EFFECT OF STRENGTH AND AEROBIC TRAINING ON BODY MASS, WAIST SIZE, AND FUNCTIONAL TEST RESULTS IN OVERWEIGHT WOMEN

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The problem of global obesity is getting worse every year. In many countries, the prevalence of overweight is higher among women. Despite the obvious metabolic effect of physical activity on human health, there is uncertainty about the effect of various types of training on functional performance, changes in body weight and a decrease in waist size in overweight middle-aged women. *The purpose of the study*: to study the effect of 12-week training of various types (strength training, aerobic training) on the health indicators of overweight women aged 45-50 years. *Materials and methods of research*. To solve these problems, information analysis and synthesis, physical fitness testing and measurement of anthropometric data, pedagogical experiment, mathematical methods of statistical data processing were used. The study involved women aged 45-50 (experimental group No. 1 (n=12) engaged in an aerobic training program and experimental group No. 2 (n=12) engaged in a strength training program). *Results.* The analysis of current research in the field of methods of strength training and aerobic training with middle-aged women who are overweight was carried out; programs of strength and aerobic training for women 45-50 years old who are overweight were developed; A comparative assessment of the impact of trainings of various orientations on body weight, waist size and results in functional tests in overweight women aged 45-50 years was carried out. *Conclusions.* The study showed that women aged 45-50 who are overweight can effectively use physical activity as a means of reducing menopause symptoms, especially to normalize body weight. A pedagogical experiment has proved that strength and aerobic training for overweight women aged 45-50 years, conducted for 12 weeks, 3 times a week for 90 minutes, helps to reduce body weight, reduce waist size, and improve functionality. The results obtained suggest that to increase physical performance and reduce waist size in overweight women aged 45-50, it is necessary to use aerobic exercises, and to develop strength, strength training 3 times a week for 90 minutes for 12 weeks or more.

Keywords: women, menopause, strength training, aerobic training, overweight.

Ольга Самолюк, Тетяна Чебан, Анастасія Шишкану. **Вплив силового та аеробного тренінгу на показники маси тіла, об'єму талії та результати функціональних тестів у жінок із надмірною масою тіла**

Анотація. З кожним роком проблема ожиріння населення планети посилюється. У багатьох країнах поширеність надлишкової маси тіла вище серед жінок. Незважаючи на очевидний метаболічний ефект від фізичної активності на здоров'я людини, відзначається невизначеність щодо впливу тренінгів різної спрямованості на функціональні показники, зміни маси тіла і зменшення обсягів талії у жінок середнього віку, що мають надлишкову масу тіла. *Мета дослідження*: вивчення впливу 12-тижневого тренінгу різної спрямованості (силовий тренінг, аеробний тренінг) на показники здоров'я жінок 45-50 років, що мають надлишкову масу тіла. *Матеріали і методи дослідження*. Для вирішення даних завдань використовувався аналіз і синтез інформації, тестування рівня фізичної підготовленості і вимірювання антропометричних даних, педагогічний експеримент, математичні методи обробки статистичних даних. У дослідженні взяли участь жінки 45-50 років (експериментальна група № 1 (n=12), що займається за програмою аеробного тренінгу і експериментальна група № 2 (N=12), що займається за програмою силового тренінгу). *Результати.* Був проведений аналіз актуальних досліджень в області методики проведення силових тренувань і тренувань аеробного характеру з жінками середнього віку, що мають надлишкову масу тіла; розроблена програми занять силовим і аеробним тренінгом для жінок 45-50 років, що мають надлишкову масу тіла; проведено порівняльну оцінку впливу тренінгів різної спрямованості на показники маси тіла, об›єму талії та результати у функціональних тестах у жінок 45-50 років, які мають надлишкову масу тіла. *Висновок.* Проведене дослідження показало, що жінки 45-50 років, які мають надлишкову масу тіла, можуть ефективно використовувати фізичне навантаження як засіб зниження симптомів клімаксу, особливо для нормалізації маси тіла. Педагогічний експеримент довів, що силовий і аеробний тренінг для жінок 45-50 років, що мають надлишкову масу тіла, що проводяться протягом 12 тижнів, 3 рази на тиждень по 90 хвилин сприяє зниженню маси тіла, зменшенню обсягу талії, поліпшенню функціональності. Отримані результати говорять про те, що для підвищення фізичної працездатності і зменшення обсягів талії у жінок 45-50 років, що мають надлишкову масу тіла, необхідно використовувати вправи аеробного характеру, а для розвитку сили – тренінг силового характеру 3 рази в тиждень по 90 хвилин протягом 12 тижнів і більше.

Ключові слова: жінки, менопауза, силові тренування, аеробні тренування, надмірна маса тіла.

Introduction

The World Health Organization classifies obesity as a pandemic. The problem of global obesity is getting worse every year. In many countries, the prevalence of overweight is higher among women [42]. Obesity can be both an independent disease and a syndrome in some systemic diseases. The causes of overweight and subsequent obesity may be overeating (excessive consumption of calories and foods rich in carbohydrates), as well as lack of physical activity, which may partially solve the problem of excessive calorie intake [13]. Endocrine diseases and damage leading to metabolic disorders and, as a result, to obesity cannot be excluded. Overweight increases the risk of developing type 2 diabetes, heart and vascular diseases, digestive organs, and reproductive function [21; 28].

Despite the fact that dietary nutrition is recognized as a very effective method of reducing body weight, it is necessary to pay attention to the amount of physical activity and the nature of physical exercises used, which can regulate body weight in different ways and affect overall well-being [29].

Various approaches to the content of training sessions are effective for improving health indicators, increasing physical performance and reducing body weight, regardless of gender [2; 3; 39]. Doctors recommend using at least 150 minutes of aerobic exercise per week to reduce risk factors in people with type 2 diabetes, such as cardiovascular diseases and obesity [9; 10].

Previous studies demonstrate the effectiveness of aerobic exercise to reduce body weight and improve metabolism, primarily lipid metabolism. These are high-intensity interval training, walking and continuous running, performed at a low pace [1; 19; 26].

On the other hand, various strength training exercises have become increasingly popular among overweight people in recent years. Strength training is chosen due to its ability to improve physical fitness, increase muscle mass, improve the quality of basic movements and reduce the risk of injury [33]. Studies show that three strength exercises a week are the most effective for weight loss when performing three or more sets of 10 repetitions per major muscle group [9].

There are ongoing disputes regarding the effects of different types of physical exercise on the body of an obese person. According to the authors themselves, many of these studies need to be clarified [27; 31].

Due to the fact that strength and aerobic training can have different effects on the functional state, body mass index and waist size, as well as cause different adaptations to stress, it is necessary to evaluate the advantage of each method. This study may be useful for those who plan and carry out wellness activities with overweight middle-aged women as part of fitness activities. These studies can also be used by attending physicians to develop lifestyle recommendations for overweight middle-aged women.

Materials and methods of research

The purpose of this study is to study the effect of 12-week training of various types (ST – strength training, AT – aerobic training) on the health indicators of overweight women aged 45-50 (body mass index, waist size, results in functional tests). Research objectives: to analyze current research in the field of methods of strength training and aerobic training with middle-aged women and overweight people; development and implementation of a program of strength and aerobic training for overweight women aged 45-50; comparative assessment of the impact of various types of training on body weight, waist size and functional test results for overweight women aged 45-50.

The study involved women aged 45-50 years. Initially, 32 women agreed to participate in the experiment. As a result of the dropout, 24 women were selected and randomly assigned to 2 groups: experimental (EG1, n=12) and control (EG2, n=12). The sample size was assigned according to the methodology [31]. The criteria for inclusion in the groups were: overweight (body mass index from 25 to 30 kg/m^2), sedentary lifestyle, absence of injuries affecting the productivity of training. The presence of physical inactivity in the life of the experimental participants was assessed using the international questionnaire for determining the level of physical activity (IPAQ) [11]. For the age of the participants, it was necessary to demonstrate a value of <14 points. The survey showed that all the participants in the experiment lead a low-activity lifestyle, stay in the workplace a lot and do not engage in organized physical activity. The groups were formed based on a randomly generated number on a computer. All participants in the experiment voluntarily agreed to participate in the experiment, were familiarized with the conditions of the study and the exercises that must be performed in training sessions. Personal data of the participants in the experiment were not disclosed. We have adhered to ethical principles in accordance with the Helsinki Declaration on Conducting Research with Human Participation.

The duration of the experiment was 12 weeks. It also took 3 more weeks for the study: 1 week for the trial period, 1 week for testing and evaluation of tests before the experiment, 1 week for testing and evaluation of tests after the experiment. Before the experiment, the participants had the opportunity to try protocol tests and get used to them.

The following anthropometric indicators were monitored as part of the study: Body mass index (kg/m^2), waist size (cm). Anthropometric measurements of body weight (using digital scales with an accuracy of 10 grams), body height (using a wall-mounted stadiometer with an accuracy of 0.5 cm), waist size (using a flexible meter with an accuracy of 1 cm) were carried out in the laboratory. The body mass index was calculated by dividing body weight by the square of body height. Functional indicators were also monitored: strength (squatting with a barbell, weighing 50 % of maximum capacity, number of times), agility (3x10 m shuttle run, seconds), physical performance (Harvard step test, points). Functional tests were conducted in the gym. Before testing, a repeated maximum was determined when performing a barbell squat. Then this indicator was divided in two. The subjects were also trained in the correct technique of performing shuttle running and were familiarized with the protocol of the Harvard step test. The step height during the step test is 43 cm [4].

The curriculum in the experimental group included classes three times a week (Monday, Wednesday and

Friday) from 5.30 pm to 7.00 pm for 3 months (12 weeks). Each lesson was divided into 3 parts. In the preparatory part of the workout, a warm-up was carried out, which included 5 minutes of jogging, 5 minutes of general exercises for the main muscle groups and 5 minutes of dynamic stretching. After the warm-up, EG1 performed aerobic training exercises, and EG2 performed strength training exercises for 45 minutes. Each session ended with breathing exercises and stretching for 10 minutes.

The EG1 program included, in the main part of the training session, steady running at a heart rate in the range from 70 to 80 % of the maximum (calculated using the formula 0.7 x age). Step aerobics exercises, jumps, dance complexes, general development exercises for the main muscle groups performed by a continuous method were also used. The pauses between exercises were filled with walking on the spot. The heart rate was monitored using heart rate monitors and had to remain at the stated level. The workload increased starting from the 1st and 2nd weeks of classes and stabilized over the remaining 10 weeks.

The EG2 program included performing exercises with free weights and on simulators in the main part of the training session. These are squats with a barbell or dumbbells, bench press with your feet, lunges with dumbbells in your hands, lunges with a barbell, bench press with your hands lying on your back (from 70 % of the maximum). In the first and second weeks, the load increased gradually, starting with two sets of 10 times in each exercise. Then, over the course of 10 weeks, the load stabilized at the level of 3 sets of 10 times. There was a pause for 2-3 minutes between the exercises and the sets. The technique of performing strength exercises was supervised by a specialist.

Statistical processing of the received data included the calculation of the average value in the group, the standard deviation, and the quadratic deviation. The normality of the distribution of independent variables was assessed by the Shapiro-Wilk criterion. Based on the average values, the reliability of the differences between the EG1 and EG2 groups was calculated using the Student's T-test. The values in the range from 2.07 (α=0.05) to 2.8 (α=0.01) were considered reliable, with the number of degrees of freedom being 22.

The results of the research

An assessment of the anthropometric data of the experimental participants at the beginning of the study showed that most of the participants, according to the Quetelet index, had a state of pre-obesity (overweight, Index = 25-30), and some of the participants also had grade 1 obesity (Index = 30-35). Fat deposits in the waist area in women are considered excessive at values of more than 90 cm. All participants in the experiment had this value above 90 cm. There were no significant differences in both indicators between the groups (Table 1).

Table 1 – Anthropometric data before the start of the experiment

Indicators	Experimental group № 1 (n=12)			Experimental group № 2 (n=12)			t	p
	$\bar{x}$	s	m	$\bar{x}$	s	m		
Body mass index	28.3	3.1	1	29.4	3.5	1.2	1.5	>0.05
Waist size (cm)	94.1	6.6	2.2	95.7	5.6	1.8	1.8	>0.05

N o t e *The differences are significant at t = 2.07 (α=0.05) – 2.8 (α=0.01); (df=22).

Prior to the start of the experiment, the participants demonstrated below-average levels of physical performance when performing the Harvard Heat Test. Most of the participants in both groups scored a little more or less than the lower limit of the average level. It can be said that the average result tends to the lowest level (55.5 and 56.5 points, the differences between the groups in the average values are unreliable, p >0.05). The demonstration of leg muscle strength when performing barbell squats weighing 50 % of the maximum was also at a satisfactory level, however, the average indicator tends to be unsatisfactory for this age (6 and 6.5 times, the differences between the groups in the average values are unreliable, p >0.05). The participants in the experiment had a lower-than-average speed of the shuttle run (10.8 and 10.9 seconds, the differences between the groups in the average values are unreliable, p >0.05). In general, the results in functional tests indicate that being overweight affects the ability to effectively perform basic movements. Participants in both groups have low levels of leg strength, agility in cyclic locomotion, and physical performance, which can undoubtedly lead to injury and reduced movement quality (Table 2).

Table 2 – Results in functional tests before the start of the experiment

Indicators	**Experimental group №1 (n=12)**			**Experimental group №2 (n=12)**			**t**	**p**
	$\bar{x}$	s	m	$\bar{x}$	s	m		
Barbell Squat (number of times)	6	2	0.7	6.5	2.1	0.7	0.7	>0.05
3x10 m Shuttle run (s)	10.8	0.12	0.04	10.9	0.12	0.06	2.02	>0.05
Harvard Step Test (score)	55.5	2.5	0.8	56.5	2	0.7	1.8	>0.05

N o t e *The differences are significant at t = 2.07 (α=0.05) – 2.8 (α=0.01); (df=22).

During the experiment, all participants followed recommendations regarding the regularity of attendance and the quality of exercise. Experts monitored the heart rate during physical activity to ensure the safety of the participants in the experiment. No injuries were recorded during the experiment and during the control testing. In addition, before the start of the experiment, no significant differences were found between the groups in these tests.

After the experiment was completed, the participants were retested as part of the study. The following changes were recorded: the body mass index in experimental group No. 1 decreased by 2 points, in group No. 2 there were also positive changes and the indicator decreased by 1.5 points. Thus, no significant differences were found between the groups (t =1.7, p >0.05), however, all participants showed a decrease in body weight and a desire for normal body weight. Waist size indicators also decreased among the representatives of both groups. Significant differences were recorded (t =2.1, p <0.05). On average, in group № 1 working on the aerobic program, this indicator improved by 4.9 cm, in group № 2 the average indicator decreased by 2.8 cm (Table 3).

Table 3 – Anthropometric data after completion of the experiment

Indicators	Experimental group № 1 (n=12)			Experimental group № 2 (n=12)			t	p
	$\bar{x}$	s	m	$\bar{x}$	s	m		
Body mass index	26.3	2.9	1	27.9	3.0	1	1.7	>0.05
Waist size (cm)	89.2	6.0	2	92.6	4.3	1.4	2.1	<0.05

Note *The differences are significant at t = 2.07 (α=0.05) – 2.8 (α=0.01); (df=22).

There have been significant changes in the results of some functional tests. Thus, significant differences were found between the groups in performing barbell squats (t =3.1, p <0.01). In group 2, the squat score increased by 3 points, which is 2 times higher than in group 1. Significant differences were also recorded when performing the physical performance test (t =4.5, p <0.01). In group No. 1, the indicator increased by 11.1 points, while in group No. 2, there was an improvement of 4.3 points. When evaluating the coordination of movements in cyclic locomotion, improvements were found in both groups without significant differences (t = 1.9, p >0.05) (Table 4).

Table 4 – Results in functional tests after completion of the experiment

Indicators	**Experimental group №1 (n=12)**			**Experimental group №2 (n=12)**			**t**	**p**
	$\bar{x}$	s	m	$\bar{x}$	s	m		
Barbell Squat (number of times)	7.5	2.1	0.7	9.5	1.8	0.6	3.1	<0.01
3x10 m Shuttle run (s)	9.9	0.3	0.1	9.6	0.4	0.13	1.9	>0.05
Harvard Step Test (score)	66.6	2.3	0.8	60.8	2.4	0.8	4.5	<0.01

Note *The differences are significant at t = 2.07 (α=0.05) – 2.8 (α=0.01); (df=22).

Discussion

Despite the fact that regular physical exercise has a proven effect on human health, in particular, it has a positive effect on the health of overweight women, uncertainty remains about the specificity of the effects. This study examined the effect of different training programs (aerobic and strength training) on body mass index, waist size, and functional parameters (performing physical exercises for strength, agility, and endurance) in menopausal women.

Physical activity for menopausal women is crucial for health and reducing the effects of aging, in particular, weight gain, which in turn affects the quality of life: appearance, physical performance and the ability to fully move [18; 36; 40]. Statistics show that women who have entered menopause are more likely to be overweight, and fat oxidation decreases when exercising [16; 35]. It is also known that women who exercise regularly report significantly fewer symptoms of menopause [14; 44].

Currently, there are no well-established training programs for overweight people. It is known that women aged 45-50 may have a number of contraindications, in particular, while performing high-intensity physical exercises, cardiac troponin levels may increase, indicating damage to the heart muscle [23; 32; 38]. Also, previous studies have shown that women before and after menopause may have different effects of high-intensity physical activity on body composition [8; 24; 25]. Experts note that high-intensity short-term training for menopausal women has a significant effect on cardiopulmonary ventilation, but should not be used constantly [20].

Practice also shows that interval training can have little effect on the body composition and body weight of overweight women, even compared to people who do not exercise. [5; 7; 22; 41]. Thus, menopausal women are recommended to use moderate and low-intensity physical activity as the most effective in the presence of excess body

weight [6; 15; 17; 37]. Since menopausal women have significant risks to the functioning of the cardiovascular system, there was no high-intensity workload in both programs in this study.

It is also noted the importance of monitoring the heart rate when prescribing physical activity in menopausal women in order to improve cerebrovascular outcomes in the following years of life [30; 34]. The most effective classes are three times a week and the duration of the training course should be 8 weeks or more [12]. Thus, the proposed training programs are consistent with the recommendations based on the results of previous studies.

Both in the group with aerobic and vigorous physical activity, most women showed positive dynamics in assessing body mass index. Undoubtedly, any lifestyle change in the form of additional energy expenditure can lead to a decrease in body weight due to the resulting calorie deficit. Due to the fact that there were no significant differences between groups 1 and 2, we can recommend both trainings as effective means for initial weight loss in overweight patients. However, it is necessary to organize a longer study to understand how much the dynamics of weight loss will change with the use of aerobic and strength training. Since weight loss occurs non-linearly and there may be a stabilization of the results and even a reverse effect in the form of weight gain, it is important to take into account the duration of the intervention within the experiment.

Waist size indicators are essential in assessing the risks of a number of diseases, including type 2 diabetes, liver disease, and impaired reproductive organ function. Since menopausal women have an increased risk of weight gain, one of the main markers is an increase in waist size. The study showed that the use of regular aerobic exercise significantly reduces waist size more effectively in overweight women ($p < 0.05$). This is consistent with previous studies, according to which aerobic exercise can involve cellular metabolic pathways and contribute to a decrease in the lipid profile [27]. Nevertheless, the question of the prospects of applying strength training remains open, since there may be a less rapid, but more lasting result for reducing body volume.

Large muscle groups are important consumers of energy [31]. In this regard, increasing the strength of the leg muscles is an important condition for reducing body weight in the future. In both experimental groups, a significant load was applied to the leg muscles. The aerobic training group used steps, jumps, running, lunges, squats without weights, but with a significant dosage. The strength training group used lunges and squats with weights, but with pauses between sets and series of exercises. Nevertheless, during the indicated period, the most effective sets of exercises were in group № 2 with a significant difference of $p < 0.01$. In this regard, it can be assumed that strength training, due to its specifics, may further have a significant impact on the effectiveness of calorie consumption during training sessions.

Along with the effectiveness of muscle contraction, high-quality movement is one of the main conditions for better energy expenditure during training sessions. It is for this reason that people who start exercising spend much fewer calories than experienced athletes [17]. The experience of this study showed that both groups showed positive dynamics in the dexterity test. This can largely be explained by the significant number of general exercises and the high variety of exercises offered. Thus, we can recommend both types of training sessions in order to improve the quality of movement for overweight women.

An increase in the level of physical performance indicates a complex effect of the applied physical exertion [6; 20]. The response of the cardiovascular system to physical activity in overweight women was significantly better in the group with aerobic exercise. In general, in the long run, this can have a significant impact on the willingness to perform higher-intensity physical exercises. In this regard, it can be noted that aerobic exercises optimize the use of oxygen by muscle fibers and create a stronger foundation for further increasing the volume and intensity of training sessions and corresponding progress.

Conclusions

1. Women aged 45-50 need regular physical exercise, as physical activity can reduce the symptoms of menopause, in particular, the presence of excess body weight.

2. Both strength and aerobic training, conducted for 12 weeks, 3 times a week for 90 minutes have a positive effect on the physical condition of overweight women aged 45-50: body weight decreases, waist size decreases, strength, agility and performance indicators improve.

3. In order to increase physical performance and reduce waist size in overweight women aged 45-50, it is necessary to use moderate-intensity aerobic exercises 3 times a week for 90 minutes for 12 weeks or more. Under equal conditions, low-intensity strength training 3 times a week for 90 minutes for 12 weeks or more has a significant effect on strength indicators in this category of people.

Conflict of interest. The authors state that there is no conflict of interest.

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