Optimization of the Physical Condition of Middle-Aged Women Through Strength Fitness Technologies of Gymnastic Orientation

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Abstract: The article is devoted to the optimization of the physical condition of middle-aged women through strength fitness technologies of gymnastic orientation. According to experts, the muscle tissue of women changes with age: the number of cells decreases, the atrophy is observed, the number of fat cells and connective tissue increases, the contractility of muscle fibers reduces. The typical disease of middle-aged women is metabolic disorder and obesity. To prevent such processes it is recommended to do strength exercises, they increase muscle mass, help to develop the strength, the arteriolovenular bridge of blood supply and oxygenation of tissues, strengthen the musculoskeletal system, increase physical efficiency, metabolism, and weight loss. The aim of the research was the theoretical, methodological, and experimental substantiation of the methodology of middle-aged women`s strength fitness techniques. To achieve the aim, the authors used theoretical analysis, the synthesis of scientific and methodological literature, pedagogical experiment, methods of biomedical research, control tests, methods of mathematical statistics. The results of the pedagogical experiment showed the effectiveness of the applied methods, it included a variety of strength fitness technologies of gymnastic orientation through the change of intensity of physical activity, the use of a circular method, the alternation of aerobic and anaerobic exercises, application of dynamic and static strength exercises and a variety of strength types of fitness technologies of gymnastic orientation.

1 INTRODUCTION

The preservation of health of middle-aged women is one of the most urgent problems and it is not only of scientific and practical interest, but also it contributes to the solution of economic, social, demographic, and cultural problems of society. Nowadays, there is a different periodization of middle age. However,

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according to the periodization adopted at the symposium of the Academy of Pedagogical Sciences of USSR in 1965, the average age of women of the first period is considered from 21 to 35 years old and the second period from 36 to 55 years old.

According to M.V. Kosheleva, N.I. Ponomareva, A.A. Zaitsev, V.F. Zaitsev, P.V. Kozlov, S.E. Artamonov, the physiology of the middle-aged is characterized by the pathophysiologic mechanism of parts and body systems aging and the consequences of this process. The biological process of women`s aging can present in reduction of muscular strength, the decrease of cutaneous flexibility and bone loss, the slowdown of hair growth, unproductive lung function, cardiovascular and other systems of the organism. The typical disease of middle-aged women is a disturbance of metabolism and obesity. Most noticeable of women`s aging is the gain in fat mass relative to bone and muscle mass. The localization of excess fat depositions changes with age: a woman's body contains 26,5% adipose tissue at the age of 20, the share of adipose tissue is 33% by the age of 30-40, it reaches 42% by the age of 50 (Kosheleva, Ponomareva, 2020; Zaitsev, Zaitsev, Kozlov, Artamonov, 2021).

As noted by T.I. Volkova, V.K. Talantseva, N.N. Pyantzina, the muscle tissue of women changes with age: the number of cells decreases, the atrophy is observed, the number of fat cells and connective tissue increases, the contractility of muscle fibers reduces. Degenerative processes occur in the musculoskeletal system: elasticity of muscles, tendons, and joints decreases. Decreased muscle tone leads to negative changes in posture, the back becomes stooped, abdominal muscles lose tone and bulge forward, and it causes pain in the spine of different localization and origin. There is also the prolapse of the abdominal organs that is caused by a decrease in intra-abdominal pressure that is supported by the muscles of the body. Accordingly, the strength abilities are reduced due to a decrease in muscle mass, as well as the water, calcium, and potassium content in muscle tissue, which results in a loss of muscle elasticity. In addition, the functions of the oxygen-transport and energy-supplying systems are impaired (Volkova, Talantseva, Pyantsina, 2019; Pyastolova, 2019). According to N.I. Zayarna, L.P. Mikita, A.D. Tuboltseva, E.A. Smirnova, the use of physical strength exercises can prevent or weaken these changes. Exercises of strength types increase muscle mass, they develop the strength, the arteriolovenular bridge of blood supply and oxygenation of tissues, eliminate posture disorders, strengthen the musculoskeletal system and neuropsychological processes, increase hormonal levels, physical performance, metabolic levels, and weight loss.

Metabolism is a set of all chemical reactions that occur in the body. It is the basis of life activity and belongs to the criteria of living. There is not a single process in a living organism that would take place without metabolism, because every physiological process is based on physical and chemical transformations. During this process, substances that enter the body are transformed by chemical changes into the tissues substances or into end products that are eliminated out of the body. During these chemical transformations, energy is released and absorbed. There is neurohumoral regulation of metabolism in the body, it includes constructive and energy metabolism, which are dynamically balanced between each other (Razina, Runenko, Achkasov, 2016; Kachan, Kolesnikov, Terekhina, 2013; Petrov, 2020).

From the point of view of A.O. Razina, S.D. Runenko E.E. Achkasov, L.V. Tkachenko, N.I. Sviridova, T.V. Skladanovskaya, female metabolism has some features, it is performed more effectively during intensive strength exercises. During strain, the female hormone estrogen begins to stimulate the release of growth hormone (somatotropin) and vasoconstrictor hormone epinephrine (adrenaline), which accelerate the fat burning, and also reduce the breakdown of the triglycerides in the blood. In addition, scientists have substantiated the idea that chemical and physical changes that occur in the contracting cells of the body during exercises (in consequences of which oxygen metabolism increases) also persist during recovery and form a large part of the effect of excess post-exercise oxygen consumption (hereinafter EPOC). During the process of metabolic recovery, muscle cells expend additional energy to restore their condition to the level before the exercises. This recovery process can be called "calorie afterburn" or metabolic acceleration, it is the restoration of several physiological indicators to the level before the exercises. Moreover, the EPOC effect will be expressed to a greater extent during physical activity in the process of intensive strength exercises (Abdullin, Tumbasova, 2019; Tkachenko, Sviridova, Skladanovskaya, 2017; Dorontsev, Morozova, Abakumova, Dorontseva, 2021).

Strength (anaerobic) exercise is a complex of means and methods; the aim is to develop strong abilities, increase muscle mass, correct figure defects, and accelerate metabolism. Each exercise is characterized by several variables that reflect external parameters of physical load: intensity of muscle contraction, duration of exercises (number of reps - series, or duration), interval and type of rest, number of sets per exercise). The intrinsic parameters of physical load include indicators of urgent biochemical and physiological processes in the body of trainees that results in long-term transformational changes (Zayarnaya, Mikita, Tuboltseva, Smirnova, 2021).

Among the most popular strength fitness techniques, there is Body Pump (strength exercises with a barbell, that are performed without a stop), Body Sculpt (strength exercises for all muscle groups based on the use of special equipment), ABS (strength exercises for abdominal and back muscles), ABL and Lower Body (strength exercises for legs, buttocks, and abs) and Upper Body (strength exercises for shoulders, chest, arms, back, abdominal muscles), Super strong (strength exercises for all muscle groups based on the use of special equipment and exercises to use the individual`s weight), Hot Iron (strength exercises with small weights), Core Training, Core Final Cuts (strength exercises on the balance boards), Core Medical Ball (strength exercises on the balance boards with medical balls), Core Barbell (strength exercises aimed at strengthening large and small muscle groups), Deadly Force, Barbell Workout (strength exercises using barbells for all muscle groups). Strength exercises have an anaerobic orientation and can be performed with an individual`s weight, physique-building, simulator, and exercises with gymnastic equipment (Thompson, 2018; Sudar, Komnatnaya, 2021; Shtoda, Esaulov, Ogneva, 2020; Bukova, Kovalskaya, Rasolko, 2016).

The aim of the research was the theoretical, methodological, and experimental substantiation of the methodology of middle-aged women`s strength fitness techniques. Thus, the problem of the research was the right choice of the system of strength exercises from the variety of existing directions for the effective development of strength abilities, metabolic acceleration, and overweight correction.

2 MATERIALS AND METHODS

The solution of the research tasks determined the use of the following methods: theoretical analysis and generalization of scientific and methodological literature, pedagogical experiment, and methods of medical and biological research, control tests, methods of mathematical statistics.

The study was conducted on the basis of the fitness club "X-Fit" in Chita (the Trans-Baikal Territory of the Russian Federation) from January 2017 to June 2018. Twenty-two women of 35 to 40 years old took part in the pedagogical experiment; they did recreational aerobics (gymnastic fitness techniques) from time to time. The average age of the women was 38 years old. The test subjects were divided into two groups: control (hereinafter CG) and experimental (hereinafter EG). Each group consisted of 11 people.

The research was conducted during three stages - from January 2017 to August 2018. Theoretical analysis, synthesis of scientific and methodological literature were carried out during the first (search-theoretical) stage, from January to August 2017. The pedagogical experiment (ascertaining, forming, controlling stages) was organized and conducted during the second (practical) stage, from September 2017 to June 2018. This stage consisted of medical and biological research, control tests, and the implementation of the experimental methodology. At the third stage (analytical), from July to August 2018, using methods of mathematical statistics, the results of the experiment were analyzed and summarized.

Medical and biological studies and control tests were conducted in the control (CG) and experimental (EG) groups at the beginning and the end of the pedagogical experiment. All studies were conducted in the afternoon. The results of each study were recorded in electronic protocols. The biomedical examinations included:

- Identification of body types of women according to M.V. Chernorutsky, which was based on the Pignet index. According to M.V. Chernorutsky's theory, there are asthenic, normosthenic, hypersthenic types of constitution taking into account morphological features of people. Constitution type is determined with the help of the Pignet Index (hereinafter PI) according to the formula: PI = H- (W + CC), where H - Height (cm), W - Weight (kg), CC - chest circumference (cm). The data are interpreted as follows: asthenic type - PI > 30 conventional units (c.u.), normosthenic type - 30 > PI < 10 c.u., hypersthenic type - PI < 10 c.u.

The women's basal metabolic rate (hereinafter BMR) study was determined using Henry's equation (basal metabolic rate (BMR) = weight x weight (kg) + height x height (m) + constant and the women's daily energy expenditure, used the physical activity ratio and the formula Daily energy expenditure (DEE) = basal metabolic rate × physical activity quotient, which was classified as: 1.49 - sedentary way of life, 1.63 - moderately active way of life (occasional exercises of physical activity), 1.78 - more active lifestyle (regular exercise of medium to high intensity 3-5 times per week), > 2 - very active lifestyle.

According to G.L. Apanasenko, the determination of the health level was assessed by the sum of points of functional and anthropometric indicators. Depending on the number of points, the scale was divided into five levels: from level I (a low level of health) to level V (a high level). According to this grading system, a safe level of health (average) was limited to 14 points. This is the smallest sum of points, which guarantees the absence of clinical signs of illness. The quantitative score of the physical condition assesses the state of health and functional capabilities of the body, and, if necessary, takes the necessary measures to prevent disease. All five scores are aggregated to determine an overall score. The first index is calculated according to the formula: weight in grams is divided by height in centimeters. The second is calculated according to the formula: Vital lung capacity index (VLCI) in ml is divided by body weight in kilograms. The third is calculated using the formula: heart rate (HR) is multiplied by the systolic blood pressure (SBP) and divided by 100. The fourth is calculated as follows: the heart rate is measured for 10 seconds at rest, and 20 squats in 30 seconds. After squats, the heart rate is counted every 10 seconds until the initial value. The recovery time is compared with the table data. The fifth index is calculated according to the formula: hand dynamometer index in kilograms is divided by body weight in kilograms and multiplied by 100 (Ponomarev, Volkova, 2016; Morozova, Kiryanova, Melnikova, Vinogradova, 2021; Trofimova, Bondarevskaya, Morozova, 2020).

Control tests were carried out to study the level of dynamic and static strength abilities in the following tests: to bend and unbend arms in the prone position, to bend the body from lying on the back with bent legs for 60 seconds, squats, to hold the body in the prone position on the forearms. Before the control tests, a standard, functional warm-up of all body systems was carried out under the specifics of motor tests.

Women in the control (CG) and experimental (EG) groups practiced for ten months (mesocycles) three times a week (microcycle) for 60 minutes (1 hour) in the afternoon. One mesocycle had an average of 12 practical sessions (about 120 sessions in total). Sports activities had a classical structure: Warm-up (functional and articular), Pre-stretch (dynamic stretching exercises) - 10 minutes, Cardio-Power (aerobic - 25 minutes, power exercises - 15 minutes) - 40 minutes and Cool-down (static stretching exercises) - 10 minutes.

The distinctive feature of the experimental technique was the modification of the content of the main part by changing the intensity of the physical load; the use of the circular method; alternation of aerobic and anaerobic exercises; the use of dynamic and static strength exercises; inclusion of various kinds of strength fitness technologies of gymnastic orientation. The duration of the power part (Power) remained unchanged during the entire pedagogical experiment. During the first and second mesocycles (September, October) women of the control (CG) and experimental (EG) groups had the same content of practical exercises and a load of moderate-intensity with heart rate = 120-130 beats/minute. They had repeated strength exercises in the aerobic mode for all muscle groups (shoulder girdle, upper extremities, trunk, buttocks, lower extremities). The complex included dynamic strength exercises with the individuals` weight to develop the strength ability.

From the third mesocycle (November), female subjects of the control and experimental groups were divided into several subgroups based on their body types:

The control group used the repetitive effort method with the frontal method of organizing the female trainees. The complex included power dynamic exercises with individuals` weight for all muscle groups (shoulder girdle, upper extremities, trunk, buttocks, lower extremities). Women with normosthenic physique did exercises according to the principle of reaching the individual maximum in the combination of aerobic and anaerobic modes at the heart rate of 150-160 beats/minute. Women with hypersthenic physique did exercises to the maximum number of times in aerobic mode with heart rate = 130-140 beats/minute. Women with an asthenic physique did exercises until fatigue at heart rate = 150-160 bpm. In subsequent mesocycles, the combinations and types of strength dynamic exercises in the complex were changed.

The experimental group used the circular method, which is the organizational and methodological form of physical exercises in November and December. During the training sessions, the trend Body Sculpt was used (strength exercises for all muscle groups based on the use of special equipment: fitball, medicine ball). The authors developed two sets of strength exercises (dynamic and static) in the combination of aerobic and anaerobic muscle work modes. One complex was used in November, the other one - in December. The sets of strength exercises were aimed at the development of proper strength abilities, dynamic and static strength endurance.

Several strength fitness techniques were introduced in January, February, and March: Body

Pump, ABS, ABL, Upper Body. Each training session had regional and global exercises depending on the volume of active muscle mass. Body Pump was used as a global exercise with a heart rate of 150-160 bpm, and ABS, ABL, Upper Body were used as a regional exercise with a heart rate of 130-140 bpm. In April, May, and June, Hot Iron was used as the global action, with heart rate = 160-170 bpm, and ABS, ABL, Upper Body with heart rate = 130-140 bpm were used for the regional action. The power complexes of exercises were used taking into account the increase in the intensity of physical activity.

Subgroups of women of all body types used the frontal method of Body Pump and Hot Iron training exercises in the same intensity mode. The repeated method of ABS, ABL, Upper Body exercises, and their dosage were used according to the physiques. Women with normosthenic and asthenic physiques did exercises according to the principle of reaching the individual maximum. Women with hyperstenic physiques did exercises up to the maximum number of times. Besides, one weekly microcycle had the following sequence: the first session had a set of exercises for strength ability; the second session had a set of exercises for dynamic strength; the third session had a set of exercises for static strength endurance.

3 RESULTS

At the ascertaining stage of the pedagogical experiment the use of M.V. Chernorutsky`s method allowed to reveal the body types of women in the control and experimental groups for the following correction of the figure in the process of training. The control group included 2 women with asthenic physiques (18%); the experimental group included 1 woman with normosthenic physiques (9%); the control group had 3 (27%) women with a normosthenic physiques and the experimental group had 3 (27%) women; the control group had 6 (55%) women with a hypersthenic physique and the experimental group had 7 (64 %) women in (Figure 1).

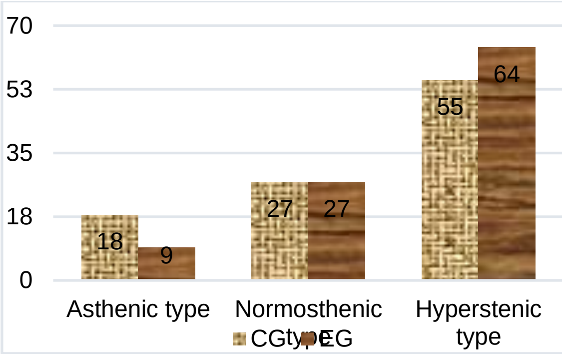

Figure 1: Ranking of female subjects by physiques.

At the beginning of the pedagogical experiment, the authors determined the average group value of the basal metabolic rate (BMR) in kcal and daily energy expenditure (DAE) in kcal for the subjects of control and experimental groups. The average BMR result of the control group was 1427,69 kcal; DAE was 2327,13 kcal. The average BMR result of the experimental group was 1430.57 kcal; the DAE was 2331.82 kcal. At the end of the pedagogical experiment the daily energy consumption in the control group was 2541, 29 k/cal; in the experimental group was 2546,41 k/cal (Table 1).

Table 1: Basal metabolic rate and daily energy expenditure at the beginning and end of the experiment.

Group name	Basal metabolic rate (к/кал) kcal	Daily energy consumption (at the beginning of the experiment)(к/кал) kcal	Daily energy consumption at the end of the experiment kcal
Control group	1427,69	2327,13	2541, 29
Experimental group	1430,57	2331,82	2546,41

At the ascertaining stage the average group index of the level of health according to the system of G.L. Apanasenko in the control group was 14,54±0,09 points; in the experimental group 14,56±0,10 points (t=0,32; p>0,05). According to this grading system, a safe level of health (above average) is limited to 14 points. This is the lowest sum of points, which guarantees the absence of clinical signs of illness. An average level of health can be considered critical. During the study of strength abilities to bend and unbend arms in the prone position, the group average index of arm strength proper in the control group was

4.75±0.10 reps, in the experimental group - 4.50±0.09 reps (t=0.41; p>0,05); during the bending the body from lying on back with bent legs for 60 seconds the group average index of abdominal proper power ability in the control group was - 26,17±0,12 reps, in experimental group - 24,08±0,14 reps (t=0,47; p>0,05); p>0,05); during the squats, the average group index of leg power proper in the control group was - 13,15±0,11 repetitions, in the experimental group - 12,78±0,12 reps (t=0,52; p>0,05); while holding the body in the prone position on forearms, mean group parameter of body strength endurance in the control group was - 25,00±0,14 seconds, in experimental group - 24,97±0,13 seconds (t=0,34; p>0,05) (Figure 2).

According to G.L. Apanasenko's system, there were no reliable differences in initial indicators (p>0.05) between the strength abilities of female subjects of the control and experimental groups at the beginning of the pedagogical experiment. These results reflected the correctly selected contingent of subjects at the beginning of the pedagogical experiment.

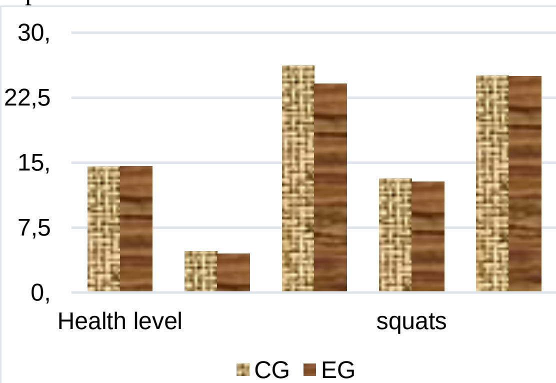

Figure 2: Indicators of health and strength abilities of female subjects at the beginning of the pedagogical experiment.

According to the system of G.L. Apanasenko and strength ability, the women of the experimental group significantly exceeded the subjects of the control group in terms of health level at the control stage of the pedagogical experiment (Table 2).

Table 2: Indicators of health and strength abilities of female subjects at the end of the pedagogical experiment.

Name of the experiment	Control group (X±m)	The experimenta l group (X±m)	Reliability
Quantitative assessment of the level of health according to G.L. Apanasenko's system (in points)	14,93±0,10	18,82±0,11	t=3,01; p<0,01
Bending and unbending arms in the prone position (amount of repetition)	4,96±1,11	6,50±1,00	t=3,22; p<0,01
Body bending in back-lying position with bent legs for 60 seconds (amount of repetition)	27,00±0,13	30,04±0,12	t=3,37; p<0,01
Squats (amount of repetition)	14,00±0,11	18,54±0,10	t=4,12; p<0,01
Body holding on forearms (in seconds)	26,08±0,10	30,00±0,10	t=4,09; p<0,01

At the end of the pedagogical experiment the average group index of the level of health according to G.L. Apanasenko's system was 14,93±0,10 points in the control group; 18,82±0,11 points in the experimental group (t=3,01; p<0,01). In the study of strength abilities during the arm bending and unbending in the prone position in the control group was 4.96±1.11 reps, in the experimental group was 6.50±1.00 reps (t=3.22; p<0,01); during body bending in back-lying position with bent legs for 60 seconds the group average index of abdominal strength ability in the control group was 27,00±0,13 reps, in the experimental group was 30,04±0,12 reps (t=3,37; p<0.01); in squatting, the average group index of leg strength abilities in the control group was 14.00±0.11 reps, in the experimental group 18.54±0.10 reps (t=4.12; p<0.01); in the body holding on forearms, group index of body strength endurance in the control group was 26,08±0,10 seconds, in the experimental group was 30,00±0,10 seconds (t=4,09; p<0,01) (figure 3).

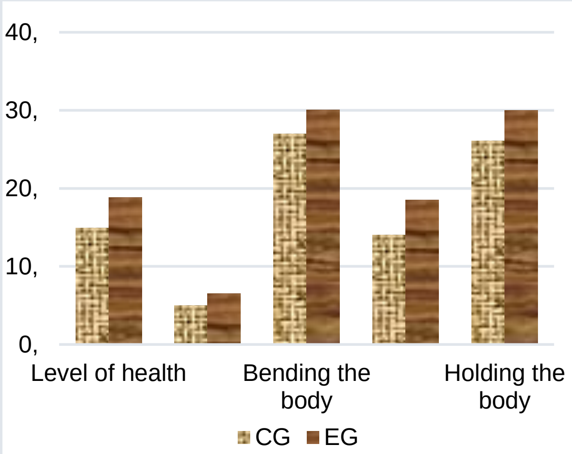

Figure 3: Indicators of health and strength abilities of female subjects at the end of the pedagogical experiment.

4 DISCUSSION

Women after 30 years old show a negative trend in muscle mass, with a decrease of up to 5% every 10 years, which causes osteoporosis, dyslipidemia, obesity, sarcopenia. Loss of muscle quantity and quality with age is a consequence of age-related hormonal changes, changes in the central and peripheral nervous system, reduction of capillary network density of skeletal muscles. Muscle mass of lower extremities is lost more actively and intensively than total muscle mass, which affects human mobility, increases the risk of falls and the occurrence of injuries.

Taking this characteristic into consideration, there is the necessity to develop a technique that will help to optimize the physical condition of middle-aged women through the power fitness technologies of the gymnastic orientation. An effective impact on the dynamics of women's strength abilities is possible but only according to the body types. That is why the authors identified body types of the female subjects to use an appropriate physical load.

The women's basal metabolic rate and daily energy expenditure were studied to control the number k/cal with food. To burn fat, the number of k/cal should be slightly less than the daily k/cal consumption.

Analyzing the average group quantitative assessment of the level of health according to the system of G.L. Apanasenko in the control and experimental groups at the control stage the authors could indicate the increase rate that was 2.64 % in the control group and 25.25 % in the experimental group. The quantitative estimation according to the system of G.L. Apanasenko made it possible to judge the physical state of health and functional capabilities of the female organism. At the beginning of the experiment, the quantitative estimation corresponded to an average level in control and experimental groups, at the end the quantitative estimation in the experimental group began to correspond to a high functional level, in the control group remained the same.

The analysis of the strength ability at the end of the experiment allowed the authors to identify the rate of increase in all control exercises: while performing bending and unbending arms in the prone position the growth rate was 4.3% in the control group, in the experimental group - 36.36%; while performing body bending from lying on the back with bent legs for 60 seconds the growth rate was 3.12% in the control group, in the experimental group - 22.02%; during the squats, the growth rate was 6.26 % in the control group, in the experimental group - 36.78 %; while holding the body in the prone position on forearms the growth rate was 4.22 % in the control group, in the experimental group - 18.30 %.

The research found, that the experimental group showed a significant increase in the indicators of physical health and strength ability at the end of the pedagogical experiment; the rate of increase in the experimental group was significantly higher than the rate of increase in the control group for all control exercises.

Thus, the use of a variety of strength fitness technology of gymnastics orientation, a gradual increase in the intensity of exercises, the use of circular method, alternating aerobic and anaerobic muscle work mode, the use of dynamic and static strength exercises with women of the experimental group, allowed to achieve an increase in daily energy expenditure, positive dynamics in the indicators of physical health and strength capabilities.

5 CONCLUSIONS

Theoretical analysis and synthesis of scientific and methodological literature on the problem of research allowed to identify the effects of the biological process of middle-aged women`s aging; the effectiveness of strength exercises that increased muscle mass, developed strength capabilities, provided the development of the capillary network of blood supply and oxygenation of body tissues, strengthened the musculoskeletal system and nervous and mental processes, increased overall hormonal levels, physical efficiency and performance.

To achieve the aims of the research the authors developed a technique to optimize the physical condition of middle-aged women through strength fitness technology of gymnastics orientation. The distinctive feature of the experimental technique was the modification of the content of the main part of the exercise by changing the intensity of physical activity; the use of the circular method; the alternation of aerobic and anaerobic work; the use of dynamic and static strength exercises; the inclusion of various strength types of fitness technology gymnastics orientation.

The results of the pedagogical experiment demonstrated the effectiveness of the methodology and testified to the positive dynamics of the indicators of the experimental group. Thus, the growth rate of the quantitative assessment of the level of health according to the system of G.L. Apanasenko was - 25,25%; during bending and unbending arms in the prone position the growth rate was - 36,36%; during bending the body from lying on the back with bent legs for 60 seconds the growth rate was - 22,02%; during the squats, the growth rate was - 36,78%; during holding the body in the prone position on forearms the growth rate was - 18,30%. Analysis of the results of the pedagogical experiment at the end of the study characterized the effectiveness of the method.

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