

## Combined application of aquafitness and the endogenous-hypoxic breathing technique for the improvement of physical condition of 30-49-year-old women

SVITLANA SALNYKOVA<sup>1</sup>, IRYNA HRUZEVYCH<sup>2</sup>, VIKTORIIA BOHUSLAVSKA<sup>2,3</sup>, IHOR NAKONECHNYI<sup>4</sup>, OKSANA KYSELYTSIA<sup>4</sup>, MARYAN PITYN<sup>3</sup>

<sup>1</sup> Svitlana Salnykova, Vinnitsia trade and economic institute, Vinnitsia, UKRAINE

<sup>2</sup> Vinnitsia State Mykhailo Kotsyubynskyi Pedagogical University, Vinnitsia, UKRAINE

<sup>3</sup> Lviv State University of Physical Culture, Lviv, UKRAINE

<sup>4</sup> Yuriy Fedkovych Chernivtsi National University, Chernivtsi, UKRAINE

Published online: December 30, 2017

(Accepted for publication December 08, 2017)

DOI:10.7752/jpes.2017.04288

### Abstract:

The article deals with the question of perfection of physical condition of 30-49 years-old women by means of combined application of aquafitness and the endogenous-hypoxic breathing technique.

During a long-term study it was established that in women in the period from 30 to 49 years, the ratio of the components that make up the body weight varies. In 37-49 year-old women, the fat content is 12.60% ( $p < 0.05$ ) higher than the content of this component in women aged 30-36 years. At the same time, the content of the muscle component in women of the older age group is lower by 7.78% ( $p < 0.05$ ) than in younger women. In 37-49 year-old women body weight and body mass index are higher by 13.18% and 10.98% ( $p < 0.05$ ) respectively, than in 30-36 years-old women. The application of the endogenous-hypoxic breathing technique during aquafitness training increases the effectiveness of their positive impact on aerobic productivity of the body, the function of respiratory and cardiovascular systems, and the ability of the body to withstand hypoxia in relative muscular resting state, that is confirmed by a reliable difference between the values of control and main groups.

**Key words:** aquafitness, endogenous-hypoxic breathing, physical condition.

### Introduction

The problem of health preservation and disease prevention at all stages of social and economic development of the society attracted the attention of scientists, stimulating the search of new health-improving technologies, the application of which contributed to the improvement of the physical condition of people of different ages and gender (Briskin, 2016; ). The defining component of such technologies is various means of physical education (Briskin, 2011, 2016; Galan, 2017; Yarmak, 2017). At the same time, diminishing of motion activity contributes to a premature reduction of the body's functional reserves, which leads to an increase in the incidence rate. (Briskin, 2015; Andrieieva, 2017; Galan, 2017).

According to the data of Concept of the National Program "HEALTH 2020: Ukrainian Dimension" (2011), almost 60% of the adult population of Ukraine have an unsatisfactory state of health. According to scientific information, the level of physical health of men in terms of maximum oxygen consumption ( $VO_{2max}$ ), as well as life expectancy is lower than that of female representatives. On the other hand, according to data of researchers, the incidence rate of Ukrainian women is 12% higher than that of men, it affects the quality of life, in particular, leads to a decrease in physical and mental performance, reproductive function, the emergence of psychological problems (Romanchyshyn, 2015; Khimenes, 2016; ). In addition, the average life expectancy of Ukrainian women is significantly lower than that of women in developed countries. Most scientists believe that the main reason for this phenomenon is the limited physical activity of women (Salnykova, 2014).

Therefore, a promising and economically- viable way to overcome this shortcoming is the introduction of innovative technologies of physical education in the everyday life of female people.

Each age period of a person, depending on gender, is characterized by a specific restructuring of the organism. In particular, in women after 30 years in the body there are changes, indicated by a decrease in the level of functionality, indicators of physical development, as well as the ability to exercise physical qualities.

The problem of preservation and improvement of the physical health of women after 30 years is determined by the further intensification of professional, creative, social activities, as well as the need to increase their life expectancy and the preservation of a full reproductive function till the beginning of the menopausal period. According to leading experts, it is advisable for women, starting from the age of 30, to use such means of physical education that would improve the physical state by stimulating aerobic energy supply processes, increasing the energy cost of physical work, reducing of the gravitational impact on cartilaginous joints, and conditioning.

In particular, aquafitness can be considered as such means of recovery, which is characterized by a wide range of activities: health, therapeutic-prophylactic, recreational, conditioning, training and sports-oriented direction. There are a number of scientific papers on the methods of using aquafitness in the health-training process of various groups of the population in order to improve their physical condition (Guo, 2007; Sulyma, 2017, Yarmak, 2017). However, specific guidelines for the use of this means of health-promoting activities when working with 30-49 year-old women are absent.

It is noteworthy that in the practice of physical education, certain means are used that enhance the effectiveness of the health-improving impact of physical exercises. In particular, in order to improve the function of the cardiorespiratory system, improve the motor qualities and even with a therapeutic purpose in the physical education of different population groups, a special technique of creating in organism of hypoxic state with the help of the "Endogenik-01" apparatus is being used in recent years. Thus, the results of studies conducted by Ukrainian scientists testify about the successful application of the endogenous-hypoxic breathing technique in combination with physical exercises, which affected the improvement of the functional condition of young oarsmen (Guo, 2008; Kerr, 2008; Boguslavskaya, 2017), swimmers (Salnykova, 2015; Hruzevych, 2017), and in various weather conditions (Gorshova, 2009, 2017).

At the same time, there is no scientifically substantiated information on the possibilities of application of the endogenous-hypoxic breathing technique when working with persons engaged in aquafitness, this fact determined the choice of the research topic.

### **Materials and methods**

For the purpose of solving problems, methods of theoretical analysis and generalization of scientific information on the research problem were used, as well as pedagogical methods (observation, summative and formative experiment), physical fitness testing, physiological methods, and methods of mathematical statistics.

Physical fitness was studied using tests that characterize such physical qualities: the strength of the flexor muscles of the fingers of the right and left hands (using a wrist dynamometer), speed (running at 30 m race from a high start), the explosive strength (standing long jump), agility ("shuttle race" 4 × 9 m with the transfer of cubes), the dynamic strength endurance of the muscles of the shoulder girdle (based on the test on push-up practice - flexion and extension of arms in front lying support on the gym bench), the dynamic strength endurance of the muscles of the lower extremities (flexion-extension of the legs, holding hands on the back of the chair), the speed-strength endurance of muscles of the abdominal muscles (flexion-extension of the legs at the maximum tempo for 15 seconds, lying on the back on the gym bench), the static strength endurance of the muscles of the back and neck (maximum lift above the couch of slightly extended straight arms and legs from the prone position), the static strength endurance of the gluteus muscles (lying on in the prone position with the maximum raised over the couch, extended by 10° and bent at the knee joints at a 45-degree angle, legs, holding hands by the couch), the dorsal spine flexibility (bending forward from the position standing on a 30 cm-high stair, touching the markers of the measuring device), general endurance (Cooper 12-minute freestyle swim test).

For the purpose of determining body weight, body mass index (BMI) and body composition, namely fat and muscle components, the bioelectrical impedance method using the OMRON BF511 unit was applied.

The capability of the aerobic energy supply processes was determined by the maximum oxygen consumption ( $VO_{2max}$ ), which was calculated from the value of physical performance obtained with the bicycle ergometric test PWC<sub>170</sub> (V.L. Karpman et al., 1988). To measure the capability of aerobic energy supply processes, the indicator of the threshold of anaerobic metabolism (TAM) was used, which was determined with the help of the test proposed by a group of scientists led by F. Conconi (1982) and modified by Yu.M. Furman (2013) (Gorshova, 2009; Salnykova, 2014; Hruzevych, 2017; Sulyma, 2017). The function of external respiration was assessed according to the results of computer spirometry with the analysis of the "flow-volume" loop, which was performed with the help of the Spirograph "CARDIO SPIRO". In order to study the recovery of heart rate (HR) after metered exercise on a cycle ergometer, the method of pulsometry was used, using the heart rate monitor "Beurer PM 70"; in the study of the dynamics of recovery of blood pressure, sphygmomanometry "LD-91" was used. The ability of women to withstand hypoxia in a state of relative muscle rest was assessed by functional tests with a breath holding (Shtange and Genchi).

The received scientific materials were processed by methods of the mathematical statistics which consisted in comparison of the connected samples; the probability of a difference between the average arithmetic values was determined according to Student's t-criterion

Research work was carried out in the laboratory of the Department of Medical and Biological Principles of Physical Education and Physical Rehabilitation of Vinnytsia State Mykhailo Kotsiubynskyi Pedagogical University and on the basis of Sports Complex "Avangard" of the LLC "League "Olympic Reserves" in the city of Vinnytsia.

### **Results**

The analysis of scientific and methodological literature has shown that so far there are no systematized scientific and methodological recommendations on the complex combination of such a means of physical

education as aquafitness and breathing with a gas mixture depleted in oxygen and enriched with carbon dioxide under conditions close to the health-training process.

It is established that in women in the age range from 30 to 49 years, the dynamics of decrease in physical qualities is observed. In 37-49 year-old women, compared with 30-36 year-old, the rates of speed abilities (by 7.30 %), explosive strength (by 11.94 %), the dynamic strength endurance of the muscles of the lower extremities (by 42.41 %) were significantly lower; the speed-strength endurance of the abdominal muscles (by 13.88 %), the static strength endurance of the muscles of the back and neck (by 34.37 %) and gluteal muscles (by 22.14 %). It should be noted that in women of the older age group, compared with the younger, the indices of active spine flexibility and dynamic strength endurance of the muscles of the shoulder girdle were lower in 2.16 and 2.13 times, respectively.

The results of the summative experiment testify that in the age period from 30 to 49 years the aerobic capacity of the body is regulated by the content of fat and muscle components. At the same time, the level of aerobic capacity of the body according to Ya.P. Piarnat in 30-36 year-old women – “good”, while in 37-49 year-old women – “mediocre”. The functionality of the respiratory muscles in 30-36 year-old women was higher than in 37-49 year-old women, as evidenced by the difference between such volume indicators of external respiration as maximum lung ventilation (MLV) and vital capacity of the lungs (VC). In women aged 30-36 years MLV is higher by 9.02% ( $p < 0.05$ ), and VC - by 9.83% ( $p < 0.05$ ) than in 37-49 year-old women. In the period from 30 to 49 years, the ability of large and medium bronchi to pass through the air in the exhalation phase, gradually decreases, as evidenced by a significant decrease in the forced vital capacity of the lungs (FVC) by 6.43 %, the forced expiratory volume in the first second (FEV1) by 13.73 %, instantaneous air volume velocity at the level of main bronchi (IVV<sub>25</sub>) by 4.26 %, instantaneous air volume velocity at the level of middle bronchi (IVV<sub>50</sub>) by 9.58 %.

The worsening with the age of the ability of women's body to adapt to hypoxia in a state of relative muscle rest is indicated in women aged 37-49 years compared with 30-36 year-old women by a decrease of breath holding time on inspiration and on exhalation by 31.21 % and 26.80 % ( $p < 0.05$ ), respectively. It was found that in women aged 37- 49years the fat content is 12.60 % higher than in the case of 30- 36 year-old women, while the content of the muscular component is 7.78 % ( $p < 0.05$ ) less. Body weight and BMI in the older age group is higher than in the younger age group by 13.18 % and by 10.98 % ( $p < 0.05$ ), respectively.

During the development of the programs, we were guided by the basic principles and provisions of the theory and methodology of physical education of the adult population, as well as by the recommendations of the leading aquafitness specialists (Briskin, 2015). In order to prevent the risk of negative impact of exercises in the water on the functional state of women, the loads were given in consideration of the age factor and the level of physical and functional preparedness.

Exercises in complexes for development of strength endurance were performed in series (3-8 series), in repeated and interval methods, with emphasis on the work of separate muscle groups. The duration of each exercise was 60-90 seconds. The heart rate during the implementation of such complexes reached the level of 115-125 beats per minute in women 30-36 years old and 105-115 beats per minute in 37- 49 year-old. In the complexes for the development of general endurance, the exercises were carried out continuously, they were characterized by the simultaneous work of large muscle groups (legs, abdominals, shoulder girdles); the character of some exercises was cyclic (walking, running, swimming) and acyclic (jumping, dance elements). Heart rate during the performance of such exercises grew to 130-140 beats per minute in 30-36 year-old women, and to 120-130 beat per minute in women aged 37-49 years. Calculation of the range of heart rate during trainings in water was carried out taking into account the information of scientists to reduce this indicator from 7-8 beats per minute to 17-18 beats per minute, depending on the level of immersion (Salnykova, 2014, 2015; Sulyma, 2017;).

The cycle of aquafitness trainings provided for the health-promoting activities for women of all groups for 42 weeks (from September to June), consisted of preparatory, basic and supportive periods. During the 4 weeks in the preparatory period, twice a week, all subjects performed work aimed at developing strength endurance, and once a week - total endurance. Under such conditions, the advantage of training aimed at the development of strength endurance contributed to the gradual adaptation of the organism to physical loads of greater volume and intensity in the basic and supporting periods.

The difference between the proposed programs was the duration of the basic period of the 42-week cycle (in women aged 30-36 years - 12 weeks, and in 37-49 year-old women - 20 weeks), as well as the ratio of training to develop strength and general endurance in week micro cycle (Table 1).

Particular attention was paid to the individual ability of women to carry loads in different phases of the ovarian menstrual cycle (OMC). During the I and III phases (menstruation and ovulation), which are characterized by a decrease in physical performance, women performed exercises aimed at developing flexibility and improving the technique of movements performing. The II and IV phase of OMC (postmenstrual and post ovulation) are characterized by high physical performance, so during this period, women performed exercises that promote the development of muscle strength, speed and endurance. Gradual increase in the number of trainings for the development of general endurance by reducing training aimed at increasing strength endurance

was taking place against the background of improving the aerobic productivity of the women's organism that participated in the formative experiment. At the same time, during the aquafitness trainings in order to develop strength endurance, as well as to improve the coordination abilities and flexibility, the load increased not owing to the duration of these exercises, but owing to the introduction of the circular training method in the basic and supporting periods.

Table 1. Structure of the 42-week cycle of aquafitness training for women aged 30-49 years

Age, years	Groups	Period of trainings	Duration of the periods, weeks	Trainings' targeting	Duration of trainings	
					In the year cycle, hours	In the week micro cycle, Number of trainings x minute
30-36	CG1, MG1	preparatory	4	Development of the strength endurance	6	2×45
				Development of the general endurance	3	1×45
		basic	12	Development of the strength endurance	9	1×45
				Development of the general endurance	18	2×45
		supporting	26	Development of the strength endurance	19.5	1×45
				Development of the general endurance	39	2×45
37-49	CG2, MG2	preparatory	4	Development of the strength endurance	6	2×45
				Development of the general endurance	3	1×45
		basic	I micro cycle 2	Development of the strength endurance	18	2×45
				Development of the general endurance	9	1×45
			I micro cycle 8	Development of the strength endurance	6	1×45
				Development of the general endurance	12	2×45
		supporting	18	Development of the strength endurance	13.5	1×45
				Development of the general endurance	27	2×45

In addition, the intensity of the physical load was gradually brought up by increasing the pace of doing exercises, the number of exercises aimed at developing general endurance, the coordination complexity of exercises, increasing the amplitude of movements, provided that the pace did not decrease. Exercises performance was also complicated by additional equipment (aqua belts, gloves, dumbbells, noodles, boots, rubber shock absorbers, swimming boards). It is worth noting that during the experiment, the dynamics of growth of the volume of physical exertion was somewhat ahead of the dynamics of the intensity of the exercises performance.

In order to maintain the training effect in the supporting period, which lasted 26 weeks in women aged 30-36 years, and 18 weeks – in women aged 37-49 years, the intensity, volume and targeting of aquafitness trainings also varied according to the age and physical condition of the subjects.

The structure of training session for women of all studied groups traditionally consisted of three parts: preparatory, basic and final.

During the preparatory part (5-7 minutes) general development exercises with a large amplitude of movements in the joints (dynamic stretching) were performed. In the main part (25-35 minutes), women performed exercises for all muscle groups, consistently solving the specific tasks of each particular training session.

In the workouts on development of strength endurance, the duration of the aerobic exercise series was 5-10 minutes, and of the strength developing exercises - 20-25 minutes. During the sessions aimed at developing general endurance, the performance of aerobic series of exercises lasted 20-25 minutes, and the strength developing activities lasted 5-10 minutes. In the main part of the training session between the series of special exercises water waves were used (high-speed movements along the whole area of the basin by step, jogging, jumping, and various methods of swimming). In the final part of the training session, which lasted 7-10 minutes, there were performed exercise to relax and actively stretch the muscles at a slow pace, which contributed to the gradual recovery of the heart rate.

The endogenous-hypoxic breathing technique with using the “Endogenik-01” breathing apparatus was applicate by women of the main groups at the beginning of each training session for 24 weeks according to the “Itinerary List”. During the inhalation and exhalation, the resistance of the passage of air through the apparatus increased, activating the work of the respiratory muscles, increasing their functional capabilities. The increase in the time of the slow exhalation promoted the formation of the economic stereotype of breathing. At the same time, breathing a hypercapnic gas mixture, which, according to the authors of the device (Gorshova, 2009; Hruzevych, 2017; Sulyma, 2017) contains 3-4 % CO<sub>2</sub> and 17-18 % O<sub>2</sub>, positively affects the vascular and Broncho motor tone.

The evaluation of physical fitness at the end of the formative study showed that regardless of the programs used, in women aged 30-49 years of all groups, it was observed significant improvement of the parameters of the explosive strength, the dorsal spine flexibility, the dynamic strength endurance of the muscles

of the lower limbs, the speed-strength endurance of abdominal muscles, the static strength endurance of muscles of the back, neck and gluteus muscles, as well as general endurance. The difference in the influence of aquafitness training sessions without and with application of the endogenous-hypoxic breathing technique was manifested by the differing degrees of increase in distance that women swam in 12 minutes, as well as the acceleration of this result in favour of the main groups. So, in 24 weeks from the beginning of the study, the results of the K. Cooper test significantly improved in women of the control groups by 37.25 % (CG1) and 28.47 % (CG2), and in the representatives of main groups - by 58.79 % (MG1) and 37.93 % (MG2).

Regardless of the applicate program, aquafitness training practices contributed to increasing aerobic possibilities of the body in terms of power ( $VO_{2max}$ ) and capacity (TAM) of aerobic energy supply processes. At the same time, in women aged 30 to 36 such positive changes occurred earlier than in 37- 49 year-old women.

In the women of the group CG1 in, the influence of the aquafitness practices after 24 weeks, the absolute and relative values of the maximum oxygen consumption ( $VO_{2max}$ ) increased by 8.24 % and 15.83 % ( $p < 0.05$ ), the threshold of anaerobic metabolism (TAM) - by 19.68 % and 27.46 % ( $p < 0.05$ ), respectively. In women of group CG 2, the absolute and relative values of  $VO_{2max}$  in the final stage of the study exceeded the baseline values by 4.65 % and 11.32 %, TAM - by 16.60 % and 24.11 % ( $p < 0.05$ ), respectively. For 24 weeks of complex application of aquafitness trainings and the endogenous-hypoxic breathing techniques, the average absolute and relative values of  $VO_{2max}$  in women of the MG1 group significantly exceeded the baseline data by 13.56 % and 20.81 %, the TAM - by 28.81 % and 36.33 %, respectively. In the representatives of group of CG2, the absolute value of  $VO_{2max}$  exceeded the initial data by 11.62 %, the relative value - by 19.80 % ( $p < 0.05$ ), the indicator of TAM - by 28.14 % and 37.62 % ( $p < 0.05$ ) respectively (Figure 1).

Under the influence of aquafitness practices in 24 weeks after the beginning of the study, the women of groups CG1 and CG2 underwent probable changes in such volume parameters of external respiration as the ratio of the maximum ventilation of the lungs to the respiratory minute volume (MVL /RMV) by 11.5 9% and 9.44 %, inspiratory reserve volume (IRV) - by 4.19 % and 3.18 %, the expiratory reserve volume (ERV) - by 3.47 % and 2.90 %, the inspiratory vital capacity (IVC) - by 4, 26 % and 5.14 %, the expiratory vital capacity (EVC) - by 3.77 % and 4.08 %, respectively.

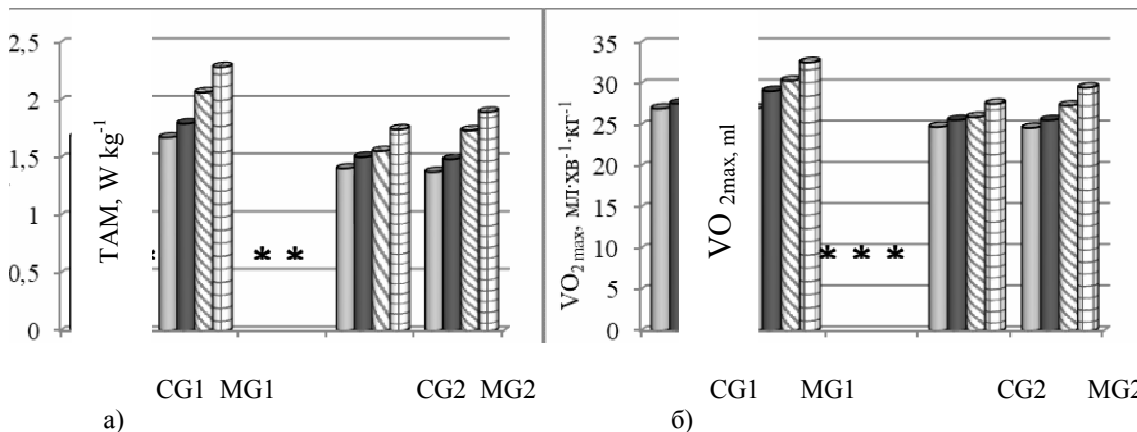


Fig. 1 Dynamics of indicators of aerobic productivity in women aged 30-49 years under the influence of the trainings:

a) - maximum oxygen consumption; b) threshold of anaerobic metabolism;

CG1 - women of the first control group; MG1 - women of the first main group;  
CG2 - women of the second control group; MG2 - women of the second main group;

□ – before the beginning of the trainings; □ – 16 weeks from the beginning of the trainings;  
■ – 8 weeks from the beginning of the trainings; ▨ – 24 weeks from the beginning of the trainings;

\* – statistically significant differences with respect to the initial data;

The application of the endogenous-hypoxic breathing technique in the training sessions promoted an increase in the effectiveness of their influence on the function of the apparatus of external respiration.

In particular, in the representatives of groups MG1 and MG2 in 24 weeks after the beginning of the trainings, the abovementioned indicators increased to a greater extent, namely, the MVL /RMV ratio increased by 25.78 % and 19.79 %, IRV by 4.79 % and 5, 16 %, ERV - by 6.21 % and 5.11 %, IVC – by 7.33 % and 7.01 %, EVC – by 7.58 % and 7.69 %, respectively. In the representatives of the main groups, in contrast to the women of the control groups, statistically significant changes in the speed indicators of the external respiration apparatus also showed the improvement of bronchial permeability in various parts of the bronchi (Table 2).

It was found that in 24 weeks after the beginning of the training sessions, the indicators of functional tests of Shtange and Genchi significantly increased in the representatives of both control groups and main groups compared to baseline data. In women of group CG1, under the influence of aquafitness practices, the breath holding time at inhalation significantly increased by 48.42 %, and at exhalation - by 39.79 %. In the representatives of the group CG 2, these parameters exceeded the initial values by 70.92 % and 45.10 % ( $p < 0.05$ ), respectively. A more significant increase in the abovementioned indices in women of the main groups emphasizes the expediency of the application of the endogenous-hypoxic breathing technique in aquafitness training sessions. Thus, the average values of the Shtange test rates in the women of the MG1 group increased significantly by 95.83 %, and in the MG2 group - by 93.91 %. Compared to the initial data, the average values of the Genchi test rates in women of the first and second main groups increased by 92.74 % and 89.72 % ( $p < 0.05$ ), respectively.

Table 2. Influence of aquafitness trainings on the speed rates of the external respiration of women aged 30-49 years of main groups at different stages of the study

Indicators	Group	Average amount, $\bar{x} \pm S$			
		Before the beginning	In 8 weeks	In 16 weeks	In 24 weeks
FVC, l	MG 1 (n=20)	2.89±0.04	2.91±0.04	3.07±0.05*	3.28±0.05*
	MG 2 (n=21)	2.78±0.04	2.81±0.04	2.92±0.04*	3.13±0.03*
FEV <sub>1</sub> , l	MG 1 (n=20)	2.08±0.05	2.12±0.04	2.28±0.04*	2.31±0.04*
	MG 2 (n=21)	1.99±0.03	2.01±0.03	2.09±0.03*	2.26±0.02*
PBEV, l sec <sup>-1</sup>	MG 1 (n=20)	6.39±0.13	6.50±0.11	6.84±0.09*	7.26±0.20*
	MG 2 (n=21)	6.35±0.05	6.39±0.05	6.49±0.05*	6.50±0.04*
IVV <sub>25</sub> , l sec <sup>-1</sup>	MG 1 (n=20)	5.29±0.05	5.32±0.04	5.46±0.03*	5.48±0.03*
	MG 2 (n=21)	5.17±0.08	5.20±0.08	5.39±0.04*	5.42±0.02*
IVV <sub>50</sub> , l·c <sup>-1</sup>	MG 1 (n=20)	4.34±0.04	4.37±0.05	4.44±0.03	4.48±0.03*
	MG 2 (n=21)	4.08±0.04	4.09±0.04	4.14±0.04	4.20±0.03*
IVV <sub>75</sub> , l sec <sup>-1</sup>	MG 1 (n=20)	1.94±0.04	1.96±0.05	1.99±0.04	2.08±0.04*
	MG 2 (n=21)	1.95±0.02	1.96±0.02	1.99±0.01	2.01±0.02*

Notes:

1. \* – statistically significant differences with respect to the initial data;
2. MG1 – women of the first main group;
3. MG2 – women of the second main group

The positive impact of aquafitness activities on the cardiovascular system of women aged 30-49 years is indicated by a decrease in the number of persons (in all experimental groups) in which dosed work on a bicycle ergometer with a power of 0.5 W and 1 W per 1 kg of body weight caused a negative reaction of the vessels, and namely, an increase in diastolic blood pressure. In addition, in women of groups MG1 and MG2, who used the endogenous-hypoxic breathing technique, in 24 weeks from the beginning of the trainings under the proposed programs, restoring of the heart rate and blood pressure after performing such work occurred earlier than in the representatives of groups CG1, CG2.

It has been established that aquafitness health-promoting training sessions, irrespectively of the used programs, positively influenced some morphological parameters of the women studied. So, in 24 weeks from the beginning of training in women of groups CG1 and MG1, the average body weight values significantly decreased by 6.83 % and 6.34 %, while in the groups of CG 2 and MG2 - by 6.37 % and 6.82 % respectively. BMI in women of groups CG1 and MG1 decreased by 6.80 % and 6.31 % ( $p < 0.05$ ), and in the groups under study CG2 and MG2 - by 6.35 % and 6.86 % ( $p < 0.05$ ), respectively. The content of the fat component significantly decreased in women of group CG1 by 11.89 %, MG1 by 14.61 %, and in the representatives of groups CG2 and MG2 by 7.23 % and by 10.19 %, respectively. It was found the dependence of aquafitness influence on the content of the muscle mass component of the body on the age factor. In 30-36 year-old women of group CG1, this index significantly increased by 7.28 %, and in representatives of group MG1 - by 9.04 %. However, in women aged 37-49 years, there was no statistically significant difference in the content of the muscle component relative to baseline data.

## Discussion

Analysis and generalization of scientific and methodological literature on the topic of the study testify to the expediency of aquafitness training sessions to correct the physical condition of women of adulthood. To enhance the health effects of physical exercises, leading scientists recommend application of special techniques that can cause hypoxia in conditions of normal atmospheric pressure. The method of creating in the body a state of moderate hypoxia and severe hypercapnia (the endogenous-hypoxic breathing technique), is considered to be safe, accessible and effective, application of which in combination with physical exercises constructively affects the physical and functional fitness of a person.

Within the age range from 30 to 49 years, a gradual decrease in the indices of physical qualities is observed in women. In 37-49 year-old women, compared to the women aged 30-36 years, it appeared to be

significantly lower the average values of such indicators as speed (by 7.30 %), explosive strength (by 11.94 %), the dynamic strength endurance of the muscles of the lower extremities (by 42.41 %), the speed-strength endurance of the abdominal muscles (by 13.88 %), the static strength endurance of the muscles of the back and neck (by 34.37 %) and gluteus muscles (by 22.14 %). In women 37-49 years compared with 30-36 year-old women, the dorsal spine flexibility index was 2.16 times less, and the dynamic strength endurance of the muscles of the shoulder girdle was lower by 2.13 times, respectively.

In women of mature age in the period from 30 to 49 years the indicators of a functional condition get worse. It has been established that the level of aerobic productivity according to the criteria of Ya. P. Piarnat in women of 30-36 year-old is on the average "good", and in 37-49 year-old women – "mediocre". In persons aged 37-49 years, the average values of VC and MVL are significantly lower than in women aged 30-36 years by 9.02 % and 9.93 %, respectively, FVC - by 6.43 %, FEV1 by 13.73 %, IVV<sub>25</sub> - by 4.26 %, IVV<sub>50</sub> - by 9.58 %. The indicators of the Shtange and Genchi tests in women aged 37-49 years lower than in 30-36years-old women by 31.25 % and 26.80 % ( $p < 0.05$ ), respectively.

With the purpose of correcting the physical condition of mature women, it is advisable to apply aquafitness trainings under such programs that contribute to improving physical qualities, aerobic performance of the organism, increasing the functionality of the respiratory muscles and the ability of the bronchi to pass air in the exhalation phase, increase tolerance to hypoxia in a state of relative muscle rest. During the development of the aquafitness programs, the basic principles and theses of the theory and methods of physical education of the adult population were used, they ensure high efficiency of studies and, at the same time, excluded the possibility of their negative impact on the physical condition of a person. To achieve this goal, the dosing of the physical load is taken into account with regard to the age factor, as well as the level of physical and functional preparedness with gradual complication of programs from one cycle period to the next. A peculiarity of the aquafitness programs for women of 30 to 49 years of the main groups is rational and systematic application of the endogenous-hypoxic breathing technique with the use of the "Endogenik-01" apparatus. This method was applied at the beginning of each training session for 24 weeks

The evidence of the positive impact of the combined application of aquafitness training sessions and the endogenous-hypoxic breathing technique is also an acceleration of the restoration of cardiovascular function after the graduated physical exertion and a reduction in the number of persons in whom such loads cause a negative vascular response due to an increase in diastolic blood pressure.

During the research, three groups of results were obtained: those that confirmed and supplemented the existing information and completely new ones.

First of all, it was confirmed the results of research in reference to the positive impact of aquafitness trainings on the physical and functional fitness of women of mature age.

The materials of our study supplement scientific information about the expediency of creating in the body a state of moderate hypoxia and severe hypercapnia with a view to improving the function of the cardiorespiratory system of various population groups.

The significant scientific results in the work have been achieved through the development of a training program for mature women, which provides for a comprehensive application of aquafitness and the endogenous-hypoxic breathing techniques. In particular, new information is received on the peculiarities of the complex impact of aquafitness trainings with the application of the endogenous-hypoxic breathing technique on the physical state of women in the age range of 30 to 49 years.

The obtained results prove the necessity of further theoretical and experimental solution of the problem of improving the physical condition of mature women. A promising area for further research is a comprehensive analysis of the impact of the combined use of aquafitness trainings and the endogenous-hypoxic breathing technique on the physical condition of women of mature age.

## Conclusions

1. In the period from 30 to 49 years, the ratio of the components that make up the body weight varies among women. In 37-49 year-old women, the content of the fat component by 12.60 % ( $p < 0.05$ ) exceeds the content of this component in women aged 30-36 years. At the same time, the content of the muscular component in women of the older age group is lower by 7.78 % ( $p < 0.05$ ) than in younger women. Body weight and body mass index in 37-49 year-old women are higher, respectively, by 13.18 % and 10.98 % ( $p < 0.05$ ) than in the women aged 30-36 years.

2. Under the influence of aquafitness training practices in women of 30-49 years of control and main groups, the indices of explosive strength, dorsal spine flexibility, the dynamic strength endurance of the muscles of the lower extremities, the speed-strength endurance of the muscles of the abdominal muscles, the static strength endurance of muscles of the back, neck and gluteus muscles, as well as general endurance. Such exercises contributed to a significant increase in aerobic capacity by indicators characterizing capacity ( $VO_{2max}$ ) and the capacity of aerobic energy supply processes (TAM). At the same time, the level of aerobic performance according to Ya.P. Piarnat in women aged 30-36 years rose from "good" to "excellent", and in 37-49 year-old - from "mediocre" to "good". The volume indicators of external respiration, characterizing the functional

capabilities of the respiratory muscles have significantly increased, the ability of the body to withstand hypoxia has increased as well. The aquafitness trainings helped to improve the function of the cardiovascular system on the ability to recover after physical exertion. Under the influence of training practices in women aged 30-36 years and 37-49 years, the content of the fat component of body weight significantly decreased. However, a significant increase in the muscular component was registered only in women aged 30-36 years. Such changes in the body weight composition of all subjects were accompanied by a possible decrease in body weight and body mass index.

3. The expediency of the application of the endogenous-hypoxic breathing technique during aquafitness training sessions was proved by a significant increase in the index of general endurance in women of the main groups in comparison with the representatives of control groups: in 30-36 year-old women - by 16.94 %, in 37-49 years-old women - by 17,16 %.

4. The use of the endogenous-hypoxic breathing technique during aquafitness training increases the effectiveness of their positive effect on aerobic productivity of the organism, the function of the respiratory and cardiovascular systems, as well as the body's ability to withstand hypoxia in a state of relative muscle rest, which is confirmed by a significant difference between the parameters of control and main groups. In women of 30-36 years of the main group, after the completion of the formative study, the average value of the relative rate of  $VO_{2max}$  compared with the representatives of the control group was significantly higher by 4.25 %; MVL - by 13.27 %, MVL / RMV - by 13.99 %; FVC - by 9.84 %, FEV1 - by 6.47 %; the values if the indicators of Shtange functional test - by 31.11 % and Genchi functional test - by 37.48 %. In 37-49 year-old women of the main group, the relative values of  $VO_{2max}$  significantly exceeded the parameters of women in the control group by 7.10 %; MVL - by 7.88 %; MVL / RMV - by 8.45 %; FVC - by 7.47 %; FEV1 - by 7.55 %; the indicators of Shtange functional tests - by 15.01 % and Genchi test - by 30.47 %.

## References

- Andrieieva, O., Galan, Y., Hakman, A., & Holovach, I. (2017). Practicing ecological tourism in physical education of primary school age children. *Journal of Physical Education and Sport*, 17, Supplement issue 1, 7-15. DOI:10.7752/jpes.2017.s1002
- 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., 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
- Briskin Y., Ostrovs'kyi M., Chaplins'kyi 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
- 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
- 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
- Gorshova, I.A., Furman, Yu. M. (2009). Improving of adolescents adaptation to adverse meteorological through the integrated application of physical exertion of different directions. *Pedagogics, Psychology and Medical-Biological Problems of Physical Education and Sport*, 12, 48-50.
- 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 (JPES)*, 17 (Supplement issue 3), 1009-1016. doi:10.7752/jpes.2017.s3155



- 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
- Nakonechnyi I., Galan Y. (2017). Development of behavioural self-regulation of adolescents in the process of mastering martial arts. *Journal of Physical Education and Sport*, 17, Supplement issue 3, 1002-1008. DOI:10.7752/jpes.2017.s3154
- Romanchyshyn O., Briskin Y., Sydorko O., Ostrovs'kyi M. and Pityn M. (2015). Pedagogical colleges student's readiness formation for sport and recreation activity. *Journal of Physical Education and Sport*, 15 (4), 815-822. doi:10.7752/jpes.2015.04125
- Salnykova S.V. (2014). The Effect of Aquafitness and the Endogenous-Hypoxic Breathing on the Dynamics of Recovery of Cardiovascular Function in Women Aged 30-36 Years. *Young Sports Science of Ukraine*, 18 (3), 182-188.
- Salnykova S.V., Furman Yu. M. (2015). Perfection of the Processes of Aerobic Energy Supply for Women Aged 37-49 years Through the Integrated Application of Aquafitness Trainings and the Endogenous-Hypoxic Breathing Technique. *Pedagogy, Psychology and Medico-Biological Problems of Physical Education and Sports*, 7, 59-63. doi.10.15561 / 18189172.2015.0708.
- Sulyma A.S. (2017). Improvement of Physical Fitness of Qualified Field Hockey Players by Applying the Endogenous-Hypoxic Breathing Technique: Author's abstract. dis. ... Cand. Sciences in Physical Education and Sports, 24.00.01 "Olympic and Professional Sport", Lviv State University of Physical Cultures, 19 p.
- Yarmak O., Galan Y., Hakman A., Dotsyuk L., Blagii O., Teslitskyi Y. (2017). The use of modern means of health improving fitness during the process of physical education of student youth. *Journal of Physical Education and Sport*, 17 (3), 1935-1940. DOI:10.7752/jpes.2017.03189
- Yarmak O., Galan Y., Nakonechnyi I., Hakman A., Filak Y., Blahii O. (2017). Screening system of the physical condition of boys aged 15-17 years in the process of physical education. *Journal of Physical Education and Sport*, 17, Supplement issue 3, 1017-1023. DOI:10.7752/jpes.2017.s3156