

Abstract

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QUALITY OF LIFE IMPROVEMENT IN MIDDLE-AGED PEOPLE WITH TYPE 2 DIABETES BY MEANS OF PHYSICAL THERAPY

**Introduction.** Diabetes is one of the most common chronic diseases in the world. Recently, this disease has been considered as a social problem, which is getting more and more urgent. The increase in the incidence and mortality of type 2 diabetes observed in recent decades requires active influence on risk factors, development of preventive measures, optimization of treatment regimens, active use of physical therapy.

**Purpose:** To investigate the possibility of quality of life improvement in middle-aged people with type 2 diabetes by means of adjustment of physical activity, namely by implementing a specially designed physical therapy program.

**Materials and methods:** survey (WHOQOL-BREF questionnaire), somatometry (height, weight, circumference), pulsometry, tonometry, dynamometry (handgrip), functional tests (static strength endurance, aerobic endurance), perceived exertion (Borg scale).

An adequate physiotherapy program for middle-aged people with type 2 diabetes that is suitable for treatment and rehabilitation process was proposed. The program was implemented in the University Clinic of Sumy State University.

**Discussion:** The theoretical part of the paper emphasizes that the use of comprehensive approach only can help normalize carbohydrate metabolism, increase exercise tolerance, reduce body weight, and improve quality of life. During implementation of the experimental part of the study, we contributed to motivation to increase motor activity, implemented a program of physical therapy for middle-aged people with type 2 diabetes and class I-II obesity, which consisted of strength and aerobic exercises of moderate intensity and relaxation exercises. The empirical part of the work proves the program to be the effective. The analysis of the results indicates positive changes in the functional systems of the organism, namely, decrease in waist circumference, hip circumference, neck circumference, significant change in shoulder arc length, increase in ankle circumference, body mass index, waist circumference to hip circumference ratio, significant increase in static strength endurance of abdominal muscles. These changes have a positive effect on a person's quality of life, self-esteem for physical and especially mental health.

**Key words:** type 2 diabetes, middle age, obesity, quality of life, physical therapy program.

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## Резюме

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## ПОКРАЩАННЯ ЯКОСТІ ЖИТТЯ ОСІБ СЕРЕДНЬОГО ВІКУ З ДІАБЕТОМ 2 ТИПУ ЗАСОБАМИ ФІЗИЧНОЇ ТЕРАПІЇ

**Вступ:** Діабет є одним з найпоширеніших у світі хронічних захворювань. Останнім часом ця хвороба стала вивчатися як соціальна проблема, що стає все більш актуальною. Зростання захворюваності та смертності від діабету 2 типу, що спостерігається в останні десятиліття, вимагає активного впливу на фактори ризику, розробки профілактичних заходів, оптимізації схем лікування, активного застосування засобів фізичної терапії. **Мета:** з'ясувати можливість покращання якості життя осіб середнього віку з діабетом 2 типу шляхом корекції фізичного навантаження, а саме, впровадження спеціально розробленої програми фізичної терапії.

**Матеріали і методи:** опитування (опитувальник WHOQOL-BREF), соматометрія (зріст, вага, обхвати), пульсометрія, тонометрія, динамометрія (сила кисті), функціональні проби (статико-силова витривалість, аеробна витривалість), інтенсивність навантаження (Шкала Борга).

Запропонована адекватна програма фізіотерапії для осіб середнього віку з діабетом 2 типу, яка придатна для застосування в лікувально-реабілітаційному процесі. Програму впроваджено в діяльність Університетської клініки Сумського державного університету.

**Обговорення:** в теоретичній частині роботи підкреслено, що застосовуючи лише комплексний підхід можна нормалізувати показники вуглеводного обміну, підвищити толерантність до фізичних навантажень, знизити масу тіла, покращити якість життя. Під час реалізації експериментальної частини дослідження ми сприяли формуванню мотивації до збільшення рухової активності, впроваджували програму фізичної терапії для осіб середнього віку з діабетом 2 типу з ожирінням I-II ступеня, яка базується на вправах помірного навантаження силового і аеробного спрямування та вправах на розслаблення. Емпірична частина роботи доводить ефективність програми. Аналіз результатів вказує на позитивні зміни в функціональних системах організму, а саме, тенденції на зниження околу талії, околу стегон, околу шиї, достовірній зміні довжини плечової дуги, збільшенні околу гомілки, індексу маси тіла, індексу співвідношення околу талії до околу стегон, достовірному зростанні статико-силової витривалості м'язів живота. Ці зміни позитивно впливають на якість життя людини, самооцінку фізичного, і особливо, психічного здоров'я. Результати дослідження можуть бути запропоновані для широкого застосування в практичній діяльності фізіотерапевтів, які працюють з хворими на діабет 2 типу.

**Keywords:** діабет 2 типу, середній вік, ожиріння, якість життя, програма фізичної терапії.

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## Вступ

According to the International Diabetes Federation (IDF) and the World Health Organization, there are currently 415 million people with diabetes in the world. Diabetes ranks first among the diseases that lead to disability and

third – among those leading to mortality. Diabetes patients are two to three times more likely to die of heart diseases and strokes, and lose vision ten times more often than the rest of the population. By 2040, the number of diabetes mellitus patients is predicted to grow to 642 million [1, 2, 3], which

is a major economic problem for every country, including Ukraine. The incidence and prevalence of diabetes in Ukraine shows a steady positive trend [4]. We share the opinion of N. Shishkina that the increase in the incidence and mortality of type 2 diabetes observed in recent decades requires active influence on risk factors, development of preventive measures, optimization of treatment regimens [5].

Diabetes is known to have a pathogenetic association with obesity, which exacerbates the negative impact on life expectancy and quality. S. Carbone notes that obesity can be treated by changing lifestyle, paying attention to healthy diet, exercise, overall motor activity [6]. However, the American Diabetes Association notes that insulin resistance may improve with weight loss and/or pharmacological treatment of hyperglycemia, but is rarely restored to normal values. The risk of developing type 2 diabetes increases with age and reduced physical activity [7].

Literature sources indicate that patients with type 2 diabetes gain weight regardless of the therapy (metformin, sulfonylurea, insulin, glitazone, sitagliptin), so maintaining a stable weight or reducing it should be considered as an important therapeutic goal [1, 9]. M. Vlasenko, T. Gradil, P. Capodaglio, E. Ilieva and other authors underline that the main reason for weight gain is an inadequate lifestyle [1, 8]. That is, an important task for physical therapists is the correction of the patient's lifestyle, selection of optimal physical exertion, body mass index control, which has to lead to the quality-of-life improvement.

**Purpose:** To investigate the possibility of quality-of-life improvement in middle-aged people with type 2 diabetes by means of adjustment of physical exertion, namely by implementing a specially designed physical therapy program.

#### **Materials and methods.**

The study involved 20 people 50–60 years of age with type 2 diabetes and class I-II obesity, who received appropriate pharmacological support and adhered to a hypocaloric diet (1200 kcal/day). Of these, two groups were formed: 10 people of group I were involved in the physiotherapy program during a month, 10 participants of group II were not involved. All patients gave their informed consent to participate in the study. The inclusion criteria for participation in the experimental program were: Type 2 diabetes at the stage of compensation (HbA1c <7%); class I-II

obesity (BMI 30.0–39.9 kg/m<sup>2</sup>); stage 1 hypertension.

The following somatometric parameters were measured: weight and height, circumference of the neck, chest, upper arm, waist, hips, lower leg; shoulder width, shoulder arch by standard methods [10]; calculation of body mass index (BMI), waist circumference (WC) to hip circumference (HC) ratio (WHR) [11]. Heart rate (HR) and blood pressure (BP) were measured, dynamometry was performed.

To evaluate physical status we used:

- 5 min aerobic endurance test – walking on a treadmill at 5 km/h for five minutes with self-assessment of exertion [12],
- time of lifted straight legs holding to determine static strength endurance of the lower abdominal muscles – the subject is in a supine position, arms along the body and lifts and holds the legs at an angle of 20–30°;
- test of lifting shoulder girdle off the floor to determine static strength endurance of the upper abdominal muscles – the subject is in a prone position, arms on the nape, legs flexed. The subject raises the straight trunk so that the shoulder girdle (shoulder blades) lifts off the horizontal surface [13].

The result of the static strength endurance test for abdominal muscles was evaluated based on the duration of holding legs and trunk (in seconds).

Perceived exertion control was performed using a 10-point Borg scale [14].

The implementation process for the experimental part of the study was conditionally divided into three parts: preparatory, main and final. During the preparatory part, we formed motivation to increase motor activity by explaining the mechanism of influence of physical exercises on the human body, approbation of physical therapy for body weight correction, counseling about morning and evening hygienic gymnastics, explaining the structure of exercising, showing the basic movements, assessment of somatometric and physiometric parameters and quality of life, formulating the goals of the physical therapy program; during the main part we implemented the program of physical therapy for middle-aged people with type 2 diabetes and class I-II obesity; during the final part we re-assessed somatometric and physiometric parameters and quality of life; discussion of the next steps for adjustment of the program of physical therapy for

middle-aged people with type 2 diabetes and class I-II obesity by other means (kinesiotherapy, hydro-kinesiotherapy, etc.), correction of the goals of physical therapy program.

The physical therapy program for middle-aged people with type 2 diabetes and class I-II obesity was aimed at reducing body weight and improving the functional state of the oxygen-transport system and musculoskeletal system. The program was estimated to last for one month, 5 times a week (20 sessions, each 60 min long). The program consisted of strength and aerobic exercises of moderate intensity and relaxation exercises. Volume and intensity of physical activity was controlled by the number of repetitions/sets per exercise; by changing the pace of exercise, area of

support, starting position and methods of exercising; by using long and short levers; rational alternation of exercise and rest time.

The peculiarity of the physical therapy program for middle-aged people with type 2 diabetes and class I-II obesity consisted in its phasing (there were three phases: sparing mode, sparing-training mode and training mode). The phasing is detailed in Table 1. Transition to the next phase was allowed under the condition of normotonic reaction to physical activity, which was characterized by an increase in heart rate by 60–80% of the maximum heart rate, an increase in systolic blood pressure by 15–30%, a decrease in diastolic blood pressure by 10–15%, and restoring of these parameters after 5 min exercising.

**Table 1 – Physical therapy program for middle-aged people with type 2 diabetes and class I-II obesity**

Physical therapy program structure		Exertion characteristics			
Phasing		I	II	III	
Mode		Sparing	Sparing-training		Training
Duration		60 min	60 min		60 min
Week		First	Second	Third	Fourth
Kinesiotherapy exercises/ breathing exercises	Back/abdominal muscles	Day: 1, 3, 5 Blocks: 2 Exercises: 6–10 times Sets: 3	Day: 2, 4 Blocks: 2–3 Exercises: 6–10 times Sets: 3	Day: 1, 3, 5 Blocks: 3 Exercises: 6–10 times Sets: 3	Day: 2, 4 Blocks: 3–4 Exercises: 6–10 times Sets: 3
	Shoulder girdle and upper extremities muscles/pelvic girdle and lower extremities muscles	Day: 2, 4 Blocks: 2 Exercises: 6–10 times Sets: 3	Day: 1, 3, 5 Blocks: 2–3 Exercises: 6–10 times Sets: 3	Day: 2, 4 Blocks: 3 Exercises: 6–10 times Sets: 3	Day: 1, 3, 5 Blocks: 3–4 Exercises: 6–10 times Sets: 3
	Aids: physiotherapy and sports equipment	No aids, mainly in prone position, dumbbells	No aids, gym ball exercises added, dumbbells	No aids, gym balls, balls, pulley weights, dumbbells	No aids, gym balls, balls, pulley weights, medicine balls, dumbbells
Aerobic cyclic/relaxation and stretch exercises		Day: 1–5 Duration: 5 min Speed: 5 km/h Sets: 1 Special aids: treadmill	Day: 1–5 Duration: 5–6 Speed: 5.5 Sets: 1–2 Special aids: treadmill/elliptical trainer	Day: 1–5 Duration: 5–6 Speed: 6 Sets: 2 Special aids: treadmill/elliptical trainer	Day: 1–5 Duration: 5–7 Speed: 6 Sets: 2–3 Special aids: treadmill/elliptical trainer/stepper

Initially, kinesiotherapy exercises were scheduled every other day: 1) back/abdominal muscles, and 2) shoulder girdle and upper extremities muscles/pelvic girdle and lower extremities muscles. The exercises consisted of 2 blocks, with breathing exercise in between. A block consisted of 6–10 exercises, 3 sets per each exercise. Isometric exercises, such as holding lifted upper and/or lower trunk in supine position,

prone position, or side position, were used for the trunk muscles. Such exercises were started with three seconds duration, and diaphragmatic breathing exercises were done during relaxation.

For upper and lower extremity muscles, auxotonic exercises were used, which significantly improved muscle strength. They consisted of blocks, too, and each block consisted of 6–10 exercises, 3 sets per each exercise. These were

aids-free exercises and/or exercises with 1 kg dumbbells in supine position: flexion-extension, abduction-adduction, rotation of arms and legs. Exercises were started with three repetitions, and diaphragmatic breathing exercises were also done between repetitions.

Aerobic cyclic treadmill exercise was performed for 5 min at a speed of 5 km/h, after which the subject did breathing exercises and relaxation and stretch exercises. Such exercises help to restore the performance of the cardiorespiratory system to the original level.

During the second stage (two weeks), the number of blocks of kinesiotherapy exercises increased according to physical capability of the subject. Duration of isometric exercises gradually increased to 5–6 seconds, and auxotonic – to 5–6 times. In addition to the above-mentioned body positions, the starting positions lying down and sitting on the gym ball were added. Exercises with pulley weights and balls were also added. Duration, speed, number of sets for aerobic-cyclic exercises increased. Elliptical trainer exercises were proposed to the subjects.

The third stage included 3-4 blocks of kinesiotherapy exercises, which depended on the functional state of the subject. Duration of isometric exercises gradually increased to 7–8 seconds, and auxotonic – to 7–8 times. Pulley weights of various stiffness, medicine balls and dumbbells of 2 kg or more were used to diversify the strength exercises. Aerobic-cyclic exercises at the request of a subject were performed on the treadmill, elliptical trainer or stepper.

The adapted international WHOQOL-BREF was used to assess the quality of life [15]. The WHOQOL-BREF international method is a shortened version of WHOQOL-100, [16]. The WHOQOL-BREF short questionnaire consists of 26 items that focus on self-assessment of physical health, psychological health, social relationships, and environment.

Statistical analysis was performed using Statistica 10 software. Statistical significance of difference was determined by Student's test with appropriate degrees of freedom.  $P < 0.05$  was considered a statistically significant difference.

#### Study results and discussion.

The use of such physiotherapy programs for people with type 2 diabetes and class I-II obesity is believed to lead to increased expenditure of glucose and glycogen. It should be noted that the effect of reduced blood sugar is observed only within the systematic, continuous implementation of physiotherapy program, since exercise stimulates glucose uptake by insulin-dependent tissues [17].

At the beginning of the study, there was no significant difference in somatometric, physiometric parameters and the quality of life between groups ( $p_{1-2} > 0,05$ ), which is indicated in Tables 2–4 and Figure 1. The parameters of cardiovascular system investigated at rest (heart rate and blood pressure) in patients of both groups were slightly over the norm age limits for 50–60 y.o. persons, which is associated with type 2 diabetes and class I-II obesity. To maintain stable blood pressure, all participants take pharmacological drugs prescribed by the doctor.

**Table 2 – Body mass index, waist circumference, hip circumference, waist-to-hip ratio (WHR) at initial level and after a month of study**

Parameters	I group, n=10		II group, n=10	
	Initially	In a month	Initially	In a month
Body mass index, (kg/m <sup>2</sup> )	34.2±0.9	33.7±1.0	34.1±2.0	33.8±1.2
	Δ% -1.43		Δ% -0.88	
WC (cm)	108.0±3.38	103.7±2.32	106.5±3.6	106.0±3.4
	Δ% -3.98		Δ% -0.51	
HC (cm)	107.4±0.65	104.2±0.54	107.9±0.74	107.2±0.96
	Δ% -2.98		Δ% -0.70	
WHR	1.0±0.01	0.9±0.01	0.9±0.01	0.9±0.01
	Δ% -1		Δ% 0	

**Table 3 – Cardiovascular parameters at initial level and after a month of study**

Parameters	I group, n=10		II group, n=10	
	Initially	In a month	Initially	In a month
Heart rate, bpm	79.0±2.7	76.4±3.3	81.1±3.4	78.45±3.6
	Δ% -3.29		Δ% -3.27	
SBP, mm Hg	140.5±2.93	138.5±2.48	148.0±3	142.0±4
	Δ% -1.42		Δ% - 4.05	
DBP, mm Hg	95.0±1.97	93.±1.9	93.0±2	90.0±3
	Δ% -2.11		Δ% - 3.23	

**Table 4 – Neck circumference, shoulder circumference, calf circumference and shoulder arc at initial level and after a month of study**

Parameters	I group, n=10		II group, n=10	
	Initially	In a month	Initially	In a month
Shoulder arc (cm)	55.9±0.95	53.2±0.89*	59.0±4	58.5±3.8
	Δ% -4.81		Δ% -0,71	
Neck circumference	41.7±1.65	40.2±1.6	42.3±1.81	42.3±1.75
	Δ% -3.71		Δ% -0.02	
Upper arm circumference (cm)	37.7±2.48	37.4±2.22	38.1±2.43	38.1±2.46
	Δ% -0.8		Δ% -0.05	
Calf circumference (cm)	41.6±1.59	42.3±1.7	40.9±2.00	39.92±1.87
	Δ% +1.78		Δ% -2.51	

Note: \* – significant difference with the initial results of the study (p <0.05)

Investigating aerobic endurance, which characterizes the state of the cardiovascular system, we found that 5 minute walk on the treadmill at a speed of 5 km/h causes a considerable exertion by the Borg scale, corresponding to 6 points. This indicates very low motor activity of the subjects during the day.

Evaluation of hand muscle strength index in the subjects shows that its values decreased in accordance with the normative values for 50–60

y.o. persons (0.4 points – for women and 0.6 points – for men) (Table 5). Static strength endurance of abdominal muscles corresponds to middle and lower that middle levels of development. Therefore, the results indicate that the muscle strength of the subjects is underdeveloped and need to be improved, which will have a positive effect on the cardiovascular system, reduce abdominal fat and improve the well-being of the study group.

**Table 5 – Strength and aerobic capability of the patients in group I at initial level and after a month of study**

Parameters	I group, n=10	
	Initially	In a month
Handgrip test (kg)	36.5±4.32	39.7±4.17
	Δ% +8.77	
Leg holding (sec)	21.9±1.72	42.6±3.49*
	Δ% +94.52	
Trunk holding (sec)	17.3±1.57	37.5±3.75*
	Δ% +116.76	
Borg scale (after 5 min)	6	4
	Δ% - 33.33	

Note: \* – significant difference with the initial results of the study (p <0.01)

WHOQOL-BREF analysis revealed that half of Group I and Group II respondents rated their quality of life as "bad" – 50%, "not good, not bad" – 35%, and "good" – 15%. We received similar answers to the question concerning satisfaction with the state of health: "bad" – 45%, "not good, not bad" – 40%, 15% – "good".

Physical Well-Being Scale consists of questions about daily life activities, dependence on pharmacological substances and medicines, energy and fatigue during the day, mobility, pain and discomfort, sleep and rest, power working capacity. Its results indicate unfavorable trends in physical health – the average of all responses is  $14.42 \pm 2.53$  points for group I and  $14.5 \pm 2.48$  points for group II with a maximum value of 35 points (Fig. 1). Psychological Well-Being Scale consists of questions about body image and appearance, negative and positive feelings, self-esteem, spirituality, personal beliefs, thinking, learning, memory and concentration. According to the results of this scale, the figures are even lower – the average of all responses is  $11.38 \pm 2.23$  points for group I and  $11.21 \pm 2.4$  points for group II with a maximum value of 30 points. The Social and Environmental Scales consist of questions about personal relationships, social support, financial resources, freedom, physical security, health and social assistance (accessibility and quality), home environment, some skills, recreation, leisure, physical environment, transport. According to these scales, the results are close to the maximum values in all subjects – the Social Relationship Scale average value corresponded to  $13.38 \pm 1.2$  points (for both group I and group II) with a maximum value of 15 points, and the Environment Scale average value was  $33.21 \pm 2.2$  points with a maximum value of 40 points. We believe that this is related to the relative stability of the financial position of people of this age.

Assessing the impact of the physical therapy program for middle-aged people with type 2 diabetes and class I-II obesity on anthropomorphic parameters, we should note first of all that no sharp changes were detected, but in group I persons the BMI decreased by 1.43%, which is almost twice as much as in group II (Table 2). Waist circumference and hip circumference in group I decreased on average by 4 cm and 3 cm, respectively, WHR decreased by 1%; in group II such reductions were not observed (Table 2). According to our data, a decrease in WHR indicates a decrease in abdominal fat, which has a positive effect on the condition of

the cardiovascular system [17]. Also favorable changes were characteristic of shoulder arc parameters – it decreased by 4.81% ( $p < 0.05$ ) in persons of group I, which indicated a decrease in subcutaneous fat in chest area and functional activation of the upper body muscular system (Table 4). Neck circumference decreased by 3.7% and shoulder circumference – by 0.8%, while calf circumference increased by 1.78%. In our opinion, this is due to aerobic exertion, which has a positive effect on the state of the oxygen transport system. At rest the values of blood pressure and heart rate did not change significantly (Table 3), but during the physical activity and after it the subjects in the first group reported the absence of shortness of breath, which had been present at the first sessions.

Aerobic endurance of group I individuals improved significantly as was shown by the self-reported exertion intensity according to the Borg scale. Thus, at the beginning of the program 5-minute walk at a speed of 5 km/h was assessed by the group I subjects as corresponding to 6 points, while at the end of the program it was 4 points (Table 5). Considering the fact that the training program included strength exercises – mostly isometric exercises for trunk muscles and auxotonic exercises for upper and lower extremities muscles – the muscular strength improved significantly. Thus, in the patients of group I, the results of handgrip test improved by 8.77%, and the values of static strength endurance of abdominal muscles ( $p < 0.05$ ) increased significantly (Table 5).

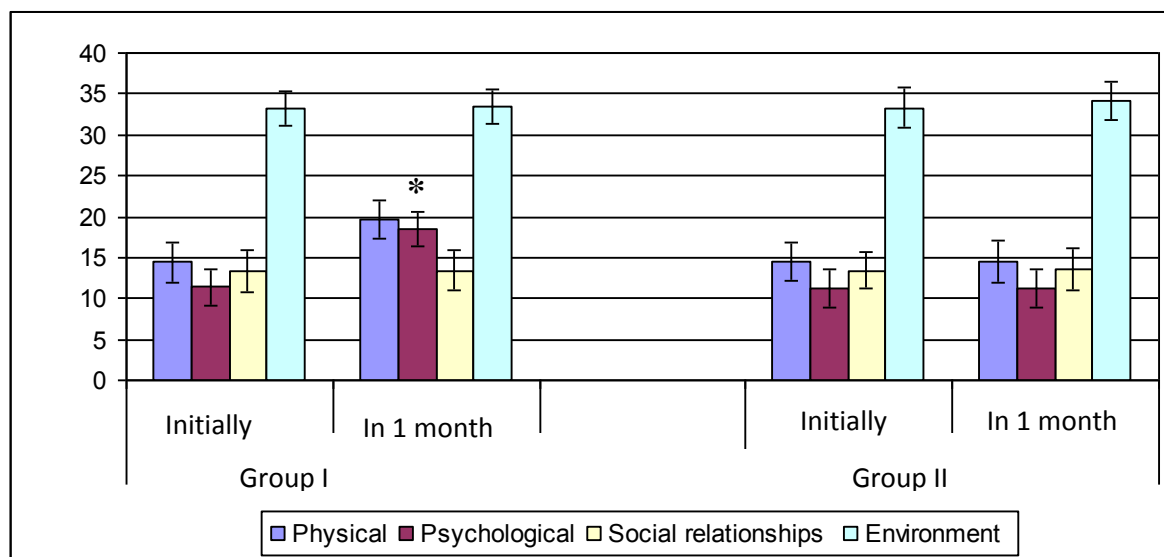
Discussing the principles and means of physical therapy for patients with type 2 diabetes and obesity, it should be emphasized that similar principles and means are used by several researchers. For example, low and medium intensity aerobic exercises were used in the studies [18, 20], exercises with/without weight [19], or a combination of aerobic and strength exercises [21].

According to the results of WHOQOL-BREF questionnaire, significant positive changes in the quality of life in group I individuals can be stated. Thus, no profiles were found having the response "I assess my quality of life as bad"; the distribution of responses was as follows: "not good, not bad" – 60%, "good" – 40%. The answers to the question concerning satisfaction with the state of health were similar: "not good, not bad" – 85%, "good" – 15%.

According to the Physical Health Scale, there was also some improvement in group I individuals, although it was not significant as compared to group II (increased by 35.99%) and its initial data

( $p > 0.05$ ) (Fig. 1). According to the Psychological Health Scale, significant changes were detected as compared to group II and the baseline data ( $p < 0.05$ ). All the respondents reported better sleep, satisfaction from everyday activities, positive

changes in working capacity, concentration, self-esteem. According to the Social Relationships and Environment Scales no changes were detected. Among the participants of group II, no changes were reported by any scale of the questionnaire.



**Figure 1 – Quality of life according to WHOQOL-BREF in the patients of group I and group II at initial level and in the end of the study (points)**

Note: \* – significant difference with the initial results of the study and the results in group II ( $p < 0.05$ ).

### Conclusions

Correction of physical activity in persons with type 2 diabetes and class I-II obesity leads to positive changes in the studied parameters. Individuals who participated in the physical therapy program had a tendency to a decrease in waist, hip, neck circumference, body indices (BMI, WHR); a tendency to an increase in calf circumference.

### Further research prospects

**Further research prospects** lie in expanding physical therapy in physical activity programs for people with type 2 diabetes and examining the

Significant changes occurred with regard to decreased shoulder arc and increased static strength endurance of abdominal muscles. These changes have a positive effect on a person's quality of life, self-esteem for physical, and especially mental health.

impact of long-term (over 6 months) physical therapy programs on physiological, somatometric parameters and quality of life.

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