For example, A.G. Shchurov et al studied dynamics of restoring functional state after physical activity using hyperbaric oxygen therapy and came to a conclusion that when the body is saturated with oxygen under high pressure in a hypobaric chamber, not only the recovery processes accelerate, but also physiological reserves expand, which, according to the authors', makes this method effective for restoring functional state after exercise [20].

V.S. Chernyj in his work justifies an effectiveness of applying the therapy for correcting functional state and performance of athletes in the pre-season period. The researcher notes that the application is advisable in case when functional state of the body and performance of athletes are at initially low level due to reduced physical activity or training effects during vacation, also during a period of "a pronounced decline in performance". It may be also implemented in case when there is a need to conduct a planned smooth reduction of the functional state and performance indicators of athletes to their initial level without a risk of readaptation processes' failure. Therefore, the therapy should be used in strict accordance with tasks

of the training process and the specific training program [21].

A.N. Polikarpochkin thinks that the therapy increases quality of adaptation to physical activity during the training process and can be maximally effective during the pre-season training. The author recommends inclusion of the therapy in the set of medical and restorative measures in case of declined functional state, to increase the performance level during competition [22].

Foreign authors also note effectiveness of the therapy when restoring functional state of athletes between intense training sessions [23]. There are studies on successful application during Olympic games in Nagano. Y. Ishii et al reported a successful experience of applying the hyperbaric oxygen therapy for recovering functional state of athletes between performances [24].

Therefore, most of scientists demonstrate that the therapy has a positive effect on the recovery of functional state and increase of athletes' adaptive capabilities.

We have also found the studies that show inclusion of the therapy to increase physical capability and functional reserves of the body of athletes. Some researchers tried to use the procedures to increase effectiveness of performing high-intensity training loads, but it led to negative results [25-27].

It is necessary to notice that different hypobaric chambers were used, exposure modes, a number of sessions and set goals were different.

Nevertheless, the use of examined methods in restoring functional state of athletes and increasing their adaptive capabilities is justified and promising. However, further research is needed for effective methods of applying hyperbaric oxygen therapy for athletes after COVID-19, which would allow increasing their functional and adaptive capabilities when resuming to training, including training in middle altitude.

Conclusion. The conducted analysis allows us to conclude that the use of hyperbaric oxygen therapy in sports practice is substantiated. The method can also be applied for restoring functional state of athletes after COVID-19, who returned to training. Still, further research in this field, correction of applied exposure modes and choice of an appropriate session number are required.

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POSTURAL BALANCE TRAINING IN THE SUPPORT AND WALK CORRECTION IN CHILDREN WITH MOTOR DISORDERS

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Annotation. The article presents the results of applying postural balance training for children with motor disorders associated with cerebral palsy. The training consisted of the comprehensive use of physical rehabilitation measures: morning hygienic gymnastics, therapeutic massage, therapeutic exercises, sessions in the ADELI antigravity suit, stability training with biofeedback, sessions with the Corvit load simulator. The authors assessed the training results with the Global Motor Functions Assessment Scale (GMFM-88), the total score in which significantly ($p \leq 0.01$) increased from 84.5±5.23 to 93.7±3.16 points. The data obtained demonstrate the effectiveness of the use of the postural balance training in the correction of support and walk in children with motor disorders.

Keywords: postural balance, support and walk correction, children, physical rehabilitation, motor disorders, motor functions, cerebral palsy.

Introduction. Motor disorders associated with cerebral palsy (CP) are of diverse nature. The main signs are the dysfunction of coordination [1], postural balance while holding vertical position, static and dynamic balance while standing and walking. The motor disorders are often connected to mental, developmental disorders, as well as sensory analyzer defects [2], which makes it difficult to identify and correct them. The recovery efficiency of motor disorders in cerebral palsy largely depends on the severity of the clinical signs of the underlying and concomitant pathologies, objectively assessed by the quality and quantity of motor actions performed in various body positions [3-4]. The quality of maintaining vertical position in terms of static and dynamic balance while standing and walking is conditioned by postural balance preservation, the training of which is important for patients with motor disorders.

The purpose of the study – to evaluate the effect of the postural balance training on the support and walk correction of children with motor disorders.

Methods and organization. The support and walk functions were evaluated with the Global Motor Functions Assessment Scale (GMFM-88) [4]. The statistical processing of the results was made with the Statistica 13 software. The authors calculated arithmetic mean values and the standard deviation of the indicators obtained. The Wilcoxon's T-test was used for assessing the significance of differences ($p<0,05$).

The study was carried out in the Oblast Children's Clinical Hospital (Yaroslavl), it included 6–8-year-old children (n=11) with motor disorders associated with cerebral palsy. The postural balance training was conducted during the rehabilitation course with passive-active recovery measures: morning hygienic gymnastics, therapeutic massage, therapeutic exercises, sessions in the ADELI antigravity suit, stability training with biofeedback using the Stabilan device (Russia) and sessions with the Corvit load simulator (Russia).

Results and discussion. The morning gymnastics sessions took place daily for 15 minutes at the beginning of the course, 5 minutes of which were given to breathing exercises aimed at reducing hypertonia, the positions of test subjects – sitting and lying. Near the end of the course, these sessions were conducted 7-8 minutes daily, the reason for it was learning the skill and the increased physical activity during the day due to application of

other rehabilitation means. The exercises were performed at a slow pace at first with a gradual increase to a medium pace. Then these exercises were performed separately with 5–10-second pauses. Exercises with sports equipment (gymnastic poles, balls, expanders) were also added. The number of exercises – 7-8, the number of repeats – 4-5. In order to form a stable vertical position during the exercises, this position was gradually added as the existing muscle imbalance was corrected and the muscles were strengthened.

Therapeutic massage was also done daily for 30 minutes before the morning gymnastics sessions to correct the asymmetrical muscle tone. It was combined with the position treatment. At the end of the massage session, orthoses or splints were put on the legs to fix the physiological position of the lower limbs.

The therapeutic exercises were done daily, included calisthenics, breathing and special exercises. Special exercises contained the following: passive exercises aimed at increasing the amplitude of joints, the physiological position of which was shifted by spasmic muscles, with a consequent special positioning (position treatment); exercises on a balance board with a gradual increase in difficulty of applied initial positions (such as lying, sitting and standing) and verticalization with a specialized stand. Later the researchers added exercises for the development of the foot's support function: feet rolling from heel to toe, squats, stepping over objects, strength exercises for improving lower limb muscles. Pauses between the exercises were gradually shortened down to 5 seconds. The pace was gradually increased from slow to medium. The set included 12-15 exercises, each of them was repeated 6-8 times. In order to preserve the correction effects, application of individual orthoses was recommended.

Application of the ADELI suit was carried out according to the principles of customization when choosing the fixating position, present disorders in preserving vertical position of the body and in walking, with a gradual load increase. On the first and second day, the duration of the session was 20 minutes. During the following days, if the tolerance to loads was strong, the duration was increased daily by 5 minutes, with total duration of no more than 30 minutes in 10 sessions. Then it was gradually increased to 60 minutes. If tolerance to loads was strong, the exercises also included stair walking.

The stability training with biofeedback was started according to the state of vertical position correction and muscle strengthening, not earlier than a week after the beginning of the physical rehabilitation course. During the course, following tasks were being solved: learning to distribute weight symmetrically on both legs, eliminating asymmetry of vertical position learning to distribute weight symmetrically between heel and toe of the affected leg; increasing amplitude of the possible shift in the center of pressure; training the speed of posture correction by voluntarily moving the center of pressure as a response to a change in body position [5]. The training session was in the form of computer stabilographic games, during which the training and reinforcement of the skill of voluntary control of the pressure center takes place, as well as training of the balance function, neuromuscular coordination and postural balance.

It is recommended to carry out these sessions in stages in order to teach children with cerebral palsy the aforementioned skill.

At the first stage (3-5 sessions), the semantic and coordination basis of the skill is formed with a detailed explanation of the training's purpose and objectives for the studied group. In order to reinforce the skill, it is recommended to play the stabilographic games 2-3 times in a row with rest intervals of 1-2 minutes. During the session, the instructor watches over and controls tasks on the computer, explains the details to the child and corrects their movements.

At the second stage (6-10 sessions) further correction and reinforcement of the skill are carried out, ensuring its stability and variability. At the same time, it is necessary to avoid and correct excessive stiffness of the child's movements, the occurrence of associated movements (synkinesis), a reduced success of performing motor actions when changing the game, the

formation of pathological strategies in the voluntary movement of the pressure center. If the increased spasticity is present, the time of force applied on the affected leg should not exceed 1-5 seconds (i.e., the time of the force phase of a healthy person's step cycle). In order to prevent the tone build-up in the pauses between games, we applied exercises with relaxing swinging movements of the affected leg. In addition, in such cases, the selection of the game should be carried out taking into account the principle of small amplitudes and a gradual increase in the radius of the pressure displacement center in such patients.

Sessions with the Corvit simulator were carried out not less than 10 times in the vertical position. First two sessions were done in the sitting position, speed – 3 km/h, percentage of force applied by the foot – 30%, duration of the session – 14 minutes. Difficulty of the following sessions was gradually increased till the following combination: initial position – standing, speed – 3 km/h, percentage of force – 30%, duration – 7 minutes; in the following 7 minutes the speed was increased to 4 km/h, percentage of force – 40%.

The efficiency of the conducted postural balance training was assessed with the Global Motor Functions Assessment Scale (GMFM-88), in which, on a 4-point scale, movements were evaluated in five categories:

a) lying and rolling;
b) sitting;
c) crawling and kneeling;
d) standing;
e) moving – walking, running and skipping (table).

Table

Results of changes in the indicators of the Global Motor Functions Assessment Scale (GMFM 88) in children with motor disorders

Indicator	Before training	After training	p<
Number of points according to GMFM-88	84.5±5.23	93.7±3.16	0.01

The total score before the training amounted to 84.5±5.2 points, which shows present changes in the muscular and ligamentous system, disorders of coordination capabilities and shift in the center of pressure, mainly in vertical positions. The postural balance training contributed to a significant increase of the result to 93.7±3.16 points and an improvement of global motor functions in children with motor disorders associated with cerebral palsy.

Conclusion. The received results of improving motor functions in the examined children were achieved due to the postural balance training aimed at optimization of muscle tone, elimination of pathological motor stereotypes, improvement of the muscle corset, preservation of physiological vertical positions while maintaining static and dynamic balance.

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INFLUENCE OF PHYSICAL REHABILITATION, INCLUDING MEANS OF PHYSICAL THERAPY ON THE PSYCHOFUNCTIONAL STATE OF ENGINE CREW EMPLOYEES WITH HYPERTENSION

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Annotation. The article presents the dynamics of indicators of the psychofunctional status of engine crew employees with hypertension after a physical rehabilitation course. The results reflected a significant decrease in body mass by 12%, an improvement in the characteristics of attention (efficiency of working capacity – by 12%, attention warm-up – by 3.2%, attention span – by 19%), trait and state anxiety – by 5%, refinement of the chronological assessment of time – by 4%. The results obtained demonstrate the positive impact of means and methods of physical rehabilitation on the psychofunctional state of locomotive crew employees with hypertension.
Keywords: engine crew employees, physical rehabilitation, physical therapy, hypertension, psychofunctional state.

Introduction. Harmful and dangerous industrial factors affect crew employees throughout the work time, and mental strain increases the risk of occupational diseases [1], including hypertension.

Such conditions as long-term voyage, night shifts, which are often accompanied with physical inactivity and the state of monotonia, serve as provocative circumstances of developing fatigue, reduced immunity, disturbance in compensatory and adaptive responses, worsen the psychological and professionally significant qualities of the workers, lead to the development of occupational health dysfunctions [2-3].

Despite a great number of research on treating hypertension with drugs, the target levels of blood pressure are achieved only in 30-40% of cases, which predetermines the search for new means and methods of treatment [4].

For example, in recent decades, interest for non-drug treatment of arterial hypertension, along with the traditional drug therapy, is growing worldwide [5].

Normally, hypertension is a concomitant disease caused by work specificity and characterized by a long progressing course with a gradual reduction in working capacity. It was the reason for a search for means and methods of physical rehabilitation that positively influence physical and psychological state of the workers with hypertension.

The purpose of this work was to evaluate the influence of physical rehabilitation measures on the psychofunctional state of the engine crew employees with hypertension.

Methods and organization. The state of the cardiovascular system's function was examined according to the systemic pressure indicators (heart rate – HR, beats/min; diastolic blood pressure – dBP, mm of Hg; systolic blood pressure – sBP, mm of Hg; BPmean – mean blood pressure, mm of Hg), identified according to the Korotkov's method. Body mass was assessed by weighing on medical scales, attention characteristics – according to the Schulte Tables, trait and state anxiety – with the Spielberger-Khanin questionnaire, chronological assessment of time – using the "Individual Minute" test during psychological testing. The statistical data processing was made with the Statistica 13 software package: the authors calculated arithmetic mean values and the standard deviation of obtained indicators, the significance of parametric indicators was evaluated with the Student's T-test, non-

parametric indicators – with the Wilcoxon's T-test if $p \leq 0,05$.

The study took place in the Rehabilitation Center of Russian Railways (Omsk). The rehabilitation course took 21 days. The study included men (n=26) who work in Russian Railways as members of the engine crew. The age of participants – 40-55 years, diagnosis – I-II degree arterial hypertension, duration of the regular medical checkup – 5 to 10 years. All test subjects did not engage in sports have a similar work routine. Patients with III degree arterial hypertension, class III obesity, coronary heart disease were not included, since the aforementioned diseases are classified as professional impropriety for engine crew workers. The course structure and distribution of physical rehabilitation means for the studied group are presented in table 1.

Table 1

Structure of the physical rehabilitation course for the engine crew workers with hypertension

Physical rehabilitation measures	Distribution percentage of recovery measures (%)
Callisthenic exercises	20
Specialized exercises Stretching exercises Relaxation exercises	20
Dynamic breathing exercises	10
Static breathing exercises	10
Autogenic training	10
Speleotherapy	30

Physical rehabilitation sessions were carried out sparingly at the outpatient stage. Duration of the speleotherapy session was 30 minutes. The autogenic training was conducted after preliminary training in the afternoon for 30 minutes.

Choice of the physical therapy method was based on a number of health factors: nature of pathological changes caused by the disease, degree of insufficient blood circulation, pronunciation of present complications and decree of adaptation to physical activity. We have used the method of dispersion and alternation of physical loads, when an exercise of one muscle group was followed by an exercise for another muscle group, while exercises with high muscle activity were alternating with exercises requiring low activity, as well as breathing exercises of static and dynamic nature. We also implemented specialized exercises for relaxation of muscle groups, stretching and breathing exercises.

The physical therapy course was divided into two stages – initial and final. At the first stage, duration of session was 25 minutes, while near the end of the final stage it increased to 60 minutes. The pace at the initial stage was slow, at the end of the final stage – medium.

Table 2

Dynamics of body mass and systemic pressure indicators in the engine crew workers before and after the physical rehabilitation course, $M \pm \sigma$

Indicators	Before	After
Body mass, kg	96.6±0.9	85.4±1.13*
HR, beats/min	71.9±1.3	71.3±1.2
sBP, mm of Hg	123.2±1.4	121.8±1.1
dBP, mm of Hg	79.2±1.1	78.4±0.23
BPmean, mm of Hg	93.6±1.6	92.6±0.15

Note: HR – heart rate; sBP – systolic blood pressure; sBP – diastolic blood pressure; BPmean – mean blood pressure; * – statistically significant results, $p \leq 0.05$

Results and discussion. The efficiency of recovery measures was evaluated according to dynamics of the studied indicators (table 2).

Reduction of body mass in the workers after the rehabilitation course amounted to 12% ($p \leq 0.05$), which significantly decreased the risk of progressing hypertension and developing complications.

Values of systemic pressure and HR during the course have slightly changed (($p \geq 0.05$) and remained within the range of standard values. It can be explained by a systematic intake of hypotensive medications.

Dynamicity of professionally important qualities of the studied group evaluated during the psychological testing after the course revealed improved characteristics of attention. The efficiency of working capacity improved from ($p \leq 0.05$) 32.6±0.2 to 28.7±0.02 s, the attention warm-up reduced ($p \leq 0.05$) from 1.1±0.02 c.u., the attention span improved ($p \geq 0.05$) from 1.1±0.01 to 0.9±0.01 c.u. The anxiety level also reduced: trait anxiety ($p \leq 0.05$) – from 38.0±0.2 to 36.6±1.07 points; state anxiety ($p \leq 0.05$) – from 37.5±0.7 to 35.8±0.53 points. The chronological assessment of time was refined ($p \leq 0.05$) – from 62.1±0.41 to 59.4±0.01 s.

Conclusion. The obtained significant changes ($p \leq 0.05$) of the following indicators: reduced body mass, improved attention characteristics, refinement of the chronological assessment of time show a positive effect of the physical rehabilitation course on the psychofunctional state of the engine crew employees with hypertension.

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PHYSICAL REHABILITATION IN THE CORRECTION OF DIASTASIS IN WOMEN IN THE LATE POSTPARTUM PERIOD: A LITERATURE REVIEW

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Annotation. The article presents an overview of Russian and foreign studies in the field of physical rehabilitation in the correction of diastasis recti in women in the late postpartum period. Statistical data indicate a high risk of developing diastasis in women both during pregnancy and in different periods of the postpartum period. Along with other, the most significant active means of correcting diastasis are physical exercises, the effectiveness and differentiated use of which are presented in an analytical review. The data obtained made it possible to identify the main directions in the use of physical rehabilitation means in the late postpartum period for the correction of diastasis recti.

Keywords: diastasis recti, pelvic floor muscles, transverse abdominis muscle, physical rehabilitation, exercise, women, postpartum period, health, quality of life.

Introduction. Diastasis recti is a pathological state described by the broadened and thinned linea alba, in severe cases – a whole muscular and aponeurotic carcass of the anterior abdominal wall, up to semilunar line [1].

According to the statistical data, diastasis can be found in both men (27.9%) and women (72.1%) mainly in the age of 25-35 years. Moreover, women are more interested in keeping an optimal functional state and form of the anterior abdominal wall compared to men, which predetermined the direction of studying the diastasis development in this group of patients. In addition, diastasis is found in 24-70% of cases in women during different postpartum terms [2].

Due to the fact that there is not enough data on diagnosis of postpartum complications related to the core, such as diastasis and weakness of the pelvic floor muscles, examination of the issue is of great relevance [3].

The purpose of this study was a theoretical analysis of ways and methods of physical rehabilitation for correcting diastasis in women in the late postpartum period.

Methods and organization. The study used the content analysis of scientific works of Russian and foreign authors, presented in peer-reviewed scientific journals, Russian and foreign databases. The authors have examined 35 sources, 20 of them were chosen.

Results and discussion. The studies show that immediately after delivery, due to stress caused by it, up to 53% of women have a number of issues related to diastasis [4]. J. Sperstad et al. and P.G. Fernandes da Mota revealed a connection between the disease and terms of pregnancy: on the 21st week of pregnancy, the incidence rate amounted to 33.1%, 6 weeks after birth – 60.0%, 6 months after birth – 45.5%, 12 months after birth – 32.6% [5].

Main risks factors of diastasis are: multiparous, hydramnious and consecutive pregnancies [2], which, accompanied by hypomobility and sedentary lifestyle, may cause changes requiring usage of effective recovery means [6]. Age, height, average body mass before pregnancy, mass gain during pregnancy, operative delivery, baby's body mass, benign hypermobility syndrome, physical fitness level of the abdominal cavity and pelvic floor muscles, total physical fitness were not attributed to risk factors of diastasis development [7].

The degree of diastasis's progression is classified by the distance between two medial borders of the abdominal rectus muscles (the table presents the R.P. Askerkhanov's classification).

Table

Diastasis recti classification (according to R.P. Askerkhanov)

Diastasis degree	Distance between the muscles at rest, mm
I	22-50
II	51-80
III	>80

Pregnancy leads to the overstretched abdominal muscles, weakness of the pelvic floor muscles, which is a frequent cause of back, lower back and collar zone pain in the postpartum period [6]. Accompanied with pain and discomfort in the abdominal region, there are also disorders in the function of the musculoskeletal system, urogynecology, changes in body parameters, deteriorated quality of life [8].

Moreover, diastasis is not considered as a problem for many postpartum women. They think that the issue will solve itself due to an increase of daily activity related to a child's delivery, which leads to preservation of diastasis recti for many years [4].

If diastasis recti remains 9 months after delivery, then this state requires elective surgical treatment [9]. However, currently there is no universal, "ideal" surgery that would solve all issues of a woman body connected to diastasis in the postpartum period [10].

Application of physical loads is considered as a way of comprehensive treatment directed towards prevention of disorders in the postpartum period, including the period after the surgical treatment of diastasis. Physical rehabilitation programs have different variants and are aimed at reducing a defect of the linea alba.

Physical exercises are one of the main means of physical rehabilitation that solve the issues occurring in a woman's body after pregnancy. Accompanied with other measures, they can be used during pregnancy to prevent possible complications [11].

According to O.N. Likhacheva [12], women who engage in special gymnastics are less likely to have complications compared to women who lead a sedentary lifestyle [12].

This statement corresponds with the data from other studies, which show a risk of developing diastasis reduced by 35% in case if pregnant women performed a special kinesiologic set of exercises for the abdominal muscles [13]. The study of M.M. Yul'tsova on diastasis correction recommends following exercises: bottom lifts while lying; alternate leg lifts while lying, legs half-bent; leg lifts while lying followed by leg bends and pulls to the body; respiratory exercises, in which one needs to suck in the stomach on the inhale and relax it on the exhale [13]. According to the author's opinion, following exercises are not recommended: stretching and curling exercises with objects and equipment; yoga positions with overstretching the anterior abdominal wall; exercises that lead to increased abdominal pressure, provoke overstretching of the anterior abdominal wall; simultaneous leg pulls to stomach without control over the linea alba [13].

The application of exercises in the early postpartum period has great importance. In their research, E.Z. Abraamyan, K.M. Nazhmutdinova, L.A. Yatskova came to a conclusion that most women who did not start health gymnastics in 6 weeks after delivery are not able to recover the pre-birth level of physical activity for several years [14].

For correction of the weakened abdominal muscles over a 1-2-month course, N.A. Danilova suggests daily repeated performance of simple respiratory exercises and a single performance of a complex of six simple corrective exercises for the abdominal muscles in following initial positions: standing, lying on the back, lying on the side, for the rectus abdominis, obliques and transversus abdominis, as well as the pelvic floor muscles [15].

The same guidelines are given by N.E. Kavtorova and O.A. Sultanova. Performance of physical exercises for obliques and transversus abdominis contributes to quicker recovery of the ligamentous and support system of the problematic area muscles [16].

In order to recover the anterior abdominal wall muscles effectively, V.L. Musnikov suggests performing respiratory exercise separately and combined with exercises for the abdominal muscles, pelvic floor muscles, adductors and abductors [17].

Implementation of various means and forms of physical rehabilitation to correct diastasis recti should have not only special, but a general direction as well, making a systemic health effect on a woman's body during the postpartum period. For example, in the study of M.A. Topchieva et al, the use of fitball in gymnastics for comprehensive rehabilitation of postpartum women with diastasis revealed a significant improvement of not only the physical fitness, but also the functional state of the cardiovascular system [18].

According to Yu.B. Tkhamucheva, the most popular form of therapeutical physical culture is health gymnastics due to its systemic effect on the body and comprehensive health recovery in the postpartum period [19].

In O.V. Onofrijchuk's opinion, the effectiveness of hypopressive gymnastics in comprehensive recovery of the body after birth is based on using postural exercises that contribute to an improvement and recovery of adequate muscle tone attributed to the deep front line [3].

In the modern research review by Majken Lyhne Jessen et al, dedicated to research of the effectiveness of existing methods of physical rehabilitation in diastasis recti correction, there are still questions that need clearance and further research. However, the authors confirm that the conservative method that includes therapeutic gymnastics for correction and strengthening of the problematic muscles, active correction combined with teaching how to preserve correct posture and passive correction in form of bandage and supporting accessories is the priority way of treatment [8].

Duration of the physical exercise course in the postpartum period defines its effectiveness, which is demonstrated in the work of Sandra L. Gluppe, Gunvor Hilde, Merete K. Tennfjord, Marie E. Engh and Kari Bø [20]. According to the authors' findings, application of special exercises on the pelvic floor muscles and transversus abdominis leads to a decreased gap between the rectus abdominis immediately after labor. After a subsequent observation over women 6 and 12 months after birth, the researchers revealed that the highest correcting and lifting effect on the linea alba is noted in case of simultaneous pelvic floor muscles' contraction with the obliques' activation [20].

The diastasis recti correction does not only eliminates a defect of the anterior abdominal wall, contributes to more effective systemic recovery of health, but also significantly improves a woman's quality of life. The study of Ali A. Thabet and Mansour A. Alshehri demonstrates that stabilization of the deep core muscles with the "deep core stability" system of exercises leads to a decreased gap of the recti abdominis and closely correlates with an improved quality of life in the postpartum period [4].

Conclusion. Diastasis recti, observed in women during pregnancy and the postpartum period, is not only a cosmetic, anatomical and functional defect of the problematic area muscles, but also a factor that prevents a full and systemic recovery of health after labor, decreasing a quality of life as well. Different active means and forms of physical rehabilitation, mainly physical exercises of general and special direction applied long-term in the postpartum period, serve as a basis for systemic correcting recovery of women with diastasis recti.

By conducting the literature analysis, we have managed to form a theoretical foundation on role and significance of applying different physical exercises for prevention and correction of diastasis recti. In future, it will

serve as a basis for development of methodological guidelines and conduction of comprehensive recovery events of corrective direction to restore health of women with diastasis after labor and improving their quality of life in the postpartum period.

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MODERN CHOREOGRAPHIC ART AS A WAY OF TREATMENT AND PREVENTION OF OBESITY IN ADOLESCENTS

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Annotation. The article presents the results of the effectiveness of using dance movements of modern choreographic art in reducing body mass and increasing the adaptive reserves of the body in girls with I class obesity.
Keywords: constitutional and exogenous obesity, overweight, adaptive potential, choreographic art, motor activity.

Introduction. Overweight and obesity are the most common endocrine disturbances among children and adolescents. The most prevalent type of obesity related with an excessive calorie intake in conditions of a sedentary lifestyle and genetic predisposition is constitutional and exogenous (idiopathic) obesity [1]. Decreased motor activity leads to disturbed balance between accumulative and expended energy, which entails a violation of adaptive mechanisms [2]. Metabolic disorders in overweight adolescents form at an early stage and always associate with insulin resistance [3-4]. Cardiovascular diseases and type II diabetes may become consequences of developing adolescent obesity [2]. Among other factors there are unbalanced nutrition, lack of physical activity and emotional stress [1, 5]. A comprehensive treatment of adolescent obesity, including diet therapy, correction of eating behavior and inclusion of physical activity will significantly and long-term reduce body mass without medicated support [4]. Adolescent often face a need to increase motor activity, choosing types of choreographic arts. Therefore, there is a necessity to substantiate new approaches for choosing special dancing programs for girls with overweight and I class obesity.

The purpose of the study was to evaluate the effectiveness of using dance types of choreographic art in reducing body mass and increasing the adaptive reserves of the body in adolescent girls with class I obesity.

Methods and organization. In order to achieve the set goal we used following methods studying functional state that evaluate the effectiveness of using dance in prevention of adolescent obesity. We identified following anthropometric indicators: waist circumference (WC, cm), hip circumference (HC, cm), calculated ratio of WC/HC and the body mass index (BMI), height (cm), weight (kg), measured skinfold thickness above the triceps (triceps S, mm), the adipose tissue percent (was calculated with the Slaughter formula), heart rate (HR, beats/min), systolic (sBP, mm of Hg) and diastolic (dBP, mm of Hg) blood pressure, vital capacity (VC, l), wrist dynamometry (kg), adaptive potential of the cardiovascular system (AP, points), calculated analytically according to the R.M. Baevskij's method [5]. We have conducted a statistical analysis with SPSS 21.0 for Windows. We calculated mean values of the indicators and the standard deviation value (σ). Significance of obtained results were processed with the Wilcoxon T-test if $p \leq 0.05$. As a diagnostic criterion of overweight and obesity, we chose the value of BMI standard deviation (BMI SDS). The overweight criteria in adolescents were identified according to the data from percentile tables or BMI's SDS (standard deviation score) [1, 6].

The study included students of the "Okhta" Youth Center in St. Petersburg, young girls (n=11) aged 16±0.5 years with I class obesity and a doctor's permission to visit dancing classes with moderate activity. According to the preliminary testing, all girls had similar levels of physical fitness.

A health program included such types of stage dance arts as classic choreography, as well as modern dance. The classes took 3 times a week, a duration of one class was 1.5 hours. The study's duration amounted to 5 months. The girls received recommendations for rational diet to control body mass. During the study, they were also advised to keep a daily calorie count (1600-1800 kcal/day).

The study was divided into 3 stages: initial, main and final.

The initial stage (15 days) included a study of the functional state of cardiovascular and respiratory system, we identified anthropometric indicators, the adaptive potential level and developed a program for applying dance types of motor activity.

The second stage (4 months): girls were engaged in classes, the following types of dance included in the program:

- Classical dance – a type of choreographic arts that includes moderate activity of aerobic direction. Ballet movements contribute to emotion expression, development of coordination abilities, sense of rhythm and plasticity. The classical dance exercises form a dancer's body, eliminate posture defects and flat-foot [7]. A classical dance class included exercises with a ballet bar (a set of exercises aimed at developing flexibility, leg turnout, strengthening of the musculoskeletal system), as well as exercises in the middle of the ballet class. The girls learned how to distribute body mass correctly when performing complex coordination movements, which contributed to stabilization development, and mastered different ballet movements such as turns and jumps.

- Modern dance is one of the directions of modern choreography. Modern dance moves are aimed towards the development of rhythm, plasticity and expressiveness [8]. The main focus was pointed at the body architecture: body movement in space, movement articulation. Dance composition included different spirals and bends combined with leg movements both in static poses and in action. The girls learned techniques of drops and sit-ups: moving weight between different body parts for a smooth transition from one position to another. The use of the "release" technique contributed to understanding their body: muscle and respiratory activity, use of different words of a dancer's choreographic vocabulary [8].

At this stage, following tasks were solved:

1. Normalization of metabolic processes;
2. Decrease of body mass;
3. Strengthening of small and medium muscle groups;
4. Increasing endurance;
5. Increase of functional capabilities of the cardiovascular and respiratory systems.

At the third, final stage (10-15 days) the girls continued visiting dance classes according to the developed program. The final research took place, we measured anthropometric indicators, main indicators of the functional state of the respiratory and cardiovascular systems.

Results and discussion. Table 1 presents dynamics of anthropometric and BMI indicators of the studied group.

The effectiveness of used dance types of motor activity is proven by positive changes in anthropometric indicators – a decrease of BMI and decrease of body circumference indicators ($p \leq 0.05$). BMI has significantly decreased by 5.82%, WC has also significantly decreased by 4.39%. We have registered a significant decrease of HC by 3.57%. The skinfold thickness has changed by 3.1 mm ($p \leq 0.05$), the adipose tissue percent has decreased by 14.92%, which indicates the loss of the fat component of body mass. According to the right and left wrist dynamometry, the indicators have improved by 3.6 and 5.5 kg respectively ($p \geq 0.05$). The results may prove a high level of strength capabilities of higher limbs of adolescents engaged in choreography [8].

The functional indicators of the respiratory and cardiovascular systems after the study have a positive trend for improvement.

The effectiveness of applying dance movements was assessed according to the dynamics of studied indicators (table 2).

Table 1

Dynamics of anthropometric indicators of the studied adolescents, Xmean±σ

Indicators	Before the study	At the end of the study	p
BMI (kg/m^2)	29.2±1.7	27.5±1.2	≤0.05
WC (cm)	95.3±3	89.2±2.6	≤0.05
HC (cm)	97.8±1.4	94.3±2.0	≤0.05
Triceps S (mm)	16.2±1.3	13.1±1.6	≤0.05
Adipose tissue percent	26.8±2.7	22.8±2.6	≤0.05
Wrist dynamometry (kg): - right wrist - left wrist	 20.7±0.7 18.1±0.3	 24.3±0.4 23.6±0.9	≥0.05

Note: BMI – body mass index; WC – waist circumference; HC – hip circumference; triceps S – measured skinfold thickness above the triceps

Table 2

Dynamics of the functional indicators in studied adolescents, Xmean±σ

Indicators	Before the study	At the end of the study	p
VC (l)	2.9±0.2	3.1±0.2	≥0.05
sBP (mm of Hg)	117.2±5.0	120.5±3.1	≥0.05
dBP (mm of Hg)	68.0±4.4	70.5±3.3	≥0.05
HR (beats/min)	77.9±3.7	74.8±2.3	≤0.05
AP (c.u.)	2.2±0.9	2.1±0.7	≤0.05

Note: VC – vital capacity, sBP – systolic blood pressure; dBP – diastolic blood pressure; HR – heart rate; AP – adaptive potential

When analyzing the functional indicators of the cardiovascular systems, we have revealed that the VC improved by 0.2 l ($p \geq 0.05$). We have also noted normalization of sBP (by 3.3 mm of Hg) and dBP (by 2.5 mm of Hg). The hemodynamic indicators' evaluation has also demonstrated a significant improvement of HR by 3.1 beats/min ($p \leq 0.05$), which indicates the myocardium's adaptation to dosed activity. According to the adaptive potential, all girls have satisfactory adaptation that reflects the effectiveness of using dance classes for losing weight.

Conclusion. The use of active dance training with measures for adjusting eating behavior contributes to the formation of muscle definition and weight loss, significant increase of adaptive capabilities, normalization of the blood pressure level, improvement of blood vessels' condition, normalization of basic hemodynamic parameters, influence on physical and mental health. Classes of different dances, such as modern and classical choreography, are the key to maintaining motor activity, they contribute to the comprehensive, balanced development [6] of the younger generation and attract an increasing number of adolescents to this activity.

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REGULARITIES OF DEVELOPING MOTOR ABILITIES IN YOUNG ATHLETES DURING SPORTS TRAINING IN AIKIDO

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Annotation. The purpose of this theoretical study is to present the characteristics of the patterns of developing motor abilities (MA) during sports training in aikido. The concept of "motor abilities" was clarified, understood as a set of morphofunctional and psychophysical capabilities of young athletes in relation to the optimal manifestation of motor qualities and related abilities, techniques for performing motor actions (primarily basic ones) in solving specific tasks of motor activity in aikido. The authors characterized the regularities of MA development. The main ones are the effective involvement in the practice of sports; dependence of MA development on the mode of motor activity; stage-by-stage approach and heterochrony of MA development and manifestation; uneven MA manifestation; reversibility of MA development and transfer; interdependence of motor qualities and motor actions.
Keywords: sports training, young athletes, aikido, regularities, characteristics, applied foundations of education.

Introduction. Sports, both mass sports and high performance sports, gain more and more popularity in Russia. Aikido, the rather young and progressively developing martial art, is no exception.

In our opinion, the most significant stage in the system of long-term sports training is the initial stage, during which the fundamental prerequisites for the formation and development of athletic skill occur at subsequent stages [1-4].

The content study of the Federal State Educational Standards in sports allowed us to conclude that the priority provisions of their implementation in the practice of sports training of young athletes at the initial training stage are:
- formation and development of a set of personal qualities that define the "involvedness" in systematic sports activities;

- development of a system of motor abilities (MA), which determine the creation of the motor base for improving athletic skill [3, 5, 6, 7].

It shall be understood that the process of improving MA (in aikido as well) has two directions: development of motor qualities (MQ) and related abilities; directed training in the technique of performing motor actions (primarily basic ones).

The study's relevance is identified according to the examined field of research – search and substantiation (description) of ways to optimize management of MA development in young aikidokas.

The purpose of the study was to present a description of regularities in the development of motor abilities during sports training in aikido. The consideration of these abilities is the main prerequisite for optimizing cognitive and training (theoretical and practical) activity of young athletes.

Methods and organization. The main methods are: study of references and best practices of sports training in aikido; analysis and synthesis; generalization and formalization; analogy and synthesis.

Results and discussion. The authors assume that the main regularities that set the order of processes for developing motor abilities of young aikidokas are as follows [3, p.124128; 4, p.109-114; 8; 9, p. 52]:

1. Involvedness in physical activity: it is the main factor (reason) for improving MA. Application of physical exercises contributes to the achievement of a certain progress in motor training of athletes. It shall be noted that such regularity is a reflection of an activity-based

approach to the arrangement and implementation of almost all educational processes [10-13], including such processes in the sports training practice.

2. Interdependence of MA development and the mode of motor activity. It means not only involvedness in motor activity, but also compliance with a certain order in the purposeful application of physical exercises to ensure positive shifts in MA indicators (training sessions with a shorter rest interval; training sessions with an optimal rest interval; training sessions during the "activity" period of the supercompensation phase) [5, 14].

3. Stage-by-stage approach to the development and manifestation of MA, where the alternating periods (stages) of growth, stabilization and reduction of MA characteristics occur (the reason for that are the same periods of formation and manifestation of adaptive mechanisms) [5, p. 16-17].

4. Uneven MA manifestation, i.e. alternation of periods of growth in MA indicators with periods of reduction. It is typical for both short and long time intervals of MA development. However, if we want to achieve greater shifts in these indicators, we need longer time intervals.

5. Heterochrony in MA manifestation is due to time discrepancies in phases of development of different organs and functions, which contribute to MA development. This is a sign of sensitive periods – time of possibilities to form properties, qualities and functions of an individual; periods of the highest possible "sensitivity" of the biosocial nature of personality to systemic pedagogical influence [4, 6, 15, 16, 17].

6. Reversibility of MA development, which means that MA will "decline" (not all of them and in unequal ratio) without the appropriate pedagogical influence. This regularity must be considered as an ability (function) of an object to return into the initial state after completing the development cycle [18]. The ability is a property of an object to reverse without losing its main properties completely.

It is important to note that there is no limit in developing motor actions, since the technique's details and defining links are constantly edited according to the requirements of competitive practice, changes in psychophysical, motor and individual states and preferences of an athlete.

7. "Transfer" of motor abilities, i.e. an ability to apply an effect achieved in one activity (development of motor qualities, training of motor actions) to improve results of other activity [19]. Therefore, there are different types of the "transfer": positive, where a growth of some MA is supported with a growth of other MA; negative, where some MA hinder manifestation of other. Consideration of the "transfer" order requires optimization of the sequence and the continuity of MA development and improvement processes.

8. Interdependence (interconnection) of the development of motor qualities on the training of motor actions, since motor qualities cannot manifest without motor activity and vice versa. Therefore, the training of motor actions (formation of motor abilities and skills) should be conducted with the development of the corresponding motor qualities. The purposefulness in comprehensive training and development is due to a number of specific principles that determine the interaction between the subjects, physical activity and the training process organization [4, 6, 9, 15, 20, 21, 22].

Conclusion. Motor abilities are a set of morphofunctional and psychophysical capabilities of a young athlete that determine quality and quantity of the specific motor activity in aikido, as well as its efficiency in training and competitive practice. Development of motor abilities is a dual-purpose process of the directed improvement of motor qualities and actions typical for aikido, which identify further improvement of athletic skill. The MA development of a young athlete occurs in accordance with the growth and development of their body.

The correct organization for this development contributes to improved thinking, memory, sense of independence and leadership, imagination; actively supports the formation of moral qualities, perseverance, courage and determination.

Accumulation of important motor actions and diversity of motor qualities contributes (at all stages of long-term sports training) to improved body control, movement harmony, movement beauty and expressiveness, satisfies and develops the aesthetic needs of children, which is typical for the practice of socialization, sports and competitive activities in aikido.

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