

Effectiveness of the application of the endogenous-hypoxic breathing technique in the physical training of the qualified field hockey players

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Abstract:

The research is devoted to the study of possibilities of professional field hockey players' physical and functional preparedness improvement on the stage of their individual opportunities maximal realization by applying the endogenous-hypoxic breathing technique.

The research represents the results of influence of training sessions with and without normobaric hypoxia and hypercapnia application on physical capacity, the body's aerobic and anaerobic (lactate and alactic) productivity, the external respiration apparatus function, as well as blood pressure recovery and cardiac rhythm, after completion of dosed physical exercises. Furthermore, the influence of such exercises on professional field hockey players general and special physical preparedness is being presented in the mentioned investigation.

It is established that the application of the endogenous-hypoxic breathing technique in the field hockey players' training process promotes their general and special physical preparedness, improves sportsmen's functional efficiency regarding the body aerobic and anaerobic productivity rates and the external respiratory apparatus functional possibilities, as well as promotes adaptation to hypoxia and accelerates the body's restorative processes.

Key words: physical and functional preparedness, field hockey players, endogenous-hypoxic breathing, work capacity.

Introduction

The long-term preparation of highly qualified athletes in playing sports requires the search for rational ways of the training process improvement. First of all, this is due to the increasing popularity of playing sports among young people, the expansion of the calendar of competitions, increased competing at the international competitions, in particular at the Olympic Games, World and Europe championships (Briskin, 2011, 2016; Kozina, 2017; Ivashchenko, 2017).

A number of scientific researches have been devoted to the problem of improving the technologies of training athletes in playing sports. (Sulyma, 2014; Briskin, 2016; Galan, 2016; Pityn, 2017) Regardless of specialization, a variety of means that enhance the effect of physical exercises are used for full realization of the body's functional reserves at different stages of the long-term sports perfection in the training of athletes (Guo, 2007; Khimenes, 2016; Briskin, 2016). In particular, for the training of athletes, during training sessions some scientists (Bohuslavska, 2017; Galan, 2017) propose to use techniques that cause the athlete's state of hypoxia irrelevant to "hypoxia of physical activity", which contributes to the improvement of the mechanisms of adaptation to physical work of different purposefulness.

It is widely applied the technique of creating an athlete's state of hypoxia by staying in hypobaric environment. There are used pressure chambers or staying in the mid-mountain conditions (Choszcz, 2012; Gorshova, 2017). The main factor in the mechanism of creating hypoxia in the use of such models is the reduction of the partial pressure of gases, in particular, oxygen in the air that is inhaled. However, the combined effect of hypoxia of physical load and hypobaric (primarily mountain) hypoxia can lead to negative structural changes in some organs, in 25 % of athletes it appears in the form of collapse, fainting, inadequate response of arterial vessels and myocardium. In addition, the use of hypobaric hypoxia is connected with economic difficulties and technical inconveniences, which limits its use by athletes. The models of creating artificial hypoxia in the body in the normobaric conditions using special instruments are more non-hazardous and economically justified. Taking into consideration the abovementioned, in the training process of field hockey players, promising is the use of accessible and safe hypoxic models that are used in normobaric conditions and cause in the body a state of hypercapnic hypoxia with a slight decrease in the oxygen content (Piarat, 1983;

Bohuslavska, 2017; Hruzevych, 2017).

Performance of physical work during the game in the field hockey players is complicated by the so-called "specific" posture, which is characterized by a slight static tension of the muscles of the shoulder girdle and the bent position of the trunk, that increases the hypoxia of physical activity. Under such conditions, as the compensatory phenomenon, the front wall of the abdomen partially relaxes, it helps to ventilate the lower part of the lungs through facilitating the work of the abdominal muscles and the diaphragm, and that compensates insufficient ventilation of the upper and middle parts of the lungs (Sulyma, 2014). In such a case the duration of the exhalation phase increases. It is expedient to strengthen the ventilation of the lungs of the field hockey players by activating the abdominal type of breathing throughout increasing of the functionality of the muscles of the abdominal press and diaphragm (Kerr, 2008; Sulyma, 2013, 2014).

So, in the training process of qualified field hockey players, as an additional means to enhance the effect of physical exertion, it is necessary to apply such hypoxic model that would contribute to improving the physical preparedness through strengthening hypoxic effect of exercise (hypoxia of physical activity) and the function of external breathing, primarily for an account of increasing the functionality of the muscles that provide the abdominal type of breathing. The endogenous-hypoxic breathing technique with the use of the Endogenik-01 apparatus meets these requirements (Sulyma, 2017).

Materials and methods

The following research methods were used: theoretical analysis and generalization of theoretical and methodological sources on the subject of scientific research; pedagogical observation; pedagogical experiment; pedagogical testing using bicycle ergometry, pulsometry, sphygmomanometry, spirometry; methods of mathematical statistics.

The research was being conducted in the preparatory and competition periods of a one-year macrocycle within 24 weeks on the basis of the laboratory of the Department of Medical and Biological Principles of Physical Education and Physical Rehabilitation of the Vinnytsia State Pedagogical University named after Mykhailo Kotsiubynskyi.

The formative experiment involved 29 male athletes, who were divided into control (14 people) and the main (15 people) group. After the completion of the formative experiment, statistical processing of the results was carried out according to Student's t-criterion; the experimental data were summarized, conclusions were formulated.

Results

Based on the analysis of literary sources, it was discovered that the stage of the maximum implementation of individual opportunities envisages achieving the highest results of the field hockey players, the share of means of special training in the total amount of training work is significantly increased compared to the previous stages of long-term training of athletes, the number of training sessions per week micro cycles is increasing; there are widely used workouts with heavy loads which can disrupt the athlete's adaptive reserves. Taking this into consideration, at the indicated stage of preparation in the educational and training process of qualified athletes it is necessary to apply additional means and methods of training that contribute to increasing the efficiency of physical exercises and preserving the adaptive reserves of athletes. In addition, there are still no systematized scientific and methodological recommendations for the possible application of the available methods of artificial creation of hypoxia in the training process of qualified field hockey players.

The conducted summative experiment showed that in the qualified field hockey players the level of aerobic productivity (LAP), which was estimated by the relative value of VO_2 max (the average value was $40,95 \pm 6,63$ ml min⁻¹ kg⁻¹), according to the criteria of Ya. P. Piarnat (1983) on average turned out to be "lower than mediocre".

Since the respiratory system plays a decisive role in ensuring the proper level of physical work capacity of the field hockey players, in our opinion, attention should be paid to the improvement of its functional capabilities, as evidenced by the results of spirometric research and aerobic productivity. A study of the body's ability to resist hypoxia caused by breath-holding at exhalation, showed that insufficiently high indicators of Genchi test ($32,28 \pm 0,64$ s) in the qualified field hockey players force to use means that would improve the adaptation of athletes to physical work in conditions of hypoxia. The obtained results of spirometric research indicate that the average values of some of the speed indicators of the external respiration apparatus were also lower than the prevailing ones. Thus, the instantaneous volume velocity of air passing at the level of main bronchi (IVV₂₅) was by 13,02% less than the proper value, the average volume velocity of air passing at the level of middle bronchi (AVV₂₅₋₇₅) - by 14,11%.

The response of the cardiovascular system to the bicycle ergometric dosage form of physical load (1W and 2W per 1kg of body weight) according to the arterial pressure parameter corresponded to the normotonic type of reaction. The heart rate recovery after work with a power of 1W was recorded after 2 minutes, and a power of 2 W - after three minutes of the recovery period.

It is established that in the studied field hockey players, the level of development of explosive force based on the results of the test "standing long jump" ($2,43 \pm 0,19$ m), the starting speed based on the results of running 30 m ($4,24 \pm 0,12$ s), explosive force in the conditions of performance of dynamic work on the test "the 5th jump" ($12,11 \pm 0,29$ m), as well as special endurance in terms of providing muscular work due to lactate energy supply processes based on the results of the test "shuttle running 180 m" ($38,16 \pm 0,45$ sec.), correspond to the norms specified in the program for Children's and Youth Sports Schools, Olympic Reserve Junior Sports Schools, School of Higher Sportsmanship and Olympic Reserve schools.

Consequently, the results of the fitness testing of the qualified field hockey players indicate that the necessary condition for improving the fitness of athletes is the use of technologies that enhance the power and capacity of aerobic energy supply processes, as well as the functionality of the external respiration system, in the process of physical training.

The annual macrocycle of training of the qualified field hockey players has two micro cycles, that is connected with the calendar of competitions (autumn-spring). The first cycle consists of the first preparatory and first competition periods (Kerr, 2008; Briskin, 2011, 2016, 2017; Bohuslavskaya, 2017). The analysis of the content of the curriculum for Children's and Youth Sports Schools, Olympic Reserve Junior Sports Schools, School of Higher Sportsmanship and Olympic Reserve schools. (Sulyma, 2014; Kozina, 2017) gives grounds to assert that the tasks of the first preparatory period of the annual macrocycle is to increase the overall level of the athlete's body, and the task of the first competition period - the preservation of the fitness and its implementation in gaming activities, the improvement of technical and tactical training of field hockey players.

The analysis of the content of training sessions of the qualified field hockey players made it possible to find out that in the process of their preparation, insufficient attention is paid to the formation of the abdominal breathing which is specific for them. In this regard, in the training sessions of athletes at the stage of the maximum realization of individual opportunities, it is advisable to use, as an additional means of improving physical fitness, special breathing exercises to form a specific type of breathing for the field hockey players – the abdominal breathing. For this purpose, in the educational and training process of qualified athletes, we implemented the endogenous-hypoxic breathing technique with the use of the "Endogenik-01" apparatus according to the elaborated "itinerary list" (Table 1).

Table 1. The "Itinerary List" of the endogenous-hypoxic breathing for the qualified field hockey players

Weeks	The amount of water in the device, ml	The duration of the inhalation, sec	The duration of exhalation, sec	Total time of workouts, min
1	3	2–3	5–7	2–3
2	4	-/-	8–9	4–5
3	6	-/-	10–11	6–7
4	8	-/-	12–13	8–10
5	10	-/-	14–16	11–13
6	12	-/-	17–19	11–13
7	14	-/-	20–21	14–15
8	16	-/-	22–23	16–17
9	18	-/-	24–25	18–19
10	20	-/-	26–27	20–21
11	20	-/-	28–29	22–23
12–24	20	-/-	30–31	24–25

The endogenous-hypoxic breathing technique was being applied in the training process of the qualified field hockey players in the preparatory and competitive periods of the annual macrocycle during a period of 24 weeks. The frequency of workouts was 5-6 times a week. The content of training sessions of the qualified field hockey players of the control and the main groups did not differ. The difference was that the athletes of the main group applied the endogenous-hypoxic breathing technique with the help of the "Endogenik-01" apparatus according to the elaborated "itinerary list" before the preparatory part of each training session. The described above method envisages the step adaptation to moderate hypoxia and pronounced hypercapnia by increasing the amount of water in the apparatus, increasing the time of a slow exhalation and also increasing the duration of training sessions. During inhalation and exhalation, resistance to air passing through the apparatus was increased and it intensified the respiratory muscles work by increasing their functionality. An increase in the time of slow exhalation contributed to formation of the economic stereotype of breathing.

At the same time, one of the main tasks of the training sessions of qualified field hockey players of the main group was the formation of the adaptive mechanisms of the body, not by increasing the volume and intensity of the training work, but by applying the artificially created state of moderate hypoxia and pronounced hypercapnia with the help of the "Endogenetic-01" apparatus in the process of preparation.

Training sessions without the application of the endogenous-hypoxic breathing technique within 16 weeks from the beginning of the formative experiment in the qualified athletes contributed to a significant increase in the absolute values of maximum oxygen consumption by 2,92 %, and the threshold of anaerobic metabolism (TAM) by 9,13 %. At the end of the formative experiment, the relative magnitude of the TAM ($p < 0,05$) also improved by 12,61 %.

In the qualified field hockey players, who used the technique of the endogenous-hypoxic breathing in their training sessions, within 8 weeks from the beginning of the forming experiment, it was revealed a significant increase in the absolute and relative values of TAM, respectively, by 5,88 % and 5,91 %. After 16 weeks, in addition to the mentioned indicator, the absolute and relative values of VO_2 max increased by 13,13 % and 11,13 %, respectively.

Under the influence of training sessions with the application of the endogenous-hypoxic breathing technique according to the elaborated "itinerary list", unlike the training sessions without using this technique, the work performance in the anaerobic energy supply zone of the field hockey players was improved within 16 weeks according to the absolute and relative values of anaerobic **alactic (VAnT10) and lactate (VAnT30)** energy supply processes. Thus, in comparison with the initial data, the absolute value of the power of anaerobic alactic energy supply processes increased by 15,43 %, and the relative value by 14,19 % ($p < 0,05$). Absolute and relative values of the power of anaerobic lactate energy supply processes increased by 8,84 % and 7,52 % ($p < 0,05$), respectively.

In the process of analysing the results of the study of anaerobic productivity of an organism of the qualified field hockey players, attention is drawn to the fact that training sessions with the application of endogenous-hypoxic breathing technique had a significantly positive impact on the absolute and relative values of the capacity of anaerobic lactate energy supply processes (in terms of the MQEMW indicator (maximum quantity of external mechanical work for 1 minute ($kgf\ m/min^{-1}$)).) (Fig. 1).

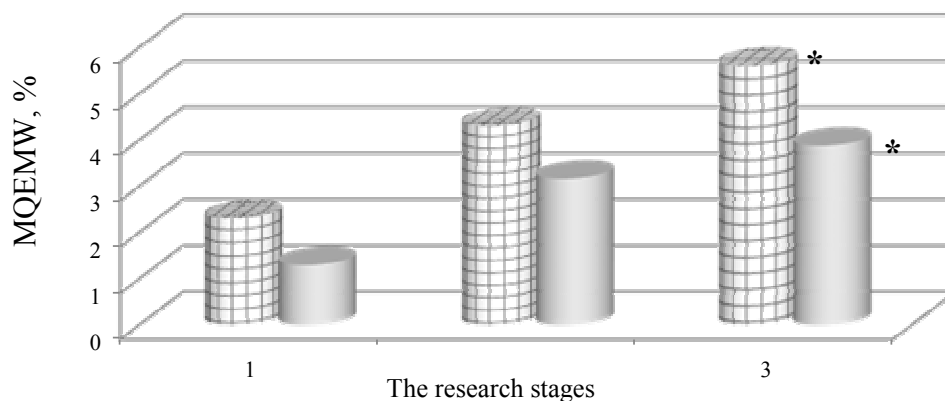


Fig. 1. Dynamics of changes in the absolute and relative index of the MQEMW of the field hockey players of the main group at different stages of the study relatively to the baseline level:

▨▨▨▨▨▨ MQEMW, $kgf \cdot m/min$;

▒ MQEMW, $kgf \cdot m/min \cdot kg^{-1}$;

1 - 8 weeks from the beginning of the formative experiment;

2 - 16 weeks from the beginning of the formative experiment;

3 - 24 weeks from the beginning of the formative experiment;

* - differences with respect to baseline data are statistically significant ($p < 0,05$)

It was found that after the completion of the formative experiment in qualified field hockey players of the main group, the breath holding time on inspiration (the Shtange test) increased significantly by 12,54 % ($p < 0,05$). It should be noted that in 16 weeks from the start of the formative experiment with the application of the endogenous-hypoxic breathing technique, they also experienced an increase in the breath holding time on exhalation (the Genchi test) by 15,87 % ($p < 0,05$). At the same time, the field hockey players of the control group had an increase in breath holding time on exhalation (Genchi test) after 24 weeks.

Thus, the results of the formative research allowed to establish that the application of the endogenous-hypoxic breathing technique in the training process of the qualified field hockey players increases the functional capabilities of the respiratory system of athletes.

During the formative experiment, training sessions under the program for the Children's and Youth Sports Schools, Olympic Reserve Junior Sports Schools, School of Higher Sportsmanship and Olympic Reserve schools contributed to a significant improvement in the volume indicators of external respiration: MVV, VC,

IRV, ERV, VC_{insp}, VC_{exp}. Such changes in the function of external respiration give grounds to assert the positive effect of the field hockey practice on the functional capabilities of the respiratory muscles.

The application of the endogenous-hypoxic breathing technique in the educational and training process of the qualified field hockey players during the preparatory and competitive periods contributes to a more significant increase in the functional capabilities of the respiratory system of athletes. Thus, the VC rose by 7,48 %, IRV - by 8,02 % and ERV by 6,08 %, VC_{insp} - by 7,47 % and VC_{exp} - by 7,87% (p <0,05). Such changes in the apparatus of the external respiration of athletes indicate an increase in the respiratory surface of the lungs, as well as the economization of the function of the apparatus of external respiration. Increase in the functional capabilities of the respiratory muscles is an increase in the MVV index (by 8,46 %).

Unlike the athletes of the control group, the field hockey players of the main group had significant changes not only in the volume parameters but also in the speed indicators of the function of external respiration in 16 weeks after the beginning of the formative experiment (Table 2).

Table 2. The impact of training sessions with and without application of the endogenous-hypoxic breathing technique on the speed indicators of the external respiration function of qualified field hockey players of the control (n = 14) and main (n = 15 groups

Indicators	Groups	Average value, $\bar{x} \pm m$			
		before the beginning of the training	in 8 weeks from the beginning of the training	in 16 weeks from the beginning of the training	in 24 weeks from the beginning of the training
VC, l	CG	4,44±0,15	4,47±0,11	4,50±0,16	4,51±0,14
	MG	4,50±0,11	4,59±0,11	4,69±0,10*	4,71±0,12*
FVC, l	CG	0,84±0,01	0,83±0,01	0,82±0,01	0,79±0,03
	MG	0,87±0,01	0,85±0,02	0,84±0,02	0,83±0,02
FEV ₁ , l	CG	3,66±0,08	3,68±0,09	3,71±0,09	3,77±0,06
	MG	3,68±0,06	3,71±0,06	3,83±0,04*	3,84±0,05*
IVV ₂₅ , l/sec	CG	6,96±0,12	7,13±0,16	7,14±0,14	7,15±0,16
	MG	6,57±0,11	6,62±0,09	6,65±0,12	6,67±0,12
IVV ₅₀ , l/sec	CG	5,87±0,11	5,98±0,14	6,09±0,16	6,11±0,13
	MG	5,47±0,10	5,49±0,10	5,73±0,08*	5,75±0,09*
IVV ₇₅ , l/sec	CG	3,12±0,13	3,15±0,15	3,19±0,16	3,21±0,13
	MG	2,95±0,15	2,99±0,15	3,01±0,15	3,03±0,14

Note. * - differences with respect to baseline data are statistically significant (p <0,05).

It was established that the general endurance, explosive strength, speed-strength endurance of the muscles of the shoulder girdle, as well as the power static endurance of the extensor muscles of the back and gluteus muscles, significantly improved in the qualified athletes of the control group at the completion of the formative experiment.

The application of the endogenous-hypoxic breathing technique in the training process of the field hockey players at the stage of the maximum realization of their individual opportunities contributed to a significant increase in the indicators of overall physical fitness. So, unlike the field hockey players of the control group, the 8 week-training sessions of the athletes of the main group contributed to an increase in their results of a 12-minute run by 2,95 % (p <0,05).

The results of the study of the special physical preparedness showed that under the influence of training sessions with application of the technique of creating in the body of the field hockey players the states of hypercapnic hypoxia, the average values of such indicators as special endurance in conditions of providing muscular work at the expense of lactate energy supply processes (according to the "shuttle run 180 m" test) and the starting speed (according to the results of 10 m and 30 m running from the high start), significantly improved by 0,7 %, 5,43 % and 2,27 % respectively.

The advantages of application of the endogenous-hypoxic breathing technique in the educational and training process of the qualified field hockey players are also proved by the fact that after 24 weeks in the athletes of the main group it was observed an acceleration of recovery of the heart rate and blood pressure after performing physical work with a power in 1W and 2W per 1 kg of body weight on a cycloergometer.

Discussion

Analysis and generalization of the scientific and methodical literature on the subject of research convincingly testify to the applicability of special means which would improve the efficiency of physical training by creating in the body additional (irrelevant to "hypoxia of physical activity") state of hypercapnic hypoxia. The endogenous-hypoxic breathing technique is considered to be Safe, accessible and effective, as it makes it possible to create in the body a state of moderate hypoxia and pronounced hypercapnia in the normobaric conditions. The application of this technique in the educational and training process produces a positive impact on the physical fitness of athletes, accelerates the recovery processes, increasing the effectiveness of physical training.

In the qualified field hockey players, the level of aerobic performance, according to criteria of Ya. P. Piarnat (1983), is "lower than the mediocre". In this regard, in the process of physical training should be used exercises that stimulate aerobic and anaerobic (Lactate) energy supply processes. In training, it is also advisable to use exercises that increase the body's ability to resist hypoxia. This is evidenced by the results of the hypoxic functional Genchi test, which turned out to be lower than the established values for athletes by 19,3 %. Lungs ventilation in the qualified field hockey players meets the norm. The vital capacity of the lungs is $4,57 \pm 0,11$ l, the maximum ventilation of the lungs is $168,93 \pm 7,42$ l. Passage of air through the bronchial tubes of large, medium and small diameters according to the indicators IVV25 ($7,08 \pm 0,09$ l / s), IVV50 ($5,90 \pm 0,12$ l / s), IVV75 ($3,26 \pm 0,11$ l / s) and AVV25-75 ($4,26 \pm 0,10$ l / s) corresponds to the norm. The functional state of the cardiovascular system of qualified athletes meets the norm on the parameters of the type of reaction of the cardiovascular system to the dosed physical exertion and the period of restoration of the heart rate after their cessation. The type of response of blood vessels for arterial pressure to the dosed physical exercise in 94,73 % of the examined athletes was normotonic. The recovery time of the heart rate after working with a power of 1 W per 1 kg of body weight is two minutes, and after working with a power of 2W per 1 kg of body weight - three minutes. General and special physical preparedness of the qualified field hockey players for the tests of the program for the Children's and Youth Sports Schools, Olympic Reserve Junior Sports Schools, School of Higher Sportsmanship and Olympic Reserve schools which characterize the starting speed, explosive force in the conditions of performance of dynamic work, special endurance in conditions of providing muscular work at the expense of lactate processes of energy supply corresponds to the norm. The result of a standing long jump is $2,43 \pm 0,14$ m, a run of 30 m from a high start - $4,24 \pm 0,18$ s, a shuttle run of 180 m - $38,16 \pm 0,38$ s, five-fold jump on two legs - $12,11 \pm 0,17$ m.

There was elaborated the "itinerary list" for the application of the endogenous-hypoxic breathing technique with the use of the "Endogenik-01" apparatus for the qualified field hockey players, aimed at the improvement of the physical fitness of athletes, increase the functionality of the respiratory muscles, the ability of the bronchi to pass air in the exhalation phase, the resistance to hypoxia in a state of relative muscle rest. This technique was used before the preparatory part of each training session for 24 weeks.

Training sessions under the program for Children's and Youth Sports Schools, Olympic Reserve Junior Sports Schools, School of Higher Sportsmanship and Olympic Reserve schools with and without the application of the endogenous-hypoxic breathing technique contribute to improving the physical fitness of the qualified field hockey players. The athletes of the control and main groups during the preparatory and competitive periods of the annual macrocycle (24 weeks) significantly increased by 4,98 % and 6,37 % the average values of total endurance, by 2,06 % and 2,46 % - explosive strength, strength endurance of the muscles of the shoulder girdle - by 8,06 % and 12,55 % in the test "flexion and extension of arms in front lying support on the floor for 1 min" and by 15,59 % and 19,58 % - according to the test "pulling on the crossbar for 1 min". In athletes, in the training sessions with application of the endogenous-hypoxic breathing technique, there were significantly improved the indicators of special physical preparedness based on the results of running 10 m (4,37 %) and 30 m (1,66 %) from high start, and shuttle running 180 m (0,7 %). In hockey players, they did not apply the methods of "endogenous-hypoxic breathing", in contrast to the sportsmen of the main group, only the result of the test "10 m from high start" (by 3,21 %, $p < 0,05$) was improved.

Training sessions under the program for Children's and Youth Sports Schools, Olympic Reserve Junior Sports Schools, School of Higher Sportsmanship and Olympic Reserve schools contributed to the improvement of the function of the respiratory muscles, as evidenced by an increase in the volume parameters of the apparatus of external respiration. In athletes of the control group, the vital capacity of the lungs increased by 10,14 %, and in the athletes of the main one - by 7,48 %, the inspiratory reserve volume - by 6,60 % and 8,02 %, the expiratory reserve volume - by 16,45 % and 6,08 %, vital capacity of lungs on inhalation - by 6,73 % and 7,47 %, the vital capacity of the lungs on exhalation - by 13,51 % and 7,87 %, maximum lung ventilation - by 10,09 % and 8,46 % respectively. Unlike the athletes of the control group, the field hockey players of the main group also increased the average values of the speed indicators of the function of external respiration. The average value of the forced vital capacity of the lungs increased by 4,45 % ($p < 0,05$), the volume of the forced inspiration for the first second - by 4,92 % ($p < 0,05$), the instantaneous volume velocity at the level of the middle bronchi - by 1,32 % ($p < 0,05$), which indicates an improvement in airflow in the area of bronchus of medium diameter.

The results of our research give grounds to assert that the improvement of physical and functional preparedness of the field hockey players at the age of 19-21 is possible not only due to the volume of performed work, but also due to enhancing adaptive capacity to hypoxia and hypercapnia by means of application of the endogenous-hypoxic breathing technique according to the elaborated "itinerary list" with the "Endogenik-01" apparatus.

Conclusions

The application of the endogenous-hypoxic breathing technique in the training process of the qualified field hockey players during 24 weeks according to the elaborated "itinerary list" improves the functional fitness

of athletes. After 8 weeks, the average value of TAM significantly increased (by 4,66 %), and it indicates an improvement in the capacity of the aerobic energy supply processes. The athletes who did not use the endogenous-hypoxic breathing technique in their training sessions increased the mentioned indicator in 16 weeks. In the qualified field hockey players of the main group, 16-week trainings contributed to a significant increase in the capacity of aerobic energy supply processes in terms of VO_2 max by 5,59 %, and in athletes of the control group - by 5,17 %. The threshold of anaerobic metabolism during this period of trainings in the athletes of control group significantly increased by 12,61 %, and in athletes of the main group - by 15,68 %. It should be noted that athletes who applied in their training sessions the endogenous-hypoxic breathing technique, in contrast to the field hockey players of the control group, the level of aerobic performance according to Ya. P. Piarnat (1983) rose from "the lower than mediocre" to "mediocre". At the same time, the capacity of anaerobic alactic and lactate energy supply processes increased by 14,19 % ($p < 0,05$) and 7.52 % ($p < 0,05$), respectively, and the capacity of anaerobic lactate energy supply processes increased by 4,32 % ($p < 0,05$).

The tolerance to hypoxia in the state of relative muscle rest increased in the athletes of the control and main groups in the training process. However, training with the application of the endogenous-hypoxic breathing technique produced more effective impact on the body's ability to resist hypoxia. In 24 weeks from the beginning of the formative experiment, the field hockey players of the main group, in contrast to the athletes of the control group, increased the time of the breath-holding during exhalation (by 12,54 %), that indicates an increase of the sensitivity threshold for hypoxia and hypercapnia. In athletes of the main group, the breath holding time during exhalation (Genchi test) increased significantly after 16 weeks (by 15,81 %), while in the field hockey players of the control group, a significant increase of this indicator was registered in 24 weeks (by 18,25 %). The acceleration of restoration of cardiovascular function after the dose form of physical exertion is also the evidence of the positive impact of training sessions with application of the endogenous-hypoxic breathing technique.

References

- Bohuslavska V., Furman Y., Pityn M., Galan Y., Nakonechnyi I. (2017). Improvement of the physical preparedness of canoe oarsmen by applying different modes of training loads. *Journal of Physical Education and Sport*, 17 (2), 797-803. DOI:10.7752/jpes.2017.02121
- Briskin Y., Pityn M., Tyshchenko V. (2016) Dynamics of changes in the functional state of qualified handballers during macrocycle. *Journal of Physical Education and Sport*, 16 (1), 46-49. DOI:10.7752/jpes.2016.01008
- Briskin Y., Ostrovs'kyy M., Chaplins'kyy M., Sydorko O., Polehoiko M., Ostrovs'ka N., Pityn M. (2015) Features of the development of physical qualities of water polo players. *Journal of Physical Education and Sport*, 15 (3), 543-550. DOI:10.7752/jpes.2015.03082
- Briskin Y., Pityn M., Antonov S. (2011) Indicators of special training of highly skilled archers in pre mesocycle. *Journal of Physical Education and Sport*, 11 (3), 336-341.
- Briskin Y., Semeryak Z., Pityn M. Vaulin O. (2016) Qualified women epee fencers technical and tactical training using of highly qualified sportsmen model indicators. *Journal of Physical Education and Sport*, 16 (2), 534-539. DOI:10.7752/jpes.2016.02084
- Briskin Y., Todorova V., Perederiy A., Pityn M. (2016) Comparative analysis of choreographic training of athletes from foreign and Ukrainian sport aerobics teams. *Journal of Physical Education and Sport*, 16 (4), 1352-1356. DOI:10.7752/jpes.2016.04216
- Choszcz, D., Podstawski, R., Konopka, S. (2012). Modeling of anthropometric determinants of rowing ergometer performance on a distance of 500 meters for physically inactive males. *Journal of Physical Education and Sport*, 12 (3), 274-283. DOI:10.7752/jpes.2012.03042
- Galan Y., Soverda I., Zoriy Y., Briskin Y., & Pityn, M. (2017). Designing an effective approach to sport for the integration in higher education institutions (the effects of yoga practice). *Journal of Physical Education and Sport*, 17 Supplement issue 2, 509-518. doi:10.7752/jpes.2017.s2077
- Galan Y., Zoriy Y., Briskin Y., Pityn M. (2016) Orienteering to optimize the psychophysical wellbeing of young teens (13 to 14-year-old). *Journal of Physical Education and Sport*, 16 (3), 914-920. DOI:10.7752/jpes.2016.03144
- Gorshova I., Bohuslavska V., Furman Y., Galan Y., Nakonechnyi I., Pityn M. (2017). Improvement of adolescents adaptation to the adverse meteorological situation by means of physical education. *Journal of Physical Education and Sport*, 17 (2), 892-898. DOI:10.7752/jpes.2017.02136
- Guo P. (2007) Improvement components, special endurance in the dam kayaking and canoe. *Theory and methods of physical education and sport*, 3, 21-29.
- Guo P. (2008) Factors Improvement of opportunities of power dams on the athletes in canoe. *Theory and methods of physical education and sport*, 3, 3-9
- Hruzevych I., Bohuslavska V., Kropta R., Galan Y., Nakonechnyi I., Pityn M. (2017). The effectiveness of the endogenous-hypoxic breathing in the physical training of skilled swimmers. *Journal of Physical Education and Sport*, 17, Supplement issue 3, 1009-1016. DOI:10.7752/jpes.2017.s3155

- Ivashchenko O., Yarmak O., Galan Y., Nakonechnyi I., & Zoriy Y. (2017). Leadership as a fundamental aspect of the performance of student-athletes in university men's sports teams. *Journal of Physical Education and Sport*, 17, Supplement issue 2, 472-480. DOI:10.7752/jpes.2017.s2071
- Kerr R.M., Spinks W., Leicht A.S. et al, (2008) Predictors of 1000 m outrigger canoeing performance. *Int J Sports Med*, 29, 675-678.
- Khimenes K., Lynets M., Briskin Y., Pityn M., Galan M. (2016) Improvement of sportsmen physical fitness during previous basic training (based on sport orienteering material). *Journal of Physical Education and Sport*, 16 (2), 392-396. DOI:10.7752/jpes.2016.02061
- Kozina Z., Prusik K., Görner K., Sobko I., Repko O., Bazilyuk T., Kostiukevych V., Goncharenko V., Galan Y., Goncharenko O., Korol S., Korol S. (2017). Comparative characteristics of psychophysiological indicators in the representatives of cyclic and game sports. *Journal of Physical Education and Sport*, 17 (2), 648-655. DOI:10.7752/jpes.2017.02097
- Piarnat Ya. P. (1983). Age and gender standards (10-50 years) of aerobic ability of a person: Author's Abstract. Dis ... Dr. Habil. of Med. Sciences: [special.] 03.00.13 "Physiology of Man and Animals" 44.
- Pityn M., Briskin Y., Perederiy A., Galan Y., Tsyhykalo O., Popova I. (2017). Sport specialists attitude to structure and contents of theoretical preparation in sport. *Journal of Physical Education and Sport*, 17, Supplement issue 3, 988-994. DOI:10.7752/jpes.2017.s3152
- Sulyma A.S. (2013). Prospects for applying the technique of creating a state of normobaric hypercapnic hypoxia in the systemic training of the field hockey players. *Physical Culture, Sport and Health of the Nation*, 15, 499-503.
- Sulyma A.S. (2014). Features of the functional preparedness of field hockey players at the stage of maximum realization of individual opportunities. *Young Sports Science of Ukraine* 18 (3), 202-207.
- Sulyma A.S. (2017). Improvement of physical fitness of the qualified field hockey players by applying the technique of the endogenous-hypoxic breathing: Author's Abstract of Dis. ... Cand. of Sciences in Physical Education and Sports, 24.00.01 *Olympic and Professional Sport*, Lviv State University of Physical Culture, 19.
- Sulyma A.S. Furman Y.M. (2014). The application of the endogenous-hypoxic breathing technique in the system of training of the qualified field hockey players for enhancing of the anaerobic energy supply processes. *Physical Culture, Sport and Health of the Nation*, 18 (2), 205-210.