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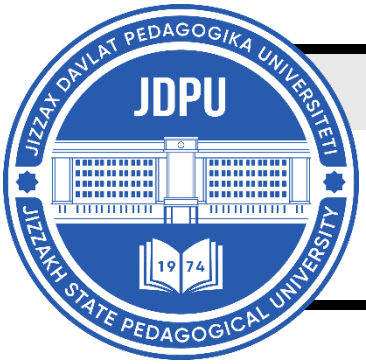


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# COORDINATION ABILITIES AND PHYSIOLOGICAL CHARACTERISTICS OF THE FUNCTIONAL STATE OF ATHLETES INVOLVED IN SYNCHRONIZED SWIMMING

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## ABOUT ARTICLE

**Key words:** functional state, physiological characteristics, coordination abilities, motor skills, synchronized swimming, environmental conditions, adaptation, central nervous system (CNS), latent time of motor reaction (LMRT), sequential reaction meter (SRE), blood pressure (BP), reaction to a moving object (RDO).

**Abstract:** The article presents the recommended characteristics of a comprehensive assessment of the coordination abilities and physiological state of young synchronized swimmers, allowing to qualitatively assess the level of development of body systems in the process of adaptation, modernly adjust the training process and rehabilitation measures.

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## INTRODUCTION

Successful acquisition of motor skills largely depends on the level of development and physiological improvement of the body's functional systems, its adequate reactivity to physical activity, its high resistance to changes in external and internal environmental conditions, the balance of nervous processes, and free control of the body in various positions.

Comprehensive studies of the age-related characteristics of the body in conditions of long-term adaptation to specific muscular activity are relevant for elucidating ways to expand the functional capabilities of a growing organism and the possible range of its trainability in the environmental conditions of Uzbekistan.

Physiological adaptation is the process of achieving a stable level of activity of functional systems, organs and tissues, as well as control mechanisms, which provides the possibility of long-term active life of the human body, animals and labor activity of people in altered natural and social

conditions of existence and the ability to reproduce healthy offspring. A large number of works are devoted to the study of the theoretical and applied aspects of this problem (A.A. Viru, 1980; V.P. Kaznacheev, 1984; F.Z. Meerson, 1978; A.D. Slonim, 1980, etc.).

In the last decade, there has been a sharp decline in the age of people involved in sports, especially in complex coordination types, where in-depth specialized classes begin at 8-10 years old, and at 13-15 years old they achieve significant success at the stage of sports mastery.

The information obtained about the physical status of young athletes involved in synchronized swimming at various levels of training is of great importance for practical recommendations aimed at ensuring the optimal development of adaptive changes that determine the performance of the required sports activities, protecting the body from unfavorable elements of the adaptation itself associated with adaptation, adaptive tension.

**METHODS AND MATERIALS**

Methodology, contingent and organization of research on the coordination abilities of athletes involved in synchronized swimming. To solve these problems, a complex of physiological research methods was used to obtain information about the functional state of the motor and autonomic systems of the body, including: neurochronometry, determination of the differential reaction, statovetibular chronometry, dynamometry, pulsometry, determination of blood pressure, duration of breath holding during inhalation and exhalation, respiratory frequency, vital capacity of the lungs, pneumotachometry.

Neurochronometric studies were carried out using an IPR-01 sequential reaction meter using a generally accepted method. The latent time of motor reaction (LMRT) to a visual stimulus was determined. The intervals between stimulators were 1-3 seconds. Individual indicators of the average from a series of 10 samples ( ) and its variance ( ), from a series of 30 samples ( ) and its variance ( ) were calculated. The first ( , ) were interpreted as indicators of the reactivity of the central nervous system (CNS), the second ( , ) as characteristics of the endurance of nerve centers to prolonged stimulation and stability of response, i.e. strength and balance of the nerve centers.

The temporary differentiated reaction was determined on the IPR-10 device along the channel (LVDR) when performing 10 tests in succession. In this case, the subjects were given the task to fix the number “10” by pressing the lock button on the device display while “running” through it a sequential series of numbers after the experimenter gave signals. The interval between signals is 1-2 seconds. The results were assessed using the RDO test reaction method: when pressing the lock button early to the number “10”, the reaction was characterized as “premature”, when fixing on the number “10” - as “accurate”, late pressing after more than “10” - as “lagging”. The time of an erroneous “premature or delayed” response in ml/sec was also determined.

To study the manifestation of the coordination activity of the nerve centers that regulate postural and vestibular reflexes, statometric and vestibulometric research methods were used. The static-chronometric method consisted of determining the duration of maintaining body balance with reduced support, displacement by the center of gravity and without visual control in 4 tests (according to A.I. Yarotsky):

- standing high on the toes, hands down;

- standing high on the fingers, arms up;

- horizontal position of the body on one leg, the other straight behind, arms to the sides, hands clenched into a fist;

- standing high on the toes of one leg, the other bent at the front at the hip and knee 90 degrees, arms at the top.

- Vestibulochronometry consisted of determining the duration of maintaining balance in a test with rapid rotation of the head without visual control (according to A.I. Yarotsky);

- Dynamometry was carried out using a wrist dynamometer according to the generally accepted method;

- The reaction of the cardiorespiratory system was studied using publicly available express methods;

- Blood pressure was determined in the supine position according to Korotkov. Pulsemetry was recorded by palpation;

- Vital capacity of the lungs (VC) was measured with an air spirometer three times;

- Pneumotachometer was determined using a B.E. pneumotachometer. I started ten times while inhaling and exhaling;

- Stange and Gench tests were also carried out.

All data were processed by publicly available methods of variation statistics with the calculation of the average statistical indicator (X), its dispersion (), coefficient of variation (C), and reliability of indicators (P).

**RESULTS AND DISCUSSIONS**

The studies were carried out in the background activity phase during the cool and hot seasons of the year. Athletes involved in synchronized swimming were examined - a total of 70 people, aged from 10 to 15 years, with sports experience from 3 to 6 years. The measurement results were analyzed by groups, divided according to the age, experience and qualifications of the subjects (Scheme 1).

*Scheme 1*

***Characteristics of the contingent***

| Age | Sports experience | Sports category | Groups |
|---|---|---|---|
| 10-12 years old | More than 3 years | I youthful | Small |
| 13-15 years old | More than 6 years | I, II category | Older |

**Characteristics of some physiological reactions of female athletes of different fitness levels in the "background activity" phase**

A comparative analysis of neurochronometric studies in synchronized swimming athletes of different levels of training: members of the national synchronized swimming team of Uzbekistan and students of sports societies revealed some peculiarities of nervous activity. Significant differences were found in the indicators of LVDR (latent time of motor reaction) (Table 1) in more trained athletes, its average value is 24.3% shorter, the fluctuation of indicators in a 10-fold test is small, as evidenced by the values of and C in more trained synchronized swimmers.

The manifestation of differentiated reactions in female athletes also has its own characteristics. The number of accurate reactions in the more trained group was 28.8% higher, and the number of premature reactions was 26% higher than in the less trained group. The same number of delayed reactions was observed in both groups.

The same direction of reaction was revealed: the predominance of delayed type reactions over premature ones. The lead error time is shorter than the lag error time.

Thus, a higher level of training is also characterized by a higher level of nervous activity, which is expressed in better reactivity of the central nervous system, greater stability of the reaction and resistance to prolonged exposure to stimuli.

*Table 1*

**Characteristics of nervous activity in athletes engaged in synchronized swimming of various levels of preparedness in the background activity phase**

| **Neurochronometry indicators** | **Average training. n=10** | **Small trainers. n=10** | **P** |
|---|---|---|---|
| ЛВДР $\overline{X}$ (мс) | 181,3 | 239,5 | 0,05 |
| n=100 $\vartheta$ | 33,72 | 49,61 | |
| $C_V$ | 18,6 | 20,7 | |
| *Дифференцировочные реакции n=100* | | | |
| - number of accurate reactions (в %) | 38,6 | 30,0 | 3,43 |
| - number of premature reactions (в %) | 24,3 | 32,9 | 2,86 |
| - advance error " $\overline{X}$ (мс) | 6,1 | 14,6 | 1,03 |
| - number of delayed reactions (%) | 37,1 | 37,1 | 3,71 |
| - lag error $\overline{X}$ (мс) | 20,3 | 18,1 | 1,92 |

The characteristics of the cardiorespiratory system in female athletes of different levels of fitness are shown in Table 2, from which it can be seen that among synchronized swimmers there are differences in indicators due to age characteristics, training, and the specifics of the activity.

Indicators of the cardiovascular system are characterized by the presence of age-related characteristics, so systolic blood pressure in the younger group is within 106.4 mm Hg, in the older group – 112.8 mm Hg, the minimum blood pressure in the younger group is within 71, 1 mm Hg, in

the older one – slightly higher (75.7 mm Hg). With age and training, pulse pressure increases, and a reduction in heart rate is observed, on average by 12.5% in representatives of the older, more trained group.

Neuro-endocrine restructuring of the puberty period completes the transformation of the morphological and functional characteristics of the body of children with some approximation to the norms of adults. The noted shifts in heart rate in the older group are the result of increased tone of the vagus nerve with age, as well as a manifestation of training.

In persons who do not engage in sports in the corresponding younger age group, the pulse indicators are characterized within 90 beats/min, while among synchronized swimmers it is 11% less than in this age group; a similar pulse pattern was noted in the older group (14.6%) according to compared with a given age of those not involved in sports (N.V. Zimkin, 1975).

Thus, in two age groups with different experience of sports readiness and level of training, not only age-related, but also natural adaptive shifts in cardiodynamics can be traced.

*Table 2*

**Characteristics of some indicators of the cardiorespiratory system in female athletes in the background activity phase**

| **Groups** | **Experience** | **Options** | **Blood pressure (mmHg)** | | | **Pulse rate** | **Vital ml.** | **Holding your breath** | | **Pneumo-tachometry (l/min)** | | **Breathing rate** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | *Systolic* | *Diastolic* | *Pulse* | | | *On inspiration* | *On the exhale* | *inhale* | *exhalation* | |
| Junior (10-12 years old) | 3 years more | $\overline{X}$<br>$\vartheta$<br>$C_V$ % | 106,4<br>6,82<br>6.70 | 71,1<br>5,39<br>7,58 | 35,4<br>4,58<br>12,93 | 80<br>8,26<br>10,32 | 16330<br>238,8<br>14,5 | 37,1<br>12,78<br>34,31 | 23,3<br>1,16<br>4,97 | 1,76<br>0,38<br>20,32 | 2,11<br>0,37<br>17,28 | 20<br>0,26<br>1,3 |
| | | min-max. | 90-120 | 60-80 | 30-40 | 72-90 | 1233-2133 | 23-60 | 17-34 | 1,13-2,06 | 1,76-2,99 | 18-22 |
| Senior (13-15 years old) | 6 years or more | $\overline{X}$<br>$\vartheta$<br>$C_V$ % | 122,8<br>9,94<br>8,81 | 75,7<br>5,84<br>7,71 | 37,1<br>3,78<br>10,18 | 70,3<br>5,5<br>7,82 | 2690,6<br>402,3<br>14,92 | 55,0<br>19,7<br>35,81 | 28,5<br>10,14<br>36,49 | 3,30<br>0,56<br>17,44 | 3,70<br>0,35<br>9,23 | 13<br>0,19<br>1,1 |
| | | min-max. | 110-120 | 70-85 | 35-40 | 60-80 | 2267 - 3467 | 29-75 | 16-46 | 2,09 -4,45 | 2,73-4,51 | 16-20 |

An analysis of the respiratory system indicators of synchronized swimmers showed that the vital capacity of the lungs in the younger group was 1633 ml, in the older group it was 2695 ml, which is 65% more.

It is known from the literature that the difference between similar age groups should be 34% (A.B. Gandelsman, K.M. Smirnov, 1966). VC depends on general physical development, height, weight, and other indicators. The vital index is the ratio of vital capacity to body weight; in the examined age groups it is 53.3 cm/kg in the youngest, and 5.5 cm/kg in the older. The noted significant difference in VC between these groups is considered as a manifestation of training. The breathing rate decreases with age. There are age-related differences in the hypoxemic resistance of the body according to the Stange and Gentsch tests (on inhalation and exhalation), which manifest themselves, as a matter of fact, in an unequal ability to voluntarily suppress and inhibit respiratory movements. Among the representatives of the older group, the indicators in the Stange test were 48.7%, and in the Gench test - 22.8% higher than those of the athletes of the younger group.

With increasing age, bronchial obstruction rates also increase. Thus, the inspiratory power of the younger group is 1.76 l/s, while in the older group it is 3.3 l/s. The exhalation power in both groups was higher than the inhalation power, so in the younger group by 20%, in the older group by 14.5%.

It is known that in adolescents the power of inhalation prevails over the power of exhalation. Such cases occurred in individual characteristics, which amounted to 145 in relation to the entire group in the younger group, and 28.6% in the older group.

Manifestation of maximum muscle effort. The results of strength indicators of hand dynamometry are shown in Table 3, from which one can see the presence of age-related characteristics and manifestations of strength. The older group prevails in voluntary maximum strength by an average of 9.5 kg in the right hand and 11.6 kg in the left hand. With age and training, a decrease in the difference in strength between the right and left hand is observed. It is interesting to note that in the older group the specific adaptive direction of changes in hand strength is clearly expressed. This is expressed in 575 cases of symmetry of the strength indicators of both hands, as well as in 30% of cases the predominance of the strength of the left hand over the right. The synchronized swimmers of the younger group show clear signs of asymmetry, with a predominance of right hand strength by an average of 2.2 kg.

Thus, age-related and adaptive shifts in the fitness of the motor system, manifested in the strength qualities of the hands, can be traced. In the process of many years of rational training, there is a completely natural increase.

*Table 3*

| Groups | Fitness | Parameters | Hand strength in kg. | | Difference |
|---|---|---|---|---|---|
| | | | *Right* | *Left* | |
| **Younger 10-12 years old** | 3 years more | $\overline{X}$ | 15,6 | 13,2 | 2,4 |
| | | $\vartheta$ | 3,17 | 2,6 | |
| | | $C_V$ % | 20,32 | 19,70 | |
| | | min-max. | 10-20 | 10-16 | |
| **Senior 13-15 years old** | 6 years or more | $\overline{X}$ | 25,1 | 24,8 | 0,3 |
| | | $\vartheta$ | 3,46 | 4,06 | |
| | | $C_V$ % | 13,8 | 16,37 | |
| | | min-max. | 20,5-30 | 20,5-32 | |

Characteristics of nervous activity in female athletes in different seasons of the year. Features of physiological reactions in female athletes of the same level of fitness during the hot period of the year. A comparative analysis of indicators of the coordination capabilities of the nervous system in female athletes of the same level of training, the same age group in cool and hot periods of the year revealed differences in the reactions studied.

LVDR indicators during the hot period decreased in athletes involved in synchronized swimming by 11%, in the test with functional load by 10.8% with single-digit variability (Table 4).

The accuracy of differentiation decreased by 14.3%; the number of delayed reactions, as well as the time of erroneous reactions, sharply increased. This indicates a deterioration in the programming of the previous action.

The manifestation of the equilibrium function in static-chronometric samples did not have significant differences in both seasons of the year, and the indicators of the most complex coordination function in sample IV decreased sharply. At the same time, a significant individual range of indicators and their high variability were noted. The duration of maintaining body balance in the vestibular test decreased by 21%.

Thus, there is a multidirectionality of indicators in the studied seasons of the year. During the hot period, increased reactivity is associated with a deterioration in differential inhibition and, in general, the balance of nervous processes, a decrease in the functional stability of the vestibular analyzer. These changes do not contribute to increasing the coordination capabilities of the central nervous system when performing muscle activity; they may be associated with some tension in the sphere of motor regulation.

*Table 4*

***Characteristics of the coordination capabilities of the central nervous system in female athletes in the phase of background activity in different seasons of the year***

| Options | Cool season | Hot season |
|---|---|---|
| *Neurochronometry* | | |

| | | |
|---|---|---|
| ЛВДР n=100 $\overline{X}$ | 181,25 | 161,60 |
| $\vartheta$ | 33,72 | 32,60 |
| $C_V$ % | 18,6 | 20,2 |
| *LVDR after functional load n=100* | | |
| $\overline{X}$ | 200,6 | 179,01 |
| $\vartheta$ | 48,23 | 38,01 |
| $C_V$ % | 24,0 | 21,2 |
| *Differentiation reactions* | | |
| - number of accurate reactions (%) | 38,6 | 24,3 |
| - number of premature reactions (%) | 24,3 | 15,7 |
| - advance error $\overline{X}$ (мс) | 6,1 | 11,0 |
| - number of delayed reactions (%) | 37,1 | 60,0 |
| - lag error $\overline{X}$ (мс) | 20,3 | 26,0 |
| *Statochronometry (in sec.)* | | |
| I try | 7,09 | 9,24 |
| II try | 6,94 | 7,23 |
| III try | 5,40 | 5,82 |
| IV try | 2,71 | 1,58 |
| Vestibulochronometry (in sec.) | 12,40 | 9,7 |

Adaptive restructuring of cardiohemorespiratory systems in female athletes of the same level of fitness during the hot period of the year. The cardiohemorespiratory system is an indicator of the state of the adaptive-adaptive detail of the organism; it is sensitive to various influences that cause changes in the organism and its habitat.

In our studies conducted in the hot periods of the year (June-August) compared with data obtained in the cool period of the year (October-December), pronounced differences are observed. In the activity of the cardiovascular system, multidirectional changes were noted according to blood pressure and pulse rate in individual responses. So, for example, athlete A. has a reduction in heart rate by 22.5% with a decrease in systolic and diastolic pressure; athlete N., on the contrary, has an increase in heart rate of 38% with a constant level of systolic pressure and with a slight decrease in the level of diastolic pressure. However, nevertheless, during the hot period, both have an increase in pulse pressure (Table 5), which is an indicator of systolic blood volume and is the result of expansion of the vascular bed as an adaptive reaction aimed at meeting the needs of thermoregulation.

Analysis of data from the respiratory system revealed significant adaptive changes during the hot period of the season, vital capacity increased by 13% compared to the winter period, indicating an increase in gas exchange, hypoxemic resistance sharply increased on inhalation by 36%, on exhalation by 62% of the values of the winter period in some representatives of this group. Pneumotachometry indices were characterized by a slight increase in inspiratory power and a decrease in expiratory power compared to the cool period.

Thus, a comparative analysis of the indicators of cardiohemorespiratory systems in different conditions with the same level of training revealed a specific feature of adaptation in young athletes

to hot climate conditions, in the restructuring of autonomic functions to a more optimal level of functioning in changed environmental conditions.

Table 5

**Characteristics of some indicators of the cardio-hemorespiratory system in female athletes in the background activity phase during hot periods of the year**

| Groups | Fitness | Parameter | AD | | | Pulse rate | Vital | Holding your breath | | Pneumo-tachometry | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | M | M | P | | | while inhaling | on exhalation | inhale | exhalation |
| Senior 13-15 years old n=7 | Experience 6 years or more | X | 114,3 | 60,3 | 54 | 71,4 | 3439 | 100 | 5,4 | 4,4 | 3,9 |
| | | $\vartheta$ | 6,7 | 14,0 | 8,66 | 13,75 | 349,3 | 11,9 | 20,7 | 0,1 | 0,2 |
| | | $C_V$ % | 5,86 | 23,22 | 16,0 | 19,26 | 10,16 | 11,9 | 35,08 | 2,27 | 5,13 |
| | Min-max | | 105 - 120 | 40-80 | 40 - 65 | 60-94 | 2930 - 3970 | 79 - 115 | 44 - 105 | 3,8 - 5,0 | 2,8 - 4,8 |

**CONCLUSION**

Studying the activity of various functional systems of the body of female athletes involved in synchronized swimming in the environmental conditions of Uzbekistan is relevant for clarifying the peculiarities of the restructuring of certain physiological functions when adapting to specific muscular activity, depending on the level of their training.

A study of the functional state of the central nervous system in young female athletes showed that a high level of training is characterized by a higher level of nervous activity: improved reactivity, greater stability of reactions, resistance to prolonged exposure to stimuli.

Highly trained female athletes are distinguished by better programming of the beginning of actions, while less trained female athletes have less perfect, differentiated reactions.

Athletes engaged in synchronized swimming showed higher indicators of reactivity, better differentiation reactions in their age groups, and at the same time, there was an increase in reactivity with age, improvement in qualitative and quantitative indicators of differentiation reactions.

In the cardiorespiratory system, age-related differences and natural adaptive changes associated with the level of training can be traced. With increasing age, bronchial conductivity increases, and adaptive changes in these indicators depending on the specifics of the training process in unusual environmental conditions, characterized by high density, can be traced.

In the conditions of a hot period, a specific adaptation was revealed, expressed in an increase in pulse pressure in multidirectional changes in pulse indicators in the restructuring of autonomic functions to a more optimal level of response (increased VC, hypoxemic resistance, increased inspiratory power), increased reactivity of the central nervous system, with worsening differential inhibition and, in general, balance of nervous processes, decreased functional stability of the vestibular analyzer. These changes do not contribute to increasing the coordination capabilities of the central nervous system when performing muscle activity and may be associated with some tension in the area of motor regulation.

The leading role in the formation of the functional state belongs to the central nervous system. To improve it, the lifestyle of female athletes is of great importance. This implies a properly organized regime of training, rest and everyday life.

To increase the adaptive capabilities of the body, especially in childhood, adolescence and youth, it is necessary to use hardening procedures with the inclusion of a temperamental factor. To reduce the excitability of the central nervous system and improve the balance of nervous processes, especially in teenage athletes, it is advisable to use autogenic training and other psychoregulatory influences.

To improve motor differentiation and balance function in general, it is recommended to perform exercises without visual control, on reduced support, with the maximum possible muscle groups involved in the work, and the use of a wide variety of body positions in space. In children's and youth sports, especially at the initial stage of training, the harmony of muscle loads on the motor system, as well as the autonomic systems of the body, is of great importance. Very effective for sports training of synchronized swimmers is training the respiratory function according to Buteyko VLGD (volitional elimination of deep breathing): calm inhalation and short exhalation and holding the breath, or partial exhalation 4-8 times, calm inhalation, lengthen the exhalation for 15 seconds, then holding the breath, and also the use of paradoxical breathing (the opposite of physiological inhalation on a compressed chest, exhalation - on an open one with a frequency of 1 movement per second, with a closed mouth, starting with 10 exercises and increasing to 50 each).

Of great importance in the regime of young athletes is the duration of night sleep, which should not be less than 9 hours, and in the most intense periods of sports training - 10 hours.

Thus, the formation of functional status and its maintenance at the proper level will be facilitated by a set of measures, including regular monitoring, strict pedagogical consideration and correction of physical activity, rational use of psychological, hygienic and biological factors of the body’s vital activity.

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