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# Study of Functional Potentials of Different Portsmanship Level Synchronous Swimming Sportswomen under Impact of Hypoxia.

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**ABSTRACT**

Being in conditions of hypoxia relates to specificities of synchronous swimming. Resistance to hypoxia is considered to be the factor of successfulness. To study functional potentials under impact of hypoxia, as a factor of successfulness prognostication for synchronous swimming sportswomen of different sportsmanship level. 70 sportswomen participated in the research. The sportswomen were divided into groups by level of their sportsmanship and by their age: 1 – (n=17), 2-1 sports grades, candidates master of sports of 12-13 years' age; 2 – (n=40), 14–16years old; 3 – (n=13), 17–20 years' age. Sportsmanship level of groups 2 and 3 corresponded to master of sports and international master of sports; group 3 was combined team of Ukraine. We assessed respiratory, cardio-vascular systems; oxygen-transportation system. we found increase of breathing volume with sportsmanship rising. This indicator was maximal in group 3 on all stages of hypoxia test. Increase of breathing frequency was minimal in group 3. We registered stability of pulse, blood pressure, stroke volume, saturation indicator and partial pressure of oxygen and carbon dioxide. Analysis of correlation matrixes proved increment of indicators in group 3, comparing with group 1. we proved expansion of functional potentials of sportswomen's adaptation to hypoxia. The absence of noticeable shifts in functional indicators of oxygen-transportation system points at absence of tension under hypoxia impact. It characterizes saving character of system's functioning; its passing to qualitatively new level of work, resulted from trainings and reflects optimal adaptation potential of synchronous swimming sportswomen.

**Keywords:** adaptation, synchronous swimming sportswomen, hypoxia test, functional state.

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## INTRODUCTION

Synchronous swimming (SS) is rather young kind of sports, included in Olympic Games' program at the beginning of 80-s years of the last century. However, the works on scientific-methodic aspects of this kind of sports are dated by earlier period [1]. The existing researches are devoted to substantiation of training theory and methodic in this kind of sports, techniques' mastering, practical skills and abilities' acquiring [2–5]. Competition activity of SS sportswomen is characterized by more quantity of fulfilled elements. Orientation in water space against the background of hypoxia and hypercapnia is complicated by unusual body position (head downward), which is rather often in sportswomen's trainings and performances.

In sportswomen's trainings fulfillment of standard stroke movement is rather important [6, 7]. It is recommended to fulfill movements against the background of significant physical fatigue, increased emotional tension, distraction, distributed attention; complicated functioning of some analyzers (movements with closed eyes). In other research [8] assessment methodic for technical complexity (solo) of free composition was worked out for its application in training and competition functioning of elite sportswomen in synchronous swimming. It was found that full time of breathing pause was 40% of free composition.

Specificity of SS is that sportswomen have to endure long lasted oxygen deficit in performances and at trainings. Analysis of SS sportswomen's physiological reactions [9] proved significant increase of breathing pause time with equal time of restoration. At the same time heart beats rate (HBR) was much lower. It is interpreted as better adaptation to hypoxia. In other research conditions of activation of "acute" hypoxia stimulus of reactions for recreational processes stimulation after tensed motor functioning were described [10]. Activation of cardio-respiratory system in conditions of standard testing was determined. It is proved by studies of intra-sensor relations' characteristics in system of sportswomen movements' control in synchronous swimming [11]; purposefulness of control perfection in substantiation of quantitative and qualitative assessment of kinesthesia in specific conditions of sports functioning [12, 13]; working out of mathematical models for determination of different factors' influence on quality of technical element's fulfillment by sportsmen [14-16].

In our research [17] it was determined that SS elite sportswomen are characterized by significant increment of physiological-metrical indicators. This principle is a reflection of requirements, set by this kind of sports to sportswomen's organisms. It is recommended to use assessment of vital capacity of lungs and calculation of physical condition indices as screening test of sportsmen's state. Such approach to assessment of sportsmen's fitness was shown on example of other kinds of sports (arm wrestling [18–20], wrestling [21], and boxing [22]), in physical education of pupils [23] and students [24, 25].

The problem of human adaptation to hypoxia is important in many kinds of professional functioning. However, just in SS it is the most significant. Peculiarities of this kind of sports permit to assume that level of resistance to hypoxia is one of leading factors, which determine successfulness and rise of sportsmanship.

### The purpose of the research

To study functional potentials under impact of hypoxia, as a factor of successfulness prognostication for synchronous swimming sportswomen of different sportsmanship level.

## MATERIAL AND METHODS

*Participants:* in the research 70 SS sportswomen of 12-20 years' age participated. *Участники.* The sportswomen were divided into groups by level of their sportsmanship and by their age: 1 – (n=17), 2-1 sports grades, candidates master of sports of 12-13 years' age; 2 – (n=40), 14–16years old; 3 – (n=13), 17–20 years' age. Sportsmanship level of groups 2 and 3 corresponded to master of sports and international master of sports; group 3 was the core of combined synchronous swimming team of Ukraine.

*Design of the research* implied assessment of oxygen transportation system's reactions to hypoxia test as well as inhaled gas mixture (content of oxygen – 11%) during 8 minutes. In relaxed state and in testing (on 3$^{rd}$ and 8$^{th}$ minutes) we registered: minute volume of breathing (MVB), partial; pressure of oxygen ($P_AO_2$) and carbon dioxide ($P_ACO_2$) in alveolar air, heart beats rate (HBR), systolic blood pressure (SBP) and diastolic pressure

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(DBP), minute volume of blood (MVBl), breathing volume (BV), frequency of breathing (FB). Saturation of arterial blood with oxygen – saturation ($SaO_2$) was determined with pulse oxygen meter «Sensor Medics» (USA). Considering possibility of hypoxia damaging effect with reduction of $SaO_2$ below 72–75%, we realized individual approach in determination of testing time (if required – premature stoppage of test). Testing of sportswomen was fulfilled in 2nd phase of ovarian menstrual cycle.

*Statistical analysis* of the received data was fulfilled with the help of licensed electronic tables Excel. We determined indicators of descriptive statistics (mean arithmetic, standard deviation and error of mean value). Confidence of differences was assessed by Student's criterion; difference was considered to be confident at ($p<0.05$). For determination of correlations between indicators we calculated correlation coefficients by Pirson and built correlation matrixes [26]. Comparative analysis of correlation matrixes was carried out with application of such indicators as specific weight of significant and confident correlations, indicator of labialization/synchronization (ILS) and mean correlation coefficient (MCC). The latter two were found by special formulas [27]:

$$ILS = [n/N(N-1)] \cdot 100\%, \quad (1),$$

Where n –sum of all significant correlations, created by every parameters of correlation structure; N – ototal quantity of all parameters of structure.

$$MCC = \Sigma rj/n, \quad (2),$$

Where Σrj – sum of all confident correlation coefficients of structure; n – quantity of significant correlations.

## RESULTS OF THE RESEARCH

The data, received at the beginning of the research are given in table 1. Analysis of cardio-vascular system's functional indicators showed distinctions in initial SBP. This indicator is the lowest in 3rd group. Sportswomen of 1st and 2nd groups are characterized by increased values, though they were also within physiological norm. In HT (hypoxia test) SBP shifts were found only in the most experienced sportswomen. Parameters of DBP and SV (stroke volume) did not significantly differ.

**Table 1: Dynamic of functional indicators of synchronous swimming sportswomen in dynamic of hypoxia test**

| Indicators | 1group (n=17) | | | 2 group (n=40) | | | 3 group (n=13) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Initial level | HT 3 min. | HT 8 min. | Initial level | HT 3 min. | HT 8 min. | Initial level | HT 3 min. | HT 8 min. |
| $BP_{syst.}$ mm.nerc.col. | 110.12± 2.53[3] | 115.23± 3.22 | 115.31± 2.27 | 110.34± 4.28 | 115.23± 4.52 | 115.67± 5.24 | 100.58± 2.23[2] | 110.18± 1.51[1] | 110.24± 3.26[1] |
| $BP_{diast.}$ mm.nerc.col. | 65.66± 4.53 | 70.12± 5.21 | 70.24± 4.25 | 60.43± 3.82 | 65.45± 4.24 | 65.76± 4.91 | 60.65± 5.54 | 65.12± 5.26 | 65.76± 3.95 |
| HBR,$bpm^{-1}$ | 68.33± 6.52 | 85.44± 4.57[3] | 100.22± 4.58[1] | 65.23± 5.24 | 73.44± 6.23 | 95.18± 5.54[1] | 65.54± 6.56 | 70.18± 5.55 | 93.22± 3.87[1] |
| SV, ml | 65.43± 3.52 | 65.23± 4.27 | 60.56± 3.34 | 70.18± 5.35 | 70.45± 2.58 | 68.19± 2.58 | 75.29± 5.54 | 75.53± 4.84 | 70.61± 6.52 |
| MVBl ml/min. | 4420.98± 122.45 | 5525.64± 131.34[1] | 6000.52± 175.62[1] | 4550.77± 143.83 | 5110.43± 181.96[1] | 6460.62± 223.12[1] | 4875.74± 256.69 | 5250.59± 251.42 | 6510.35± 232.66[1] |
| FB, $min^{-1}$ | 16.12± 1.14 | 32.41± 0.94[1,2,3] | 39.28± 0.74[1,2,3] | 15.29± 1.25 | 23.32± 1.16[1] | 25.46± 0.96[1] | 15.34± 0.95 | 20.12± 1.16[1] | 22.00± 1.11[1,2] |
| BV, ml | 0.753± 0.013[2,3] | 0.756± 0.025[3] | 0.658± 0.025[1,2,3] | 0.809± 0.012 | 0.807± 0.011 | 0.795± 0.025 | 1.113± 0.023[2] | 1.125± 0.031[2] | 0.917± 0.023[1,2] |
| MVB, l | 12.43± 1.27[3] | 23.32± 0.81[1,2] | 25.16± 0.75[1,2,3] | 12.38± 1.35[3] | 18.46± 1.19[1,3] | 20.07± 1.44[1] | 17.32± 0.96[1] | 22.07± 1.05[1] | 20.64± 0.79[1] |
| $SaO_2$, % | 96.09± 3.29 | 78.65± 4.54[1] | 80.76± 3.83[1] | 96.43± 5.27 | 83.05± 3.13[1] | 80.54± 2.21[1] | 96.75± 2.84 | 86.39± 3.53[1] | 84.08± 4.21[1] |
| $P_AO_2$, mm.nerc.col. | 102.49± 5.68 | 101.05± 4.82 | 100.34± 6.22 | 102.08± 6.26 | 102.53± 5.97 | 101.83± 5.82 | 102.61± 4.55 | 101.89± 5.58 | 101.29± 6.36 |
| $P_ACO_2$, mm.nerc.col. | 40.44± 1.27 | 40.09± 1.13 | 41.33± 1.27 | 40.28± 1.25 | 40.09± 1.21 | 41.53± 1.18 | 40.72± 1.15 | 40.91± 1.18 | 41.65± 1.27 |

Notes: 1- differences from initial level are confident ($p<0.05$), 2 – differences from group 2 are confident by background ($p<0.05$), 3 – differences from group 3 are confident by background ($p<0.05$); HT- hypoxia test; SV – stroke volume.

HBR initial data also did not differ significantly and reflected physiological norm with some tendency to bradycardia. The dynamic of this indicator in all three groups was of similar type – passing to tachycardia due to HBR increase by the 8th minute of HT ($p<0,05$). It is also interesting that in the middle of testing HBR of 1st group sportswomen was significantly higher than in group 3.

Analogous changes were found during analysis of MBV. In groups 1 and 2 during HT we significant increment of this parameter was confirmed; in group 3 increase was observed only by the end of HT.

Functional indicators of respiratory system also changed to some extent. First of all, distinctions in initial level of BV attracted attention ($p<0.05$). This indicator increased with rising of sportsmanship and was the highest in group 3.Этот показатель увеличивался с ростом спортивного мастерства и был наибольшим в 3 группе. Analysis of HT showed its multidirectional dynamic. In group 1 we registered confident increase of BV by the end of HT; in group 2 – we observed no significant shifts; in group 3 significant reduction of this indicator was observed at the end of HT. Comparison of values inside every group also permits to speak about certain dynamic. BV indicators of the most experienced sportswomen were the highest on all stages of HT.

Coming from specificities of experiment changes in FB (breathing frequency) were quite logical. With absence of differences in initial level of all sportswomen, fulfillment of HT resulted in increase of this criterion. However, we found distinctions in dynamic, depending on sportsmanship and experience. The most expressed they were in 1st group sportswomen, where quantity of breathing movements increased 2-2.5 times. With increasing of sportsmanship, BF shifts became less and less expressed. Increment of breathing movements was 56–66% in 2nd group and 33–46% in group 3.

When analyzing the results of the research we considered the fact that MVB is a calculated indicator. This indicator depends on BV and FB. Its level in groups 1 and 2 reflects to large extent changes of these functional criteria of respiratory system. Initial level did not differ noticeably in groups 1 and 2. The most experienced sportswomen had initial level much higher than in these groups. In dynamic of HT the highest increase of MVB was observed in group 1, where results significantly exceeded the same in groups 2 and 3. It interesting also that in groups 1 and 2 MVB dynamic was equal and increase of the indicator was observed on all stage. At the same time in group 3 MVB increase was registered after 3 minutes and after 8 minutes – stabilization of the indicator.

Specificities of the research design pre-determined interest to arterial blood saturation with oxygen ($SaO_2$) and determination of oxygen ($P_AO_2$) and carbon dioxide ($P_ACO_2$) partial pressure in alveolar air. With absence of significant differences between groups, $SaO_2$ dynamic, in the process of HT, was of similar typeв. In all sportswomen we registered significant reduction of this indicator after 3 and 8 minutes of HT, comparing with initial level. Final indicators of $SaO_2$ were stable in respect to the middle of testing.

Oxygen and carbon dioxide partial pressure was stable in all participants of the research. We did not register any significant shifts of these parameters in dynamic of testing and with comparing of the tested groups.

In our research [28] we proved adequacy of correlation matrixes method for analysis of different sportsmanship sportsmen's condition. It pre-conditioned its application in this very case. Main indicators of correlation structures (see table 2) witness about increase of data in group of the most experienced sportswomen, comparing with groups of beginners. In group 1 and 2 there were no confident shifts of specific weight of significant and confident correlations. In group 3 we found rather noticeable increase of these indicators, comparing with group 1.

**Table 2: Indicators of correlation matrixes of forearms' strength in experienced group and group of beginners**

| Group | Specific weight of significant correlations (%) | Specific weight of confident correlations (%) | Indicator of labialization/synchronization | Mean correlation coefficient |
|---|---|---|---|---|
| 1 | 54.65±6.20 | 33.22±3.67 | 31.92 | 0.37 |
| 2 | 62.79±5.83 | 38.12±4.23 | 38.76 | 0.46 |
| 3 | 73.13±6.18[1] | 45.71±4.23[1] | 43.55 | 0.61 |

Notes: 1 – differences from group 1 are confident ($p<0.05$)

Increase of labialization/synchronization indicator in group 2 was 21.4%, and in group 3– 36.4% comparing with group 1. It is interesting that value of mean correlation coefficient increases with rising of sportswomen's sportsmanship. If in group 1 this indicator relates to interval of average correlation values, then in group 3 it characterizes strong correlation.

**DISCUSSION**

Impacts of hypoxia type are widely used in sports for improvement of adaptation abilities and expansion of functional potentials. It is noted that usage of adaptation to highlands (natural or simulated) is one of effective means of sportsmen's adaptation potential's perfection [29]. All these influence on their successfulness and increase of competitiveness. Combination of hypoxia training with modified diets permits to significantly raise training effectiveness.

For triathlon sportsmen intermittent hypoxia was used as mean of impact on production of erythropoietin [30]. Significant increase of erythropoietin concentration in blood is proved that can be assessed as increase of organism's adaptation potential.

Study of bicyclists' adaptation to highland with application of norm baric hypoxia confirmed the presence of tendency to endurance reduction in sportsmen, is to use norm baric hypoxia [31]. In other research urgent influence of endogenous hypoxic breathing on respiratory apparatus functioning in bicyclists was determined [32]. It was found that single application of endogenous-hypoxic breathing facilitates maximal lungs' ventilation: vital capacity of lungs at inhale, instant volume speed in large and fine bronchus.

Mykhalchuk R.V. [33] applied breathing exercises of hypoxic character for sportsmen- weight lifters. The received results confirmed positive influence on efficiency at the account of functional indicators, characterizing cardio-vascular and respiratory systems' condition.

On example of game kinds of sports sportsmen (football and hockey) it was determined that adaptation to acute intermittent hypoxia significantly increase speed indicators of sportsmen [34]. In other research it is noted that hypoxia influences on sprinters' indicators [35]. It was found that hypoxia renders more expressed influence than, for example, increase of environmental temperature.

For increasing of adaptation effectiveness it is offered to alternate hypoxic and normoxic impacts [36]. It was proved that intermittent hypoxic impact permits to minimize harmful effects of chronic hypoxia. Intermittent hypoxia permits to increase adaptation potential and improve nervous-muscular and cardio-vascular determinants of loads for endurance.

In our opinion this is the way how to assess the absence of shifts in cardio-vascular system (DBP, SV). It reflects stability of state, optimal potential of SS sportswomen's adaptation potentials. Reduction of SBP initial level in the most experienced sportswomen can be interpreted as evidence of saving character of system's functioning; its passing to qualitatively new level of functioning, resulted from trainings. It is proved by HBR indicator, as far as it responds to hypoxic loads first of all. In this context the highest expressiveness of HBR shifts in group 1 shall be assessed as evidence of less functional potentials of the beginners. At the same time change of cardio-vascular system's reaction witnesses about reconstruction of adaptation strategy and its realization at the account of other functional reserves of cardio-vascular and respiratory systems.

Results of other researches witness about use of training with application of interval hypoxia. For sportsmen with adaptation to long-lasted aerobic loads application of highly intensive exercises in anaerobic mode permits to increase efficiency without changes in metabolism and increase of muscular mass [37]. For increase of efficiency it is offered to use physical exercises, artificial moderate hypoxia and expressed hypercapnia [38, 39]. Application of such complex for 12-14 years' age swimmers permits to raise speed-power, dynamic and general endurance.

Charles R. et al [40] studied dynamic of organism's bio-chemical and physiological indicators under influence of hypoxic training. Due to large scattering of data substantial shifts were not proved, but there was a conclusion about effectiveness of hypoxic training for some people.

Results of Balamutova N.M. [41] proved that usage of original methodic of hypoxic training for elite swimmers permits to significantly increase indicators of sportsmen's anaerobic workability and achieve higher sports results.

The registered MVBl changes confirm the presented literature data and made earlier assumptions. The most experienced SS sportswomen significant increase of the parameter was registered only by the end of HT. That is their adaptation potentials permitted to cope with load for rather long period, comparing with sportswomen of group 1 and 2.

Specific features of SS (as kind of activity) pre-determined changes of sportswomen's respiratory system's indicators. Increase of BV with sportsmanship rising definitely proves expansion of adaptation potentials. Dynamic of this criterion in the process of HT is one more proof of experienced sportswomen's organism's transition to qualitatively new level. Sportswomen of group 1 react to hypoxia by increasing of BV, while more experienced participants endure load without noticeable changes of the indicator. The most experienced SS sportswomen's reduction of BV by the end of HT reflects high adaptation and maximally saving reaction to hypoxic load.

Analogous data are presented in research, devoted to underwater swimmers' resistance to hypoxia [42]. Application of special exercises resulted in increase of saving character of cardio-respiratory system's functioning; increase of sports efficiency.

Absence of distinctions in initial FB indicators is an evidence of good fitness and stable condition of all participants of the research, while its changes shall be assessed as proof of potential possibility to compensate hypoxic loads by all participants. In this context the less shifts were in more experienced sportswomen prove higher level of fitness better ability to endure hypoxia. The same conclusion can be made also on the base of analysis of MVB. Its level and specificities of dynamic prove that with rising of sportsmanship and fitness level, adaptation potential of sportswomen's respiratory system also increases.

Stability of oxygen transportation system also witnesses in favor of earlier conclusions. Specific features of SS sportswomen's training conditioned increase of resistance to hypoxia that permits to predict increase of the sportswomen's successfulness. Permanent character of the studied indicators shall be interpreted as proof of functional tension and de-compensation absence; as feasibility of the used hypoxic loads for trained sportswomen. Basing on available literature data we can assume even more profound functional reconstructions. On system level adaptive response to hypoxia is accompanied by lungs' vasoconstriction. It ensures gas metabolism in lings and haemo-transduction of carotid glomeruluses that facilitates lung ventilation's stimulation [43, 44]. It can explain the absence of confident changes of oxygen ($P_AO_2$) and carbon dioxide ($P_ACO_2$) partial pressure in alveolar air. It is a mechanism of gas homeostasis at level of alveolar ventilation even, when inhaling air with reduced oxygen content.

Study of hypoxia impact on functional potentials in the process of physical exercises' fulfillment showed that in state of rest short-term hypoxia causes slowing of brain neurons' activity, providing no changes in cortex irritability [45]. With increase of hypoxia period irritability of corticospinal structures increases. Long-lasted impact causes respiratory alkalosis that can be explained by reduction of neurons' irritability. Fulfillment of exercise with acute hypoxia facilitates progressing of peripheral fatigue. With increasing of hypoxia intensity, fatigue of CNS becomes dominating. In the authors' opinion better effect of locomotion, which take place in acclimatization is caused by decrease of fatigue progressing with chronic hypoxia.

Application of artificial hypoxia for increase of runners-sprinters' training effectiveness permitted to find substantial expansion of adaptation potentials, providing bio-chemical status remained unchanged [46]. Also positive influence on catecholamine's level, increase of CPK level, absence of negative changes in nitrogen balance with parallel increase of physical workability were also proved.

Rather contradictory information is available in respect to correlations of hypoxia and oxidation stress. For example, Bridget Peters et al. [47] found that hypoxia progressing results in intensification of oxidation stress. The conducted researches permitted to specify temps of progressing of adaptation to hypoxia. Assessment was carried out with indicators, characterizing anti-oxidant system's condition and level lipids' per-oxidation. At the same time Paul S.R. et al. [48] determined that hypoxia influences a little on

oxidation stress. The results, rendered by them, permit to assume promising character of these indicators' studying in SS sportswomen. It is proved by analogous researches in context of sports training theory (arm-wrestling [49], Judo [50, 51], boxing [52], gymnastic [53]) and methodic of physical education [54, 55]. The data about assessment of anti-oxidant system's activity and lipids' per-oxidation; degree of imbalance between pro-oxidants and anti-oxidants in biological substrates can be regarded as objective and very sensitive indicators of organism's general condition as well as activity and perfectness of functional systems of regulation and maintaining stable homeostasis.

Comparative analysis of functional indicators' correlation matrixes of SS sportswomen witnesses in favor of our earlier conclusions. Application of correlation matrixes [28] permitted to carry out comparative analysis of different sportsmanship arm-wrestlers' fitness and assess their functional condition as stable. Such state is characterized by sufficient quantity of correlations with minimal imbalance. It permitted to make conclusion that state of sportsmen's functional tension was lower, comparing with control group. Appropriateness of such approach is proved by other researches [56–61].

Other authors think that SS sportswomen of different sportsmanship have confident distinctions in coordination, strength, flexibility and special endurance [5, 8]. The presence of these indicators' correlation with sportswomen's efficiency was determined.

Results of our research proved that the most experienced sportswomen have increase of specific weight of significant and confident correlations ($p<0.05$). It can be assessed as evidence of system's stabilization and its adaptation to hypoxic loads. With it, with transition from group 2 to group 3 there happens qualitative jump. It reflects system's transition to new level of functioning. Analysis of mean correlation coefficient of system, which increases up to level of strong correlation, witnesses in favor of it.

## CONCLUSIONS

Study of functional potentials of different sportsmanship level synchronous swimming sportswomen under impact of hypoxia proved expansion of functional potentials of adaptation. Absence of shifts in cardio-vascular system's indicators reflects optimal adaptation potential of SS sportswomen. Such potential is characterized by saving character of system's functioning; by its passing to qualitatively new level of functioning, resulted from trainings. The determined changes of cardio-vascular system's reactions to hypoxic loads witness about reconstruction of adaptation strategy of elite sportswomen.

Increment of functional indicators of sportswomen's respiratory system with sportsmanship rising definitely prove expansion of adaptation potentials. Dynamic of respiratory system's state criteria in the process of hypoxia test is one more proof of organism's transition to qualitatively new level, reflecting high adaptation, maximally saving character of functioning. It is also witnessed by stability of oxygen transportation system's indicators.

Peculiarities of training in synchronous swimming conditioned increase of resistance to hypoxia that permits to predict increase of sportswomen's successfulness. Permanent character of the studied indicators proves absence of functional tension and de-compensation; feasibility of hypoxic loads for trained sportswomen. Comparative analysis of correlation matrices of the found sportswomen's functional indicators proves one more the made conclusions.

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