

Determining the effectiveness of the physical therapy program for obese patients according to the dynamics of metabolic syndrome parameters

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Purpose: to determine the effectiveness of the physical therapy program for obese patients by the dynamics of the components of the metabolic syndrome.

Material & Methods: 214 people of the second adulthood with obesity I and II degree were examined. In terms of compliance, they were divided into a comparison group (low level) and a main group (high level). The control group consisted of 63 people without signs of obesity. The components of the metabolic syndrome were evaluated by anthropometric indicators (body mass index, waist and hip circumference, their ratio) and biochemical parameters (blood glucose, cholesterol, triglycerides, high density lipoproteins, leptin), and the visceral obesity index was calculated. The examination was carried out before and after the introduction of the annual program of physical therapy, which included maintaining a high level of compliance, increasing physical activity, changing the diet, reflexology, massage, and psychocorrection.

Results: in all obese individuals were determined by abdominal obesity, fasting hyperglycemia and impaired glucose tolerance, high levels of total cholesterol, triglycerides, leptin, low levels of low-density lipoproteins. The visceral obesity index exceeded those of people with normal body weight ($p < 0,05$). Compliance with the principles of the developed program made it possible to achieve a statistically significant ($p < 0,05$) improvement relative to the initial indicators of all the studied parameters of the persons of the main group. Patients in the comparison group showed an increase in body mass index, a tendency to deteriorate atherogenic dyslipidemia and glucose uptake, a high content of leptin.

Conclusions: as a result of the implementation of the developed program of physical therapy, a statistically significant improvement in the studied parameters of the metabolic syndrome in obese patients was compared with the initial result and the comparison group.

Keywords: metabolic syndrome; obesity; physical therapy; rehabilitation.

Introduction

According to the World Health Organization (WHO), a global public health problem among diseases of eating disorders is obesity and overweight, which are considered an epidemic of the XXI century, because now they have more than 1,6 billion people on Earth; every 10 years their number increases by 10% [13]. 80% of all diseases to one degree or another are associated with malnutrition, and 41% is their direct consequence. The urgency of the problem of these conditions is justified by the high prevalence, increased disability and mortality from related disorders [10; 12].

The concept of "metabolic syndrome" (MS) was proposed to highlight a cluster of individuals at increased risk of developing cardiovascular disease and type 2 diabetes. In all definitions of MS, the main criterion is considered to be central (abdominal) obesity, that is, we are talking about options for its combination with an increased level of low density lipoproteins (LDL), triglycerides (TG), a decrease in the concentration of high density lipoproteins (HDL), high blood pressure, disorders carbohydrate metabolism (all of them belong to additional criteria of MS) [6; 7].

Like obesity, MS is characterized by an increase in the mass of visceral fat, a decrease in the sensitivity of peripheral tissues to insulin and hyperinsulinemia, the development of disorders of carbohydrate, lipid, purine metabolism, arterial hypertension, microalbuminuria, an increase in the level of fibrinogen,

a highly sensitive C-reactive protein, interleukins 1, 6, 18, tumor necrosis factor, leptin and a decrease in adiponectin levels. It was determined that people with overweight have a 50% higher risk of developing hypertension than people with normal body weight, and the risk of developing diabetes is 4,0–6,0 times higher; Also, the risk of developing fatty liver, digestive, respiratory, musculoskeletal, neoplasms, etc. [6; 9].

Both conditions – obesity and MS – have similar pathogenetic mechanisms and clinical manifestations. In practice, this means that without obesity it is not MS, but the etiopathogenetic correction of its individual signs that must necessarily include a decrease in the amount of abdominal fat. Directions of the correction of MS aimed at stabilizing the main links of the metabolic chain, combined by common components of pathogenesis, drug and non-drug measures. Among the latter, lifestyle modification, hypocaloric nutrition, and the expansion of physical activity occupy a prominent place [2–5], which also echoes the correction of excess body weight [9; 11; 12].

The problem of reducing body weight is that, despite the well-known methods of its correction (creating a deficit between the intake and consumption of energy compounds through hypocaloric nutrition and an increase in physical activity) [9; 10; 12], the results of conducting rehabilitation programs are not always satisfactory due to non-compliance with the recommendations provided by patients – a low level of adher-

ence to treatment or low compliance) [13]. Thus, the creation of a program for reducing body weight in obese patients with elements of overcoming non-compliance and assessing its effectiveness in terms of the dynamics of MS components is an urgent issue in modern physical therapy.

Purpose of the study: to determine the effectiveness of the PT program for obese patients by the dynamics of the components of MS.

Material and Methods of the research

The study was based on a survey of 214 people of the second adulthood with nutritional and constitutional obesity: I degree – 65 women and 51 people; II degree – 64 women and 34 men. The control group (CG) consisted of 63 people with normal body weight (32 women, 31 people). The average age of the examined with obesity was $39,6 \pm 1,6$ years, and the CG – $41,3 \pm 2,6$ years. According to the results of determining rehabilitation compliance (consent to the implementation of rehabilitation recommendations), patients were divided into two parts. The comparison group (CG – depending on the degree of obesity according to CG1 and CG2) consisted of individuals with a low level of compliance; they refused to undergo the PT program to reduce body weight, but were informed about the consequences and complications of obesity; acquainted with the basic principles of hypocaloric nutrition and physical activity with it. The main group (MG, in accordance with the degree of obesity of MG1 and MG2) consisted of individuals with a high level of compliance, they underwent the PT program for one year and included the following components:

- constant support and improvement of the compliance level, which is the key to patient compliance with the developed PT program (adapting the program to individual social conditions; educational conversations; psychological support; regular

personal and electronic consultations; setting and achieving short and long-term goals of PT) [1];

- the gradual development of a long stereotype of a healthy diet (by optimizing calories and diet)

- Increase in physical and physical activity (morning hygienic gymnastics, stretching, cardio, strength training);

- Corporate and auricular acupuncture (in order to suppress feelings of hunger and thirst, reduce the degree of discomfort during the period of limiting nutrition, improve the functioning of internal organs);

- massage (lymphatic drainage, general, abdominal cavity) in order to accelerate the removal of excess fluid, recovery after training, improve the functioning of the abdominal organs;

- psychological support (improvement of the psychoemotional state, behavioral psychocorrection, development of a conscious active attitude to the process of losing weight).

The main principle of creating the program was an individual approach, taking into account the possibilities, concomitant diseases, the psycho-emotional state of the patient with constant monitoring of the state of body functions against the background of maintaining a high level of compliance.

As the main criteria for MS in this study, according to the recommendations of the International Diabetes Association [6; 7], considered a combination of abdominal obesity (a mandatory criterion) (according to the ratio of waist circumference (WC) and hips (HC)) and a high content of TG, fasting hyperglycemia, and a decrease in HDL content. Additional criteria were considered impaired glucose tolerance (according to the results of a 2-hour exercise test), high levels of leptin,

Table 1
Dynamics of anthropometric parameters under the influence of the PT program ($\bar{X} \pm S$)

Indicators	CG n=63	Obesity I degree				Obesity II degree			
		CG1 before n=60	CG1 after n=60	MG1 after PT n=56	MG1 after PT n=56	CG2 before n=57	CG2 after n=57	MG2 after PT n=41	MG2 after PT n=41
BMI									
men	23,9±0,8	31,4±0,6*	32,6±0,5*	31,4±0,4*	25,0±0,2●	36,2±0,7*	36,8±0,5*	38,0±0,3*	30,2±0,2**●
women	22,4±1,1	31,8±0,4*	32,2±0,5*	31,9±0,4*	24,1±0,2●	35,6±0,3*	37,4±0,4*	36,4±0,9*	26,2±0,5**●
WC, cm									
men	80,3±1,2	109,7±1,5*	110,5±1,2*	109,1±2,0*	85,9±1,1●	117,3±1,5*	122,8±1,6*	121,6±1,4*	100,6±0,8**●
women	73,5±1,5	93,4±1,1*	95,1±0,9*	93,7±1,2*	76,2±0,8●	106,6±1,3*	112,3±1,8*	112,9±1,3*	93,2±1,0**●
HC, cm									
men	90,6±1,2	112,2±1,6*	114,1±1,5*	110,5±1,4*	98,1±0,5●	120,4±1,2*	125,9±0,8*	122,7±0,6*	104,8±0,9**●
women	97,2±1,2	108,8±1,1*	111,1±0,6*	107,1±1,0*	96,9±1,5●	115,1±1,7*	118,5±1,5*	119,4±1,2*	106,1±0,9**●
WC/HC									
men	0,89±0,07	0,98±0,02	0,97±0,04	0,99±0,03	0,88±0,04●	0,97±0,02	0,98±0,04	0,99±0,03	0,96±0,03
women	0,76±0,05	0,86±0,05	0,86±0,06	0,87±0,04	0,79±0,03●	0,93±0,06	0,95±0,04	0,95±0,03	0,88±0,02●

Remark. * – statistically significant difference compared with the value of the corresponding indicator of CG ($p < 0,05$); * – statistically significant difference compared with the initial examination indicator (for CG) or the corresponding indicator in PT (for MG) ($p < 0,05$); ● – statistically significant difference compared with the corresponding indicator of CG ($p < 0,05$).

total cholesterol (cholesterol). Biochemical studies were carried out using a CardioChekRA express analyzer. The Visceral Adiposity Index was calculated [8].

Testing was carried out before and after the summer observation period (persons CG) or the period of implementation of the rehabilitation program (persons MG).

The study participants were acquainted with the main provisions of the study and signed an informed consent to participate in it. The data obtained were processed using Microsoft Excel programs. The arithmetic mean value (\bar{X}) and the standard deviation (S) of the studied parameters were calculated. To assess the reliability of the obtained indicators, student criteria were used. The critical level of significance in testing statistical hypotheses in this study was taken equal 0,05.

Results of the research

In patients with obesity of I and II degrees, abdominal obesity was determined according to the calculation of the ratio of WC to HC (greater than 0,95 in men and 0,80 in women) (Table 1). An increased content of visceral (brown abdominal) fat is considered a predictor of high cardiovascular risk and metabolic disorders [7].

Certain fasting hyperglycemia and impaired glucose tolerance according to the analysis of the glucose profile after a stress test in obese patients indicate insulin resistance and is interpreted as the presence of type 2 diabetes mellitus (Table 2).

In patients with obesity, TG revealed atherogenic dyslipidemia. Dangerously high levels of the threat of developing athero-

sclerosis were characterized by the level of total cholesterol and TG; low levels of LDL cholesterol having an antiatherogenic effect were also identified (Table 2).

In patients with obesity, the levels of leptin, a key mediator between the hypothalamic-pituitary system and adipose tissue, were also characterized by high levels (Table 2). It is a protein that is encoded by the genome in fat cells, causes excessive development of adipose tissue; participates in the processes of regulation of body weight, increases with its increase. Normally, in response to an increase in insulin concentration, the production of leptin also increases, which, by the principle of negative feedback, inhibits further production and release of insulin [7; 12].

Indicative were the results of the calculation of VAI, an integral marker that combines the parameters of WC, BMI, TG, HDL and is a parameter of visceral adipose tissue function and insulin sensitivity [8]. In the presence of obesity, this parameter was several times higher than the value of individuals with normal body weight.

Obesity patients adhering to the principles of the developed PT program against the background of a high level of compliance showed an improvement in all the studied parameters.

With obesity of the first degree, BMI in women was normal, in men it reached the indicator of overweight. In obesity of the II degree, women also achieved a better result: BMI reached the level of overweight, in men – obesity of the I degree (Table 1).

Due to interventions, the amount of abdominal fat in all groups

Table 2
Dynamics of biochemical blood parameters under the influence of the PT program ($\bar{X} \pm S$)

Indicators	CG	Obesity I degree				Obesity II degree				
		CG1 before	CG1 after	MG1 after PT	MG1 after PT	CG2 before	CG2 after	MG2 after PT	MG2 after PT	
Glucose, mmol/l										
on an empty stomach	3,92±0,08	5,68±0,03*	5,85±0,02*	5,74±0,06*	4,32±0,02**●	6,16±0,05*	6,47±0,05*	6,08±0,06*	5,18±0,03**●	
after glucose loading	5,17±0,02	7,15±0,06*	7,62±0,05*	7,59±0,08*	6,08±0,03**●	8,09±0,11*	8,22±0,04*	8,15±0,07*	7,32±0,05**●	
Total cholesterol, mmol/l	5,03±0,06	5,95±0,07*	6,15±0,08*	6,08±0,04*	5,12±0,02**●	7,45±0,07*	7,92±0,0*	7,33±0,08*	5,61±0,03**●	
HDL, mmol/l										
men	1,21±0,06	1,02±0,02*	1,05±0,04*	1,05±0,03*	1,17±0,03**●	0,86±0,05*	0,83±0,01*	0,87±0,03*	1,04±0,04**●	
women	1,39±0,08	1,08±0,03*	1,11±0,04*	1,12±0,05*	1,26±0,05*	0,99±0,02*	0,98±0,01*	0,97±0,04*	1,13±0,05**	
TG, mmol/l	1,38±0,07	1,76±0,03*	1,72±0,04*	1,72±0,06*	1,42±0,05**●	2,93±0,07*	3,04±0,09*	2,92±0,06*	2,02±0,05**●	
Leptin, ng/ml										
men	4,13±0,08	16,98±0,09*	16,67±0,06*	17,05±0,05*	10,92±0,04**●	26,39±0,11*	27,15±0,09*	27,91±0,7*	19,37±0,04**●	
women	5,81±0,05	22,58±0,11*	21,31±0,14*	23,08±0,18*	15,63±0,07**●	32,45±1,06*	33,18±0,16*	31,52±0,20*	20,48±0,12**●	
VAI										
men	1,38±0,03	2,44±0,06*	2,24±0,08*	2,30±0,07*	1,53±0,06**●	4,72±0,25*	5,25±0,11*	4,68±0,06*	3,66±0,03**●	
women	1,74±0,05	2,95±0,05*	2,79±0,04*	2,79±0,07*	1,86±0,09**●	5,70±0,06*	6,09±0,06*	6,06±0,08*	3,63±0,04**●	

Remark. * – statistically significant difference compared with the value of the corresponding indicator of CG ($p < 0,05$); ** – statistically significant difference compared with the initial examination indicator (for CG) or the corresponding indicator in PT (for MG) ($p < 0,05$); ● – statistically significant difference compared with the corresponding indicator of CG ($p < 0,05$)

decreased relative to the initial parameter. In representatives of MG1 they reached normal ratios; in MG2 – statistically significant improved relative to the initial parameters ($p < 0,05$).

Under the influence of the developed measures, the severity of biochemical manifestations of metabolic and dyslipidemic manifestations relative to the parameters of the initial examination decreased in the main groups. Fasting glucose parameters normalized, tissue sensitivity to glucose was restored. Positive changes occurred in the concentrations of atherogenic lipid fractions – total cholesterol, LDL, TG; respectively, improved VAI (Table 2).

In MG1 and MG2, an improvement in the concentration of leptin was determined relative to the initial parameters and the level of CG ($p < 0,05$). However, the lack of full normalization indicates an incomplete metabolic rearrangement of metabolism in adipose tissue. That is, the duration of correction of body weight and its content requires a long intervention than 1 year.

At the same time, in patients of the comparison groups with low compliance there was a visible increase in body weight, a tendency to worsen atherogenic dyslipidemia, that is, signs of MS, and, accordingly, the risk of cardiovascular catastrophes increased.

Conclusions / Discussion

Obesity is an independent chronic disease with many complications, which in the practice of a physical therapist is advisable to adjust as a separate class. Its correction goes beyond the endocrinological direction and acquires the character of a multidisciplinary pathology. In the framework of obesity, it is advisable to distinguish MS – a complex of individual symptoms that indicate a potentially high risk of cardiac pathology [7].

If the problem of medical compliance with an emphasis on medication is given some attention, the problem of rehabilitation compliance remains poorly understood [3], and data on compliance of patients with obesity are generally absent. obese patients.

Therefore, studies of the effectiveness of the developed rehabilitation programs taking into account the level of compliance is a new look at reducing body weight in the framework of rehabilitation programs.

When correcting the constituent components of MS in the framework of rehabilitation of obese patients, it is necessary to eliminate or reduce the influence of factors acting on its formation (lack of exercise, poor nutrition, smoking, alcohol abuse, psychosocial stress) [2; 4, 6; 7], because an improper lifestyle promotes the manifestation of genetically engineered biological risk factors for MS. It is advisable to correct these aspects in the framework of rehabilitation interventions, which are carried out by a physical therapist. In addition, it is advisable to consider ways of correcting body weight from a position of improving the issues of rehabilitation compliance, because the level of agreement on the implementation of measures is the basis for making progress in rehabilitation and explains the lack of results in some patients.

The results complement and expand information on the need for an integrated approach to body weight correction, in particular, the use of nutrition and physical activity modifications to correct dysmetabolic and dyslipidemic disorders, increase the risk of cardiovascular complications [7; 9; 13].

A high level of compliance and its maintenance at a sufficient level is a key point for obese patients adhering to recommendations on lifestyle modification and physical activity both independently and as part of a physical therapy program. A decrease in dysmetabolic and dyslipidemic manifestations indicates the sufficient effectiveness of non-drug remedies for body weight correction in obese patients. To achieve indicators of normal body weight and complete normalization of indicators, the duration of rehabilitation of patients with II degree of obesity should be long for one year, and for all patients in this profile, a balanced diet should be maintained for life.

Prospects for further research in this direction include a thorough study of the influence of the developed physical therapy program on the state of the cardiovascular system of

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