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Original Article

Dynamics of anthropometric and hemodynamic indicators on the condition of young women with alimentary obesity in the application of a comprehensive program of physical therapy

YULIYA KALMYKOVA[1], SERGEY KALMYKOV[2], HELEN BISMAK[3]
[1,2,]Department of Physical Therapy, Kharkiv state academy of physical culture, UKRAINE
[3]Department of Physical Therapy and Ergotherapy, National University of Ukraine on Physical Education and Sport, UKRAINE

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Abstract:
Purpose: to study and determine the anthropometric and hemodynamic parameters of the examined patients with alimentary adiposity of the I-II degree, to evaluate the effectiveness of the complex physical therapy program developed by us on the basis of studying the dynamics of the parameters of the functional state of the cardiovascular system, the anthropometric parameters of women, patients with alimentary adiposity of I-II degree during rehabilitation process. *Material and methods:* the study was based on a clinical and laboratory examination of 50 women, patients with alimentary obesity I-II degree, the main (25 women) and control (25 women) group. The average age of women in the main group was 24,49±0,71 years, the control age was 24,06±0,57 years. In the main group, a comprehensive physical therapy program was developed for women, patients with mild obesity of I-II degree, which includes a hypocaloric diet; massage according to the method of P.B. Efimenko (2013) physiotherapeutic treatment in the form of influence of sinusoidal modulated current with sympatho-mimetics on the region of local fatty deposits (according to the method of I. Tereshchenko, 1997) and thermal hydroprocedures in the form of contrast baths; therapeutic gymnastics; morning hygienic gymnastics; dosed walking. *Result:* application of the program of physical therapy made it possible to reveal positive changes in the anthropometric and hemodynamic parameters of young women with obesity. *Conclusions*: physical exercises contribute to the improvement and normalization of metabolism; reduce the excess weight of the body restore the body's adaptation to physical stress; normalize the function of the cardiovascular system, motor activity and psychoemotional state.
Key words: obesity, anthropometric indicators, physical therapy, cardiovascular system.

Introduction

According to the report of the WHO Committee on Obesity, "overweight and obesity are now, so spread, affecting the health of the population more than traditional health problems" (The WHO, 2000, 2006, 2008-2013). Obesity is a group of diseases and a pathological condition characterized by excessive deposition of fat in subcutaneous fatty tissue (Hairston, Vitolins, Norris, 2011) and other tissues and organs due to metabolic disorders, and is accompanied by changes in the functional state of various organs and systems.

Recently, the World Health Organization (The WHO, 2000, 2006, 2008-2013), the National Institutes of Health (National Institutes of Health, 2006), "Healthy People 2010" (People, H., & US Department of Health and Human Services, 2010) and "US Dietary Guidelines for Americans" (DeSalvo, Olson, & Casavale, 2016) proposed recommendations for the classification of weight status by determining the body mass index (BMI) WHO, 2006). Although BMI usually correlates with the percentage of body fat in curvilinear form, some patients with a BMI characteristic of obesity may have a normal amount of fat and increased muscle mass, while others with "normal" BMI may have an excessive amount of fat and a reduced muscle bulk (Schoeller, 2008; Kalmykova, 2014; Csaba P. Kovesdy, et al., 2017).

Despite the fact that the causes of weight loss are associated with a violation of the energy balance in the body, it is logical to assume that all methods of fighting civilization against this ailment solve one of the two tasks - to limit the supply of energy to the body or vice versa, to increase the total energy consumption . In other words, in order to bring the components of fat stores to physiological norms, one must realize at least one of the two ways. Most experts in determining the etiology of overweight and obesity agree that it is a multifactorial. (Bessessen, & Kouchner, 2004). At the same time, considering that the energy balance is determined not only by the amount of calories consumed, but also by the volume of energy costs, it is logical to assume that hypokinesia, characteristic of the majority of the modern population, contributes to the development of this pathology along with food disorders (Trifon, et al, 2016).

Corresponding Author: YULIYA KALMYKOVA, E-mail: yamamaha13@gmail.com

Studies conducted in Ukraine showed that the prevalence of obesity among people over 45 years of age can be 52,6%, and the excess body weight – 33,4%. Normal body weight is manifested only in 13,2% of the adult population of Ukraine. A large-scale study, conducted simultaneously in 15 countries of the European Union, in which 15,239 people over the age of 15 took part, showed that obesity and weight gain are closely related to a sedentary lifestyle (OECD/EU, 2016; Achkasov, et al, 2016; Lazareva, et al, 2017; Runenko, et al, 2018).

Studies conducted in the US and the UK shows a steady increase in the prevalence of obesity with age in both men and women. Interesting were the studies of L. Wier, J. Ayers et al. (2001), who evaluated changes in body weight, depending on the level of motor activity in men and women for five years. In our opinion, the reasons for this situation lie in the reduction of the level of motor activity and control over their own body weight, which prompted us to conduct this study.

There are a lot of studies in the scientific literature that show that people who actively spend their free time or participate systematically in physically active occupations are more likely to maintain a normal body weight during life (Bulich, & Muravov, 2003).

Obesity is an important risk factor for many serious medical problems, leading to a decrease in the quality of life, a significant increase in the incidence and premature death, disrupts the cardiovascular system, and this is one of the main manifestations of obesity (Osipov, et al, 2018). Patients with obesity have a significantly higher risk of hypertension, lipid metabolism disorders, insulin resistance and hyperinsulinism, ischemic heart disease (Turco, & Kalmykov, 2015; Kalmykov, & Fedi, 2016). Violation of the cardiovascular system may be complicated by the development of myocardial infarction, cardiovascular failure (Kalmykov, 2013). With the progression of obesity as body weight increases, fat is deposited in connective tissue layers of the myocardium, hampering its contractile function. These changes in the myocardium lead to a marked decrease in the contractility of the muscle of the heart (Kalmykov, & Dranishcheva, 2015; Kalmykov, & Kalmykova, 2017). Excess body weight and obesity increase the risk of ischemic, but not hemorrhagic, stroke in both men and women. The risk of fatal and nonfatal ischemic stroke increases progressively with an increase in BMI and approximately 2 times higher in obese individuals than in leanщ.

The results of a significant number of large epidemiological studies indicate that the symptoms of gastroesophageal reflux disease (GERD) are more common in obese patients than in lean individuals. The relationship between obesity and known risk factors for GERD, such as lower esophageal sphincter pressure at rest, the acidic environment of the lower esophagus, remains unclear due to conflicting results from various studies (Kalmykov, Kalmykova, & Urdina, 2016).

A metabolic syndrome is known as an insulin resistance syndrome or X syndrome. This is a specific phenotype in combination with a group of metabolic abnormalities that are risk factors for coronary heart disease (Grundy, 2016; E de França, et al., 2018). Typical features of this syndrome include obesity by the abdominal type, insulin-dependent glucose metabolism (hyperinsulinemia, impaired glucose tolerance, type 2 diabetes mellitus) (Kalmykov, 2012; Chen, et al., 2016), dyslipidemia (hypertriglyceridemia, low level high-density lipoproteins) (Kalmykov, 2010) and hypertension (Kalmykov, et al., 2015; Kalmykova, 2017). Obesity in itself is not a necessary condition of the metabolic syndrome, which is observed in obese individuals and in persons with normal body weight, but probably with excessive weight of abdominal fat (Pearl, et al, 2017; Yuliya, K., & Sergey, K., 2018).

In the treatment and rehabilitation of obese patients a set of methods is applied, the most important of which are exercise and diet, aimed at the following tasks: improving and normalizing metabolism, in particular, fat metabolism; reduction of excess body weight restoration of the body's adaptation to physical exertion; normalization of the functions of the cardiovascular, respiratory, digestive and other systems of the body of patients; improvement and normalization of the patient's motor activity; increase in nonspecific resistance (Epifanov, 2006; Popov, Valeev, & Garaseeva, 2008).

The use of kinesitherapy in the complex therapy of patients with metabolic disorders is based on its general toning and trophic effects. Increase in motor activity contributes to the normalization of the metabolism of carbohydrates and fats, activation of lipolysis, enhancement of the functional activity of other body systems. The implementation of this direction can be carried out by using mechanical devices - simulators, dosed running, swimming, intensive walking, rowing, skiing, cycling, hiking, etc. (Kazakov, Sokrut, & Povazhnaya, 2003; Runenko, et al, 2018).

Thus, among a large number of works on the problem of rehabilitation with obesity no conventional methods of physical exercises have been found, there is no classification of the most physical exercises, and there are conflicting data on the exact methods of monitoring and regulating physical activity in accordance with the state of patients. In addition, the recommendations on the use of diet therapy, massage and physiotherapy are quite contradictory and not individualized. Therefore, the treatment of obesity should be comprehensive, and include kinetotherapy (Kazakov, et al, 2003; Epifanov, 2006; Popov, et al, 2008); phytotherapy (Kalmikov, 2010); massage (Verbov, 2002; 2006; Vakulenko, 2006; Efimenko 2013), physiotherapy, diet therapy, drug therapy and many other physical therapies (Kazakov, et al, 2003), which will increase the overall performance of patients, will help to normalize body weight, more complete recovery of cardiovascular, autonomic nervous systems (Kalmykov, Kalmykova, & Bezyazichnaya, 2015; Marchenko, & Kalmykova, 2017).

Material & methods

Material: A survey of 50 women with alimentary obesity was conducted on the basis of the Kharkiv City Student Hospital. Patients were randomly divided into two groups: the main group (MG) (25 women) and the control group (CG) (25 women). By age, number, presence of concomitant pathology, the main and control groups of women were homogeneous (Table 1).

Table 1. Concomitant pathology of patients in the main and control groups

№ i/o	Concomitant pathology	Surveyed groups	
		MG, n=25	CG, n=25
1.	Hypertensive disease II st.	8	7
2.	VSD hypertensive type	6	7
3.	Chronical bronchitis	2	1
4.	Chronical pharyngotracheitis	3	3
5.	Chronical sinusitis	1	2
6.	Chronical pancreatitis	2	2
7.	Chronical cholecystitis	3	3
8.	Dyskinesia of the biliary excretory system	5	6
9.	Chronica gastroduodenitis	10	12
10.	Chronical colitis	1	-
11.	Chronical adnexitis	4	3

Research methods: with the aim of studying the evaluation and generalization of baseline and repeated anthropometric, hemodynamic indicators, the women were examined prior to the application of physical therapy (primary examination) and 4 months after the introduction of complex physical therapy programs (re-examination).

Anthropometric studies play an important role in assessing the effectiveness of rehabilitation measures in patients with alimentary obesity. A more practical and simple method of screening obesity is the calculation of the body mass index (BMI), reflecting the relationship between body weight and body length - the Quetelet index (Kalmykova, 2014; Csaba P. Kovesdy, et al, 2017). It is proved that even moderately elevated BMI leads to the development of hyperglycemia, arterial hypertension and dangerous complications. At the same time, the definition of BMI is quite simple manipulation, which ensures the timely prevention of these conditions. In general medical practice, it is recommended to determine BMI in all patients, followed by measures to reduce or maintain a normal level. BMI was determined by length and body weight:

$$\text{BMI} = \text{weight (kg)}/\text{height}^2 \text{ (m2)} \quad (1)$$

According to the received BMI, it is possible to estimate the limit of the deviation of the actual body weight from the proper one (Table 2).

Table 2. Assessment of the limits of the deviation of the actual body weight from the BMI

Body Mass Index (kg/m2)	Body weight, kg
Less than 18,5	Underweight
18,5-24,9	Normal weight
25,0-29,9	Overweight
30,0-34,9	Obese class I
35,0-39,9	Obese class II
Over 40	Obese class III

A method for determining the thickness of the skin fold using a calipers was used. To estimate fat loss, we measured the thickness of the skin-fatty folds: on the back surface of the shoulder - measured the vertical skin fold between the shoulder and elbow joints; on the side - the thickness of the diagonal skin-fat fold between the ileum and the lower edge of the thorax is measured; on the abdomen - the thickness of the vertical skin-fat fold is measured away from the navel at a distance of about 2.5 cm (Kalmykova, 2014). The overall result was scored according to Table 3.

Table 3. Average calculations of fat tissue in the body of men and women (%)

Thickness of skin folds (mm)	Men (age in years)				Women (age in years)			
	17-29	30-39	40-49	50+	16-29	30-39	40-49	50+
15	4,8	-	-	-	10,5	-	-	-
20	8,1	12,2	12,2	12,6	14,1	17,0	19,8	21,4
25	10,5	14,2	15,0	15,6	16,8	19,4	22,2	24,0
30	12,9	16,2	17,7	18,6	19,5	21,8	24,5	26,6
35	14,7	17,7	19,6	20,8	21,5	23,7	26,4	28,5
40	16,4	19,2	21,4	22,9	23,4	25,5	28,2	30,3
45	17,7	20,2	23,0	24,7	25,0	26,9	29,6	31,9
50	19,0	21,5	24,6	26,5	26,5	28,2	31,0	33,4
55	20,1	22,5	25,9	27,9	27,8	29,4	32,1	34,6
60	21,2	23,5	27,1	29,2	29,1	30,6	33,2	35,7

65	22,2	24,3	28,2	30,4	30,2	31,6	34,1	36,7
70	23,1	25,1	29,3	31,6	31,2	32,5	35,0	37,7
75	24,0	25,9	30,3	32,7	32,2	33,4	35,9	38,7
80	24,8	26,6	31,2	33,8	33,1	34,3	36,7	39,6
85	25,5	27,2	32,1	34,8	34,0	35,1	37,5	40,4
90	26,2	27,8	33,0	35,8	34,8	35,8	38,3	41,2
95	26,9	28,4	33,7	36,6	35,8	36,5	39,0	41,9
100	27,6	29,0	34,4	37,4	36,6	37,2	39,7	42,6
105	28,2	29,6	35,1	38,2	37,1	37,9	40,4	43,3
110	28,8	30,1	35,8	39,0	37,8	38,6	41,0	43,9
115	29,4	30,6	36,4	39,7	38,4	39,1	41,5	44,5
120	30,0	31,1	37,0	40,4	39,0	39,6	42,0	45,1
125	31,0	31,5	37,6	41,1	39,6	40,1	42,5	45,7
130	31,5	31,9	38,2	41,8	40,2	40,6	43,0	46,2
135	32,0	32,3	38,7	42,4	40,8	41,1	43,5	46,7
140	32,5	32,7	39,2	43,0	41,3	41,6	44,0	47,2
145	32,9	33,1	39,7	43,6	41,8	42,1	44,5	47,7
150	33,3	33,5	40,2	44,1	42,3	42,6	45,0	48,2
155	33,7	33,9	40,7	44,6	42,8	43,1	45,4	48,2
160	34,1	34,3	41,2	45,1	43,3	43,6	45,8	49,2
165	34,5	34,6	41,6	45,6	42,7	44,0	46,2	49,6
170	34,9	34,8	42,0	46,1	44,1	44,4	46,6	50,0
175	35,3	-	-	-	-	44,8	47,0	50,4
180	35,6	-	-	-	-	45,2	47,4	50,8
185	35,9	-	-	-	-	45,6	47,8	51,2
190	-	-	-	-	-	45,8	48,2	51,6
195	-	-	-	-	-	46,2	48,5	52,0
200	-	-	-	-	-	46,5	48,9	52,4
205	-	-	-	-	-	-	49,1	52,7
210	-	-	-	-	-	-	49,4	53,0

Hemodynamic parameters were determined and analyzed: the heart rate (HR) was performed by palpation of the pulse on the radial artery, with auscultation at rest, at the beginning, at the middle and at the end of exercise therapy according to the generally accepted method; arterial tonometry was performed according to the standard method using the BPI AGI-80 membrane tonometer (manufacturer Microlife, Switzerland, plant No. 46527318, certificate of calibration of the measuring instrument No. 5086/436), the systolic (SBP) and diastolic blood pressure (DBP) values were determined. In order to fully obtain information on the cardiovascular system in patients with nutritional status of grade II, and also to determine the amount of physical exertion in the preparation of individualized physical rehabilitation programs, we determined and analyzed hemodynamic characteristics such as shock (SV) and minute (MVB) volume blood, cardiac (CI) and shock (SI) indices (Kalmykova, 2014).

The research design. In the main group of women, a complex program of physical therapy for obesity of I-II degree was developed and introduced, which included the use of hypocaloric diet No.8 (Kholodova, & Sharonina, 2005; Samoylov, 2007; Polumbrik, 2008); massage by the method of Efimenko, P.B. (2013); physiotherapeutic treatment in the form of influence of sinusoidal modulated current with sympathomimetics on the area of local fat deposits (according to Tereshchenko, I.V. 1997) and thermal hydroprocedures in the form of contrast baths; therapeutic gymnastics; morning hygienic gymnastics; dosed walk.

Physical exercises were applied for the muscles of the upper limbs and shoulder girdle, neck, trunk with aerobic elements with full amplitude; exercises for the coordination and training of the vestibular apparatus; regulated breathing exercises when walking, taking into account the activity of the autonomic nervous system (ANS); Pause rest and relaxation exercises. All physical exercises were performed from the initial positions "sitting on the floor", "standing". The basic exercises in aerobics are various types of walking and running, jumping and jumping, flying legs, squats, lunges. The application of these exercises in combination with movements, turns, hand movements provides a different effect on the human body. In addition to aerobic exercises, the exercises include a large number of exercises aimed at reducing body weight, developing strength and strength endurance of various muscle groups, correcting the figure, and developing flexibility (Howly, & Franks, 1997). The aerobics classes used rhythmic music in the style of "foxtrot", "charleston", "tango", Latin American rhythms ("cha cha", "samba", "rumba"), fast music in the style of "disco", "rock n-roll "," break-dance ".

In the control group of women, the physical therapy program included dietotherapy using a hypocaloric diet (Kholodova, & Sharonina, 2005; Tronko, 2005; Samoylov, 2007), exercise therapy according to Popov, S.N. (2005, 2008), and Belaya, N.A. (2001), therapeutic massage by the method Verbov, A.F. (2002, 2006).

Statistical analysis. Generalization of the studied characteristics was assessed by mean arithmetic value, standard deviation and error of mean arithmetic. Confidence of differences between mean values was stated by Student's t-criterion. Assessment of statistical hypothesizes based on 5% significance level. For statistical processing of data we used licensed program Microsoft Excel (2010). Statistical analysis of the received results was conducted, considering recommendations on the Microsoft Excel tables' usage for computer data analysis.

Results of the study and their discussion.

From the anthropometric indices in the examined women of the main and control groups, we determined the length and weight of the body, the abdominal circumference, the thickness of the skin fold, the body mass index and the percentage of fat tissue were calculated. When comparing the anthropometric indices of the patients of both groups, we did not find statistically significant differences in the studied parameters (p>0,05) (Table 4).

Table 4. Anthropometric indices for the primary study of the main (n = 25) and control (n = 25) group of women ($\overline{X} \pm m$)

Indicators	Surveyed groups		t-criterion of Student	p
	main group (n=25) $\overline{X} \pm m$	control group, (n=25) $\overline{X} \pm m$		
Length of body, m	163,68±1,04	165,48±1,14	1,08	>0,05
Body weight, kg	84,66±1,57	86,30±1,69	0,71	>0,05
Body mass index, kg/m^2	31,67±0,46	31,48±0,49	0,28	>0,05
Abdominal circumference, cm	86,56±1,24	85,40±1,28	0,65	>0,05
Total thickness of the skin fold: on the back of the shoulder, on the side, on the stomach, mm	62,72±1,94	64,08±2,04	0,48	>0,05

In the main group with obesity of the 1st degree, we found 22 people (88,0%), with obesity of grade II - 3 people (12,0%). In the control group of persons with obesity of the I degree - 23 people (92,0%), with obesity of the II degree - 2 people (8,0%).

The total thickness of the skin fold: on the back surface of the shoulder, on the side, on the abdomen in the women of the main group was 62,72±1,94 mm, the control - 64,08±2,04 mm, indicating that the fat content in the body is above the average - at the level of 26-30%. Thus, the conducted anthropometric study confirms the presence of alimentary obesity of I-II degree in the patients under examination.

According to the literature (Kalmykova, & Yakovenko, 2015; Kalmykov, Kalmykova, & Poruchchykova, 2015; Kalmykov, & Fedi, 2016) it is known that the course of nutritional obesity, depending on the degree of severity, is complicated by CAD (coronary artery disease), hypertension, autonomic dysfunction. The hemodynamic parameters obtained during the initial examination testified to the absence of economization of the cardiovascular system, confirms the data of the literature sources (Tronko, 2005; Kalmykov, Kalmykova, & Bezyazichnaya, 2015; Marchenko, & Kalmykova, 2017).

In the initial study, there was an increase in the level of systolic blood pressure and heart rate in patients of both groups (Table 5).

Table 5. Hemodynamic parameters of the examined groups in the primary study of the main and control group of women (M±m)

Indicators	Norm	Surveyed groups		t-criterion of Student	p
		main group (n=25) $\overline{X} \pm m$	control group, (n=25) $\overline{X} \pm m$		
Heart rate, beats/min.	**60-84**	90,56±1,43	91,68±1,53	0,54	>0,05
SBP, mmHg	**100-139**	150,28±2,72	152,36±2,94	0,52	>0,05
DBP, mmHg	**60-89**	81,60±2,39	83,48±2,56	0,54	>0,05
SV, ml	**60-120**	66,98±1,74	65,42±1,95	0,60	>0,05
MVB ml/min	**3000-7000**	6025,0±115,5	5949,7±133,5	0,31	>0,05
SI, l/min./m^2	**2,5-4,5**	3,16±0,09	3,08±0,09	0,57	>0,05
CI, ml/m^2	**40-50**	35,29±1,19	34,08±1,19	0,72	>0,05

Thus, in women of the main and control groups, hypertension was observed with an increase in systolic pressure (150,28±2,72 and 152,36±2,94 mm Hg, respectively) (p>0,05). Parallel to this, we found in patients of

both groups an acceleration of heart rate (90,56±1,43 in patients of MG and 91,68±1,53 beats/min in patients of CG) (p>0,05).

The shock volume in the patients of the main and control groups was observed at the lower limit of the norm – 66,98±1,74 and 65,42±1,95 ml, respectively. MVB in both groups was determined within the limits of normal values (p>0,05). The cardiac index in main group MG and CG was observed within the limits of normal values – 3,16±0,09 and 3,08±0,09 l/min/m^2, respectively. The primary primary values of SI (35,29±1,19 in MG and 34,08±1,19 ml/m^2 in CG) are within the normal range and indicate a predominance of hypokinetic hemodynamics in patients with MC and CG (p>0,05) (Kalmykova, 2014).

When reexamining the anthropometric indices in the examined patients, we determined the positive dynamics, namely, weight loss, BMI, abdominal circumference and total thickness of the skin fold (Table 6).

Table 6. Dynamics of anthropometric indicators before and after experiment in the main (n=25) and control (n=25) group of women ($\overline{X} \pm m$)

Indicators	Group	Before experiment $\overline{X} \pm m$	After experiment $\overline{X} \pm m$	t-criterion of Student	p
Body weight, kg	Main Control	84,66±1,57 86,30±1,69	74,81±1,50 81,95±1,70	4,53 1,82	<0,001 <0,05
Body mass index, kg/m^2	Main Control	31,67±0,46 31,48±0,49	27,89±0,48 29,73±0,45	5,70 2,62	<0,001 <0,05
Abdominal circumference, cm	Main Control	86,56±1,24 85,40±1,28	79,68±1,01 83,28±1,20	4,31 1,21	<0,001 >0,05
The total thickness of the skin fold: on the back of the shoulder, on the side, on the stomach, mm	Main Control	62,72±1,94 64,08±2,04	56,52±2,08 62,52±2,01	2,18 0,55	<0,05 >0,05

In the women of the main group, in a second study, we observed a decrease in body weight by 11,6% compared to the initial study. In the control group, the body weight decreased by 5,0%.

The body mass index in the exhaust gas decreased from 31,67±0,46 kg/m2 to 27,89±0,48 kg/m^2 - by 11,9% (p>0,001). In the CG, the BMI decreased from 31,48±0,49 kg/m^2 to 29,73±0,45 kg/m2 - by 5,6% (p>0,05). In both groups, BMI responded with "excess body weight.

Abdominal circumference in the main group decreased from 86.56 ± 1.24 cm to 79,68±1,01 cm (p>0,001) - by 7,9%; in the control group - from 85,40±1,28 cm to 83,28±1,20 cm - by 2,5%, and in the control group the dynamics of this indicator was statistically insignificant.

The total thickness of the skin fold in the MG decreased by 9,9% and was 56,52±2,08 cm; in CG - decreased by 2,4% and was 62,52±2,01 cm, indicating that the fat content in the body is above the average - at the level of 26-30%.

Comparing the anthropometric indices in the patients of the main and control groups, we came to the conclusion that when the second group was re-examined after the author's program of physical rehabilitation they were better (p>0,05) (Table 7).

Table 7. Comparative characteristics of anthropometric indices of the main (n = 20) and control (n = 20) groups of women after experiment ($\overline{X} \pm m$)

Indicators	Surveyed groups		t-criterion of Student	p
	main group (n=25) $\overline{X} \pm m$	main group (n=25) $\overline{X} \pm m$		
Body weight, kg	74,81±1,50	81,95±1,70	3,15	<0,05
Body mass index, kg/m^2	27,89±0,48	29,73±0,45	2,78	<0,05
Abdominal circumference, cm	83,28±1,20	83,28±1,20	2,30	<0,05
The total thickness of the skin fold: on the back of the shoulder, on the side, on the stomach, mm	56,52±2,08	62,52±2,01	2,08	<0,05

At repeated investigation of hemodynamic parameters after the application of rehabilitation measures, the parameters of heart rate, SBP, DBP in women of the main group (p>0,001), in the control group, the dynamics of DBP was statistically insignificant (p>0,05) (Table 8).

Table 8. Dynamics of hemodynamic parameters in the main (n=25) and control (n=25) group of women before and after experiment ($\overline{X} \pm m$)

Indicators	Group	Norm	Before experiment $\overline{X} \pm m$	After experiment $\overline{X} \pm m$	t-criterion of Student	p
Heart rate, beats/min.	Main Control	**60-84**	90,56±1,43 91,68±1,53	72,60±1,54 83,60±1,51	8,57 3,76	<0,001 <0,001
SBP, mmHg	Main Control	100-139	150,28±2,72 152,36±2,94	136,56±2,23 144,48±2,52	3,90 2,03	<0,001 <0,05
DBP, mmHg	Main Control	**60-89**	81,60±2,39 83,48±2,56	72,60±1,39 80,20±1,95	3,26 1,02	<0,001 >0,05
SV, ml	Main Control	**60-120**	66,98±1,74 65,42±1,95	68,23±1,12 63,67±1,64	0,61 0,69	>0,05 >0,05
MVB ml/min	Main Control	**3000-7000**	6025,0±115,5 5949,7±133,5	4933,5±95,0 5286,9±116,1	7,34 3,75	<0,001 <0,001
SI, l/min./m^2	Main Control	**2,5-4,5**	3,16±0,09 3,08±0,09	2,68±0,07 2,81±0,08	4,28 2,14	<0,001 <0,05
CI, ml/m^2	Main Control	**40-50**	35,29±1,19 34,08±1,19	37,01±0,88 33,89±1,09	1,16 0,12	>0,05 >0,05

In women MG the HR of the heart rate decreased by 19,8% in comparison with the primary one, the SBP level decreased by 9,1%, the DBP level decreased by 11,0%. In addition, in the main group, the number of patients with elevated SBP from 19 patients decreased by a primary examination to 8 after the author's program of physical rehabilitation, an increased DBP was registered in 7 patients with a primary examination, with a repeat one - those with elevated DBP were not registered.

In the MG, the level of SV increased from 66,98±1,74 to 68,23±1,12 ml (p>0,05), while MVB decreased due to a decrease in heart rate in the patients under examination. Reducing the SI from 3,16±0,09 to 2,68±0,07 l/min./m^2 indicates an improvement in the functional state of the cardiovascular system. The growth of CI in 37,01±0,88 ml/m^2 testifies to the approach of the type of circulation in women of MG to the most optimal, eukinetic.

In patients in CG, the heart rate decreased by 8,8% in comparison with the primary heart rate, the SBP level decreased by 5,2%, the DBP level decreased by 3,9% (p>0,05). The number of people with high systolic blood pressure decreased from 19 people with a primary to 18 people with a second examination. The number of women in the control group with elevated DBP decreased from 9 in the primary group to 6 in the case of a second examination. In patients with CG, a re-examination showed a statistically insignificant decrease in the level of SV from 65,42±1,95 to 63,67±1,64 ml and a decrease in the MVB level from 5949,7±133,5 to 5286,9±116,1 ml/min. at the expense of both the heart rate and SV. The decrease in CI in patients of the control group from 34,08±1,19 to 33,89±1,09 ml/m^2 indicates the presence of a hypokinetic type of circulation.

Comparing the performance of the cardiovascular system in the patients of the main and control groups, we came to the conclusion that when the second group of patients was re-examined after applying the author's program of physical rehabilitation, they (except the cardiac index) were better, which indicates the economization of cardiovascular work system (p>0,05) (Table 9).

Table 9. Hemodynamic parameters after the experiment of the main (n = 25) and control (n = 25) groups of women ($\overline{X} \pm m$)

Indicators	Norm	Surveyed groups		t	p
		main group (n=25) $\overline{X} \pm m$	main group (n=25) $\overline{X} \pm m$		
Heart rate, beats/min.	**60-84**	72,60±1,54	83,6±1,51	5,11	<0,001
SBP, mmHg	100-139	136,56±2,23	144,48±2,52	2,35	<0,05
DBP, mmHg	**60-89**	72,60±1,39	80,20±1,95	3,17	<0,005
SV, ml	**60-120**	68,23±1,12	63,67±1,64	2,30	<0,05
MVB ml/min	**3000-7000**	4933,5±95,0	5286,9±116,1	2,36	<0,05
SI, l/min./m^2	**2,5-4,5**	2,68±0,07	2,81±0,08	1,29	>0,05
CI, ml/m^2	**40-50**	37,01±0,88	33,89±1,09	2,23	<0,05

Discussions

Obesity is based on an imbalance between the amount of calories entering the body and energy costs. However, the mechanisms that lead to this imbalance are still not well understood. Obesity is genetic in nature, but its development also depends on the characteristics of the environment in which the individual is from

excessively consumed calories, low physical activity, social and economic factors, and also from metabolic and endocrine disorders (Samoylov, 2007; Polumbrik, 2008).

It is proved that physical activity leads to a moderate increase in energy consumption and contributes to a change in the energy balance. But sometimes physical loads with undoubted advantage do not give a significant reduction in body weight, which is explained by the redistribution of the fat content (it decreases) in the direction of increasing muscle mass. Classes of curative physical culture with obesity have a positive effect on the function of the digestive system, usually these individuals actively function. Physical exercises for abdominal muscles stimulate the digestive processes, activate the respiratory function of the stomach and intestines and have a positive effect on the secretion of the stomach, contributing to the reduction of stagnant phenomena, gravity in the abdominal area and reducing constipation, enhance the contractile function of the gallbladder and the entry of bile into the intestine (Epifanov, 2006; Popov, Valeev & Garaseeva, 2008; Kalmykov, Kalmykova, & Bezyazichnaya, 2015).

Systematic dosed execution of physiotherapy in obese patients, providing an intensification of the functions of the basic systems and metabolic processes, contributes to the formation of a new, more stable and full-fledged "dynamic stereotype" characterized by a higher level of functioning and efficiency of the whole organism. The effect of growing and regular dosed workouts is manifested in the improvement of the contractile function of the myocardium and its more complete blood supply. Training also contributes to the improvement of the function of the anticoagulant system of blood and the development of collateral (bypass in the disturbed area) blood circulation. Counteracting the progression of atherosclerosis, physical training improves the function of the entire vascular system, facilitating the work of the heart (increasing blood flow to the heart, expanding the blood vessels of the heart, improving the nutrition of the heart muscle). During physical exercises stimulation of auxiliary circulatory factors occurs (increase of tone and working capacity of the muscular system, as well as movements in the joints). Thus, the effect of curative physical education on the cardiovascular system in obesity is expressed in strengthening and improving the function of the myocardium, the vascular system, the auxiliary circulatory factors, and also in improving metabolic processes, both in the myocardium and throughout the body. Regular training of the cardiovascular system with obesity increases its efficiency and most appropriately develops the process of adaptation of the circulatory function in the case of impaired metabolism (Kazakov, et al., 2003; Epifanov, 2006, Popov, 2008).

One of the important factors in the prevention and treatment of obesity is proper breathing (Popov, 2005; Popov, Valeev & Garaseeva, 2008): so that fats liberate the energy contained in them, they must undergo oxidation. Lessons should be long (45-60 minutes or more), movements are performed with a large amplitude, large muscle groups are involved in the work, flies are used, circular movements in large joints, exercises for the trunk (tilts, turns, rotations), exercises with objects. A large proportion in the employment of people with overweight should take cyclical exercises, in particular walking and running.

According to Kazakov, V.N., Sokrut, V.N. & Povazhnaya, Ye.S. (2003) physiotherapy and physiotherapy treatment for obesity should be appointed taking into account the dominant syndromes during this disease: dyshormonal, metabolic, dyscirculatory, astheno-neurotic.

According to Vardimiadi, N.D. & Mashkova, L.G. (1998) and Belaya, N.A. (2001) with obesity, the total physical load should be submaximal and individualized in accordance with the functional capabilities of the patient's body. To achieve the greatest effect, different forms of exercise therapy should alternate throughout the day. The duration of each TE (therapeutic exercises) procedure is from 5 to 45-60 minutes. In the TE should use objects and shells - Medbol (1-4 kg), dumbbells (1-3 kg), expanders, etc.

With this disease, massage is an effective component of complex treatment. Its effectiveness is based on mechanical, neuro-reflex and humoral factors of influence on the human body. The action of the mechanical factor is manifested in the loosening of fatty tissue, and the neuro-reflex and humoral - in stimulating the function of the whole organism and the general metabolism. All this together will help reduce the deposition of adipose tissue (Verbov, 2002, 2006; Vakulenko, 2006). According to the recommendations of Efimenko, P.B. (2013) of the complete solution of the tasks posed do not directly result in the excessive accumulation of adipose tissue in certain areas, but in the case of a full body massage. Therefore, the best result is obtained with a general massage, applying all the massage techniques in a certain sequence and variety of manipulations. The intensity and duration of massage of individual parts of the body is directly dependent on the location and amount of adipose tissue deposition. Massage is carried out by the method of general hygiene massage.

Therapeutic diet plays a leading role in the complex therapy of obesity. Dietotherapy is aimed at limiting the deposition of fat in the body. It provides for reducing the energy value of the diet, inhibiting the food center and secretory activity of the stomach, limiting digestion and absorption in the intestine, inhibiting lipogenesis and increasing lipolysis in fat stores, stimulating oxidative processes in the body. Therapeutic diet should be differentiated taking into account the degree of obesity, the energy costs of the organism, the nature of the complications and the presence of concomitant diseases (Samoylov, 2007; Polumbrik, 2008; Trifon, et al., 2016).

Conclusions

The conducted studies supplemented and expanded the existing data on the positive effect of metered physical loads on anthropometric indicators, the functional state of the cardiovascular system in patients with alimentary obesity of I-II degree (Kalmykov, Kalmykova, & Bezyazichnaya, 2015; Marchenko, & Kalmykova, 2017).

In the initial study of anthropometric indices in both groups of women, pathological changes were found confirming the presence of alimentary obesity of the I-II degree. Differences in the study indices between the patients of the main and control groups were statistically insignificant. The increases in blood pressure, the increase in the heart rate in primary study indicate a predominance of hypokinetic hemodynamics in the main and control groups of women. The decrease in stroke volume is associated with an increase in the total peripheral resistance with constant values of venous return and adequate contractility; the presence of normal MVB parameters in patients of both groups is associated with increased pumping function of the heart under the influence of the sympathetic nervous system.

The study of the effect of the developed complex physical rehabilitation program revealed positive changes in hemodynamic parameters: in women's MG, the heart rate decreased by 19,8%, the level of systolic blood pressure decreased by 9,1%, the level of diastolic pressure decreased by 11,0%, the level of SV increased from 66,98±1,74 to 68,23±1,12 m ($p>0,05$) while MVB significantly decreased due to a decrease in heart rate in the patients under examination; there was a decrease in SI from 3,16±0,09 to 2,68±0,07 l/min./m^2, which indicates an improvement in the functional state of the cardiovascular system.

A rational combination of therapeutic gymnastics based on aerobic rhythmic gymnastics, morning hygienic gymnastics, dosed walking with regulated breathing exercises, taking into account the tone of the sympathetic or parasympathetic parts of the autonomic nervous system of patients with a hypocaloric diet number 8, massage according to the method of P.B. Efimenko (2013) and physiotherapeutic treatment by means of the effect of a sinusoidal modulated current with sympathomimetics on the area of local fat deposits (according to the method of I.V. Tereshchenko, 1997) and thermal hydroprocedures in the form of contrast baths created conditions for mutual potentiation of their action on the patient's organism and promoted anthropometric indicators and functional parameters of the cardiovascular system.

Conflict of Interest. The authors declare that there is no conflict of interests.

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