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OBESITY AS A PREDICTOR OF FLATFOOT DEVELOPMENT AND POSTURE DISORDERS AND THEIR CORRECTION THROUGH PHYSICAL THERAPY METHODS

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Abstract. The research describes the impact of obesity as a factor contributing to the development of flatfoot and posture disorders, as well as the development of a physical therapy program for their correction. A total of 90 persons were examined, and they were divided into 3 groups: 30 students with normal body weight, proper posture, and without flatfoot. The comparison group consisted of 60 students with obesity, posture disorders and flatfoot, who were further divided into two groups.Comparison Group 1 (CG1) consisted of 30 students who were informed about the risks associated with obesity, posture disorders, flatfoot, and general hypodynamia. They were provided with recommendations on the basics of balanced nutrition according to the WHO and principles for reducing hypodynamia.Comparison Group 2 consisted of 30 students who underwent restorative interventions using a physical therapy program.

According to the results of the questionnaire, the condition of students with obesity was characterized by shortness of breath during physical exertion, increased fatigue, discomfort in the body, and psycho-emotional depression. According to the IPAQ, they showed lower time spent on vigorous and moderate physical activity compared to their healthy peers. Weekly energy expenditure was at the level of low physical activity. According to FMS tests, people with obesity lagged behind healthy peers. Their handgrip and leg strength were at a low level. Quality of life, as measured by the EQ-5D-5L questionnaire, was found to be low. Obesity was associated with high body weight and body mass index (BMI), as well as the presence of abdominal obesity. The state of the spine was characterized by low flexibility in the chin-chest, Ott Schober Schober, Sediina, Tomayer tests. The feet were characterized by a decrease in arch height, as indicated by Friedland's index. A deterioration in stability and balance was diagnosed.

A physical therapy program was developed, lasting 6 months, and included the following elements: kinesitherapy methods, massage, kinesiological taping, nutrition modification recommendations, and patient education. The comprehensive nature of the program aimed to address the identified disorders across all domains of the ICF (International Classification of Functioning, Disability, and Health) and focused on increasing participation in social life by improving the participants' health.

The impact of the developed physical therapy program was reflected in the positive dynamics of the students' subjective condition. Weekly energy expenditure increased according to the IPAQ, expanded physical capabilities were established via FMS, muscle strength improved according to the results of dynamometry tests for the legs and hands, and quality of life improved according to the EQ-5D-5L questionnaire. In comparison group 2, there was a reduction in body weight and BMI (to the level of overweight), a decrease in abdominal obesity, an increase in muscle tissue content, and a reduction in body fat. Flexibility in all sections of the spine improved based on the results of the chin-chest, Ott Schober, Sediina, Tomayer tests. Functional reserves of the feet showed improvement, with students exhibiting normal arch height and a reduction in the number of individuals with a high degree of flatfoot. Stability during stabilometry improved, indicating better overall coordination and strength of the core and limb stabilizing muscles, as well as the vestibular system.

Keywords: physical therapy, ICF, physical therapy in orthopedics, obesity, posture disorders, flat feet, therapeutic exercises, quality of life.

Introduction. The impact of obesity on the health of children and adolescents determines the health of young people, and then the adult population of the country [4]. Considering the causes of obesity, it is important to note that in adolescence there is a risk of changing the influence of its pathogenic factors - hypodynamia, stress and eating disorders. One of the ways to reduce weight is to implement a comprehensive physical therapy program. It is the development of a physical therapy program taking into account the characteristics of the history of childhood and adolescent obesity and the characteristics of the student lifestyle that is an urgent issue in rehabilitation practice.

The purpose of the research is to theoretically substantiate, develop, and test the effectiveness of a compre-

hensive physical therapy program for adolescents with obesity, flat feet, and posture disorders.

The object of the research is the process of physical therapy for patients with obesity, posture disorders, and flat feet.

Materials and Methods of Research. To determine the level of physical activity as an indicator of hypodynamia and a factor in the development of excess body weight, a shortened version of the International Physical Activity Questionnaire (IPAQ) was used. The IPAQ was used to determine the levels of physical activity and load over the course of a week. The level of activity was determined by summarizing the duration and frequency of each type of activity performed [2].

The motor fitness of the subjects was assessed using the Functional Movement Screen (FMS) – a set of tests recommended for identifying mobility and stability imbalances during basic simple movements [3]. The FMS included seven test movements, each of which was scored from 1 to 3 points. The score for tests 4, 6, and 7 was used as a criterion for either passing or failing the entire FMS. If a subject failed part of the test, the overall score was 0.

Hand grip strength was measured using a hand dynamometer. Patients placed it on the palm with the scale facing inward, then gradually squeezed it with maximum effort, keeping the arm straight and at a horizontal level, without bending the elbow.

Trunk extensor strength (deadlift strength) was measured using a deadlift dynamometer. The subject leaned forward without bending the knees [5].

The quality of life of patients was assessed using the EQ-5D-5L universal questionnaire (European Quality of Life Questionnaire, EuroQol Group), which is used to measure the health status of patients, provide evidence of cost-effectiveness, and survey populations to study public health. The final data of the questionnaire represent a summarized score of the respondent's health, and therefore, the questionnaire is used as a universal tool for both population-wide surveys and specific patient groups [7].

The Body Mass Index (BMI) (Kettle) as a determining indicator of the presence and degree of obesity was calculated using the formula: **BMI = Body weight (kg) / Height² (m²)**

The degree of obesity was characterized according to the WHO classification (table1):

Table 1.

Principles of BMI Assessment

BMI (kg/m²)	Description
18.5 - 24.9	Normal body weight
25 - 29.9	Overweight
30.0 - 34.9	Obesity Grade I
35.0 - 39.9	Obesity Grade II
40 and above	Obesity Grade III

Anthropometric measurements of waist circumference (WC) at the level of the navel and hip circumference (HC) at the level of the buttocks were taken. Abdominal obesity was diagnosed when WC exceeded 94 cm in males or 80 cm in females, as well as based on the calculation of the waist-to-hip ratio (WC/HC) – a value equal to or greater than 0.95 in males and 0.80 in females.

The body composition of the students was assessed using the Tanita BC-601FS FitScan body composition monitor, which operates based on the bioimpedance method (table 2). The amount of body fat was determined separately for males and females.

Table 2.

Criteria for evaluating body fat percentage based on bioimpedance analysis results.

Gender	Body Fat Percentage , 17-21 рік (%)			
	Low	Normal	High	Very High
Female	< 21,0	21,0-32,9	33,0-38,9	≥39,0
Males	< 8,0	8-19,9	20,0-24,9	≥25,0

The content of muscle tissue (table 3) was also characterized as a percentage of total body mass, and visceral fat was measured in arbitrary units [13]. Criteria for evaluating muscle tissue content in the body based on bioimpedance analysis results [8]

Table 3.

Gender	Muscle Tissue Content in the Body (ages 17-21) (%)			
	Low	Normal	High	Very High
Females	< 24,03	24,3 – 30,3	30,4 – 34,3	≥35,4
Males	< 33,3.0	33,3 – 39,3	39,4 – 44,4	≥44,1

The results of the visceral fat content were assessed based on the following parameters: 1-12 arbitrary units –

normal level, 13-59 arbitrary units – elevated [9].

The normal range for total body water content percentage in healthy adult individuals was considered to be 45-60% for females and 50-65% for males.

The obtained results for visceral fat content were evaluated based on the following parameters: 1-12 arbitrary units – normal level, 13-59 arbitrary units – elevated [10].

The range of normal values for total body water percentage in a healthy adult was considered to be 45-60% for females and 50-65% for males.

Results of the research. The research is based on the examination of 90 individuals, who were divided into 3 groups: the control group (CG), comparison group 1 (CG1), and comparison group 2 (CG2). The control group (CG) consisted of 30 students with normal body weight (according to BMI), proper posture, and no signs of flatfoot. The comparison group consisted of 60 students with obesity, posture disorders, and flatfoot, who were further divided into two groups. Comparison group 1 (CG1) consisted of 30 individuals who were informed about the health risks associated with obesity, posture disorders, flatfoot, and general hypodynamia. They were given recommendations on the basics of balanced nutrition according to the WHO [12] (as a foundation for body weight correction) and principles recommended for mitigating the risks of hypodynamia through physical activity levels [9]. Accordingly, this group corrected the diagnosed health disorders based on the provided recommendations independently and/or in self-chosen rehabilitation facilities. Comparison group 2 (CG2) consisted of 30 students who underwent restorative interventions using a physical therapy program (PT) presented in this study.

The survey of students showed that the combination of obesity, posture disorders, and flatfoot caused disturbances in their subjective condition, associated with physical weakness and reduced endurance (table 4).

Table 4.

Complaints of patients with obesity, posture disorders, and flat feet

Complaints	KG (n=30) abs. count (%)	GP1 (n=30) abs. count (%)	GP2 (n=30) abs. count (%)
Shortness of breath with physical exertion	5 (16.6)	30 (100)	30 (100)
Difficulty with movements of daily life activities	0	11 (36.6)	11 (36.6)
Pain / discomfort in the back	6 (20)	26 (86.6)	28 (93.3)
Pain / discomfort in the feet	2 (6.7)	27 (90.0)	26 (86.6)
Psycho-emotional depression	5 (16.6)	21 (70.0)	24 (76.6)
Increased fatigue	4 (13.3)	30 (100)	30 (100)
Decreased overall performance	8 (26.6)	25 (83.3)	25 (83.3)

The physical activity of patients was determined using the IPAQ questionnaire. The results of the patient survey showed that the presence of pathological processes was associated with a statistically significant delay compared to individuals in the control group (KG) in terms of vigorous and moderate activity levels, as well as the amount of time spent walking, according to the IPAQ ($p<0.05$). At the same time, individuals in both comparison groups showed a significant excess of time spent in sedentary activity. Movement stereotype disorders in students with obesity, posture disorders, and flat feet are substantiated and confirmed by their level of physical activity and the results of the IPAQ survey. In the comparison groups, during the initial examination, patients did not report high-intensity exercise during the week. The level of physical activity in the boys and girls of the control group was classified as «moderate physical activity,» while both experimental groups were classified as «low physical activity» (their energy expenditure was nearly 60% lower than that of the control group). The overall result of FMS (Functional Movement Screen) tests, which assess the ability and completeness of movement execution associated with habitual activities, showed during the initial examination that both groups of students with polymorbidity demonstrated statistically significant lag in all FMS exercises compared to young individuals with normal body weight, posture, and foot arch condition. When studying strength, it was found that patients in both comparison groups had significantly lower average values for trunk muscle strength (on average, 41% less in boys and 42% less in girls), which justifies the presence of posture disorders in them. According to the hand dynamometry results, boys (by 40%) and girls (by 27%) lagged behind their peers in the control group. The presence of objective and subjective changes in the health status of patients with obesity, posture disorders, and flat feet logically affected their quality of life, as established by the EQ-5D-5L questionnaire. It should be noted that even students in the control group, who were considered relatively healthy, did not rate their quality of life as excellent on a 100-point scale, which emphasizes the relevance of improving the health status of the selected group.

Parameters that characterize the state of adipose tissue.

Excessive development of adipose tissue was characterized by the presence of abdominal obesity in patients of the comparison groups, as determined by the calculation of the waist-to-hip ratio (WHR) and waist circumference, both in boys and girls, against the background of general obesity of the first degree.

Results of anthropometric measurements. In pa-

tients with obesity, a statistically significant lower content of muscle tissue and water was found compared to peers with normal body weight, while the content of adipose tissue and visceral fat was higher, which is a risk factor for the development of cardiovascular pathology. The fat content in individuals of both experimental groups (GP) was high, while in the control group (KG), it was at a normal level.

Indicators that characterize the functional reserves of the foot and balance status An analysis of the arch structure of the foot using Friedland's index showed that among the patients in the comparison groups, flatfoot of varying degrees of severity was prevalent – severe (around one-third), moderate (around 40%), and moderate degree (28-30%).

The determination of stabilometric parameters showed a deterioration in balance control based on the displacement of the center of pressure and its oscillations, both with open and closed eyes. Various systems, including the feet, are responsible for this process. The length of the statokinesiogram (L) in the experimental groups (GP) was greater by 50% with open eyes and by 15% with closed eyes. The area of the statokinesiogram (S) in the GP was larger by 51% with open eyes and by 30% with closed eyes. There was a shift in the frequency center of the center of pressure oscillations: along the abscissa axis, there was an increase of 54.8% with open eyes and 17% with closed eyes. The corresponding frequency of oscillations along the ordinate axis showed a deterioration relative to the control group (KG) of 112% and 78%, respectively.

The pathological changes identified at this stage of the study in patients with obesity, posture disorders, and flat feet justified the need for the development of a comprehensive physical therapy program, taking into account the combination of pathology and the lifestyle of the student population.

General Principles for Creating a Physical Therapy Program.

When developing a physical therapy (PT) program for patients with obesity, postural disorders, and flat feet, the principles derived from the initial research phase were applied.

The developed PT program took into account the key principles of physical therapy and rehabilitation (individuality, comprehensiveness, achieving rehabilitation goals related to normal social functioning):

Functional training on PROSEDOS platforms to correct detected motor stereotype disturbances;

Therapeutic exercises to develop strength and overall body conditioning;

Therapeutic exercises to develop endurance;

Therapeutic exercises to improve joint range of motion in the trunk and limbs;

Therapeutic exercises for balance, coordination, and agility development using the «BlazePod» trainer;

Massage to normalize tissue trophism, muscle tone, improve internal organ function, and enhance overall and emotional well-being;

Kinesiological taping (kinesiotaping) to reinforce and prolong the therapeutic effects achieved through exercise and massage;

Diet modification (dietary education);

Education to reduce external risk factors influencing the onset and progression of obesity, postural disorders, and flat feet, improving the mental and overall health of students.

The PT program lasted for 6 months, which was dictated by the need for sustainable changes in the body. Active therapeutic exercises are the main tool for improving the condition of patients with the studied pathologies, as they improve the functional reserves of all body systems (primarily cardiovascular, respiratory, nervous systems, etc.), general physical qualities necessary for performing motor functions (strength, flexibility, endurance, speed, coordination), contribute to the improvement of musculoskeletal structures involved in posture and arch formation, improve metabolic processes, and promote fat tissue breakdown [10].

The tasks of kinesitherapy were to improve the general condition of students by correcting specific disorders caused by obesity, posture problems, and flat feet, as well as their combined effects.

During movement exercises, the principle of individual approach was strictly followed, with continuous monitoring to assess the adequacy and tolerance of physical load intensity through respiratory rate, heart rate, blood pressure, pulse oximetry, and subjective signs of fatigue (considering cardiovascular risks related to obesity and anticipated low compliance among students with obesity) [11].

In choosing exercises and their combinations during in-person, remote, and independent sessions, the general principles for exercise prescription were followed according to the American College of Sports Medicine's Exercise Testing and Prescription - 2018 guidelines, including the FITT (Frequency, Intensity, Time, Type) and FITT-VP (Volume, Progression) principles.

Therapeutic Exercises (TE).

Therapeutic exercises were considered from the standpoint of specialized correction of obesity signs, posture disorders, and flat feet, as well as improving the general functional reserves of the body.

Features of TE for Obesity Correction: The primary type of TE for obesity correction was aerobic exercise (moderate walking, aerobic strength exercises—running was not recommended unless by individual preference due to potential negative effects on joints and cardiovascular system in obese individuals with flat feet). To determine optimal load, the training zone ensuring health benefits was defined. Using the formula «Max HR = 220 - age,» the maximum heart rate was determined, and the training range was considered to be 60-70% of this value [12].

Walking was the most accessible form of independent aerobic load for individuals with any fitness level. For patients with low compliance, like those with obesity, it was an accessible and simple method to increase overall weekly activity. As physical condition improved, intensity was increased by altering pace and distance, monitored with

fitness trackers or pedometers.

TE for Postural Correction: Postural correction was focused on teaching proper posture, with exercises practiced in front of a mirror (visual control). The new motor-joint sensory stereotype and spatial orientation were developed by performing TE while consciously maintaining correct posture of the pelvis, chest, head, and shoulder girdle.

TE for Flat Feet Correction: Specialized TE for the lower limbs—feet, calves, and thighs—were used to strengthen muscles, improve flexibility, joint stability, and proprioception, increase the arch height, and enhance the foot's elasticity. TE included barefoot exercises using inflatable balance platforms, half-spheres, elastic bands, and items of varying weights moved by the feet. Different walking patterns (on toes, heels, sideways, backward, with changing speeds and directions) were performed both barefoot and with shoes.

Functional Training: Functional training is a specific form of movement action aimed at restoring activities disrupted by disease, simulating typical daily and professional activities. The result of functional training is reduced risk of injury during various activities and prevention of the development and progression of musculoskeletal disorders. For assessing functional progress, the FMS test was used to evaluate common movements related to the most frequent daily activities.

For correcting motor stereotypes due to obesity, posture disorders, and flat feet, functional training was conducted on PROCEDOS PLATFORMS 9™ Pro and PROCEDOS WALL9 platforms to normalize motor stereotypes and strengthen the muscles of the trunk and limbs.

Kinesiological Taping Principles:

The rationale for using kinesiological taping in students with obesity, posture disorders, and flat feet was its corrective action on muscle activity, lymphatic drainage, and the structures of the foot and back.

Kinesiological taping of the back, abdomen, and feet was integrated into the PT program to achieve specific therapeutic effects and prolong the changes induced by kinesitherapy and massage.

Nutritional Modifications (Dietary Education):

Diet modification is a key component in reducing fat tissue in patients with obesity, as significant fat loss is achievable only by eliminating prolonged calorie excess (which cannot be accomplished solely by increasing energy expenditure).

In the developed PT program, students were given recommendations for balanced nutrition based on WHO guidelines. To determine the target daily calorie intake for individuals aged 18-30, the following formulas were used:

Women: (0.0621 * weight in kg + 2.0357) * 240 = X kcal

Men: (0.063 * weight in kg + 2.8957) * 240 = X kcal

For weight maintenance, the target daily calorie intake was set at 1200-1500 kcal/day for women and 1500-1800 kcal/day for men. For weight loss, a calorie deficit of 500-750 kcal/day (or about 30% of the total calculated intake) was recommended.

The education (patient education) aimed at providing information about the disease and its future risks, creating a long-term concept for managing their condition through a reduction in fat tissue and improvement in musculoskeletal system function, which they could adhere to for an indefinite period.

Evaluation of the effectiveness of implementing a physical therapy program based on the dynamics of functional reserve indicators in students with obesity, postural disorders, and flatfoot.

Dynamics of General Functional Reserve Indicators in the Body

A follow-up survey of students aimed at assessing the impact of the developed physical therapy (PT) program on their general health status showed a change in the structure of complaints (table 5).

Table 5.

Dynamics of Complaints of Students After the PT Program Implementation

Complaints	Control Group (CG) (n=30)		PT Group 1 (GP1) (n=30)		PT Group 2 (GP2) (n=30)	
	Initial examination	Repeat examination	Initial examination	Repeat examination	Initial examination	Repeat examination
Shortness of breath during physical exertion	5 (16,6)	5 (16,6)	30 (100)	28 (93,3)	30 (100)	14 (46,6)
Difficulty with daily life movements	0	0	11 (36,6)	10 (33,3)	11 (36,6)	0
Back pain / discomfort	6 (20)	6 (20)	26 (86,6)	24 (80,0)	28 (93,3)	0
Foot pain / discomfort	2 (6,7)	1 (3,33)	27 (90,0)	24 (80,0)	26 (86,6)	2 (6,7)
Psychosocial distress	5 (16,6)	5 (16,6)	21 (70,0)	19 (63,3)	24 (70,6)	5 (16,6)
Increased fatigue	4 (13,3)	5 (16,6)	30 (100)	30 (100)	30 (100)	7 (23,3)
Decreased overall work capacity	8 (26,6)	8 (26,6)	25 (83,3)	19 (63,3)	25 (83,3)	8 (26,6)

Students in GP2 characterized their subjective state as one in which, as a result of the PT program implementation, there was a reduction in subjective signs of fatigue: shortness of breath during physical exertion, difficulty with daily movements, increased fatigue, and decreased overall work capacity. Furthermore, students reported improvements in mood, with almost no pain or discomfort in their back and feet (table 5).

The positive impact of the developed physical therapy program – active sessions alongside the students' education – focused on increasing interest in maintaining a healthy lifestyle and expanding physical activity, manifested in GP2 as a positive change in the motor activity profile. Specifically, a statistically significant difference was found between the indicators of GP1 and GP2 concerning the time spent on vigorous physical activity, the number of days they engaged in vigorous physical activity, and the time spent walking ($p<0.05$) (table 1.6).

Table 6.

Dynamics of Survey Results Based on IPAQ After the PT Program Implementation (± S)

IPAQ Questions	Control Group (CG) (n=30)		PT Group 1 (GP1) (n=30)		PT Group 2 (GP2) (n=30)	
	Initial examination	Repeat examination	Initial examination	Repeat examination	Initial examination	Repeat examination
1. In the past 7 days, how many days did you engage in vigorous physical activity (days per week)?						
male	2,28± 0,16	2,16± 0,18	0*	1,90± 0,08°*	0*	2,26± 0,10°●
female	2,19± 0,11	2,10± 0,08	0*	1,83± 0,07°*	0*	2,19± 0,08°●
2. How much time did you spend on vigorous physical activity on one of those days? (min/day)						
male	115,42± 15,07	107,23±10,30	0*	88,09± 5,12°*	0*	110,55± 12,13°●
female	109,02 ±12,41	116,14 ±8,75	0*	81,11± 4,41*	0*	102,17± 8,14°●
3. In the past 7 days, how many days did you engage in moderate physical activity (not including walking)?						
male	2,39± 0,13	2,75± 0,25	2,11± 0,06*	2,18± 0,11*	2,03± 0,08*	2,51± 0,18°●
female	2,55± 0,06	2,63± 0,12	2,10± 0,13*	2,13± 0,06*	2,03± 0,11*	2,43± 0,15°●
4. How much time did you usually spend on moderate physical activity on one of those days? (min/day)						
male	90,08± 7,11	88,16± 5,23	60,08± 7,12*	62,55± 8,62*	58,63± 9,04*	82,16± 5,45°●
female	85,45± 5,12	80,44± 6,32	65,13± 5,16*	59,66± 9,42*	60,70± 8,13*	79,21± 8,11°●
5. In the past 7 days, how many days did you walk for at least 10 minutes? (days per week)						
male	6,02± 0,15	5,93± 0,12	4,90± 0,09*	5,08± 0,20*	5,07± 0,12*	6,11±0,18°●
female	5,76± 0,11	5,52± 0,17	4,81± 0,13	5,05± 0,16	5,00± 0,23	6,04± 0,12°●
6. How much time did you usually spend walking on one of those days? (min/day)						
male	155,36± 10,64	163,09±12,48	105,68± 18,77*	112,50± 16,33*	111,59± 23,07*	150,92± 20,12°●
female	160,15±11,40	152,25±12,08	115,41±14,08*	103,11±13,66*	108,70± 17,25*	167,28±15,11°●
7. In the past 7 days, how much time did you spend sitting on weekdays? (min/day)						
male	301,88± 20,14	311,08 ±16,17	372,18± 22,13*	*368,25± 19,11**	*362,45± 15,20**	*282,64± 20,10°*●
female	281,16±18,19	305,08±15,16	359,06±20,50*	*362,16±14,22**	*370,11± 20,11**	*294,16± 21,18°*●

Note: *– $p<0.05$ – statistically significant difference between corresponding parameters of CG and GP; ° – $p<0.05$ – statistically significant difference between corresponding parameters at initial and follow-up examinations;

● – p<0.05 – statistically significant difference between corresponding parameters of GP1 and GP2.

The observed trend indicates improved rehabilitation compliance among students in GP, supporting the effectiveness of educational work aimed at increasing physical activity within the activities of a physical therapist.

The dynamics of weekly energy expenditure in students are presented in Table 1.7 . The energy expenditure for walking in GP2 girls increased by 15%, and in boys by 20% (statistically significant compared to baseline, p<0.05), reaching the level of the CG indicators (p>0.05). Corresponding energy expenditures in GP1 students also increased but did not reach the CG level (table 7).

Table 7.

Changes in Weekly Energy Expenditure and Activity Under the Influence of the Physical Therapy Program According to IPAQ (± S)

Weekly Energy Expenditure, MET	Control Group (CG) (n=30)		PT Group 1 (GP1) (n=30)		PT Group 2 (GP2) (n=30)	
	Initial examination	Repeat examination	Initial examination	Repeat examination	Initial examination	Repeat examination
Walking						
male	475,3± 17,12	451,4± 16,23	383,1± 15,32*	411,7± 20,15*°	375,4± 20,11*	429,5± 28,44°●
female	436,3± 12,62	419,2± 20,10	337,6± 20,17*	396,4± 19,10*°	344,2± 22,24*	416,2± 11,48°●
Moderate-intensity load						
male	357,4± 8,55	364,3± 18,32	184,7± 15,18*	208,2± 19,66*°	199,1± 11,51*	284,2± 21,55*°●
female	344,2± 11,14	358,1± 19,18	177,4± 22,26*	215,6± 16,48*°	162,4± 10,12*	290,5± 18,36*°●
High-intensity load						
male	656,2± 20,0	640,5± 25,41	0*	116,6± 10,06*°	0*	533,4± 20,35*°●
female	620,13± 15,3	609,28± 28,18	0*	109,7± 9,18*°	0*	512,2± 15,23*°●
Total weekly load						
male	1488,9± 36,42	1456,1± 50,14	567,8± 20,45*	736,4± 19,27*°	574,5± 25,57*	1247,0± 29,44*°●
female	1400,6± 32,15	1386,55± 46,25	514,9± 19,33*	721,7± 26,15*°	506,4± 27,15*	1218,9± 38,16*°●

Note: *– p<0.05 – statistically significant difference between corresponding parameters of CG and GP; ° – p<0.05 – statistically significant difference between corresponding parameters at initial and follow-up examinations; ● – p<0.05 – statistically significant difference between corresponding parameters of GP1 and GP2.

Thus, the level of weekly energy expenditure increased in both GP groups. Specifically, students began to spend more time on high-intensity load, which increases the functional reserve of the cardiovascular system and reduces the risk of complications. In GP2, the energy expenditure level related to walking reached the CG level.

The weekly physical load level in GP1 also increased, although it was 48% lower than in CG, falling within the «moderate physical activity» category. Meanwhile, the weekly load in GP2 increased significantly, with a 13% difference compared to CG (p<0.05), although this result still indicated moderate activity.

After the implementation of the program, there was an improvement in the FMS (Functional Movement Screen) indicators, which is a parameter of overall stability, balance, and the interaction of all body parts during standard movements related to the functional activities of daily life, confirming the effectiveness of the developed physical therapy program (figure 1). According to the results of the «Deep Squat» test, the male students showed an improvement of 60.8%, and female students – 78%. In the «Hurdle Step» test, the improvements were 27.1% for male students and 20.2% for female students.

The «In-Line Lunge» test showed improvements of 25.4% for male students and 28.5% for female students. In the «Shoulder Mobility» test, the improvements were 23.2% for male students and 29.7% for female students. The «Active Straight Leg Raise» test showed an improvement of 37.2% for male students and 34.1% for female students. In the «Trunk Stability Push-up» test, male students improved by 46.6%, and female students by 67.1%. Finally, the «Rotary Stability» test showed improvements of 27.9% for male students and 66% for female students (p<0.05 for the baseline result and the corresponding indicator for GP1).

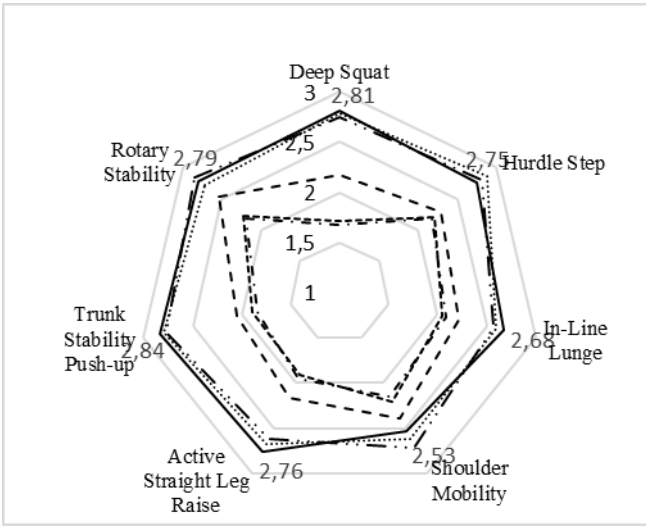

Fig. 1. Changes in the motor stereotype in males according to the FMS results (scores) under the influence of the physical therapy program (* – p<0.05 – statistically significant difference between the corresponding parameters of CG and GP;

° – p<0.05 – statistically significant difference between the corresponding parameters at the initial and repeated examinations;

● – p<0.05 – statistically significant difference between the corresponding parameters of GP1 and GP2).

The results of the repeated assessment of the motor stereotype in GP2 showed that the developed functional training program within the rehabilitation program led to statistically significant improvement in the performance of all tests, both relative to the baseline data (p<0.05) and relative to the GP1 indicators (p<0.05), and reached the level of the CG (p>0.05). The restoration of the motor stereotype indicates the normalization of the postural musculature, dynamic coordination abilities, which are the basis for safe locomotor function (figure 2).

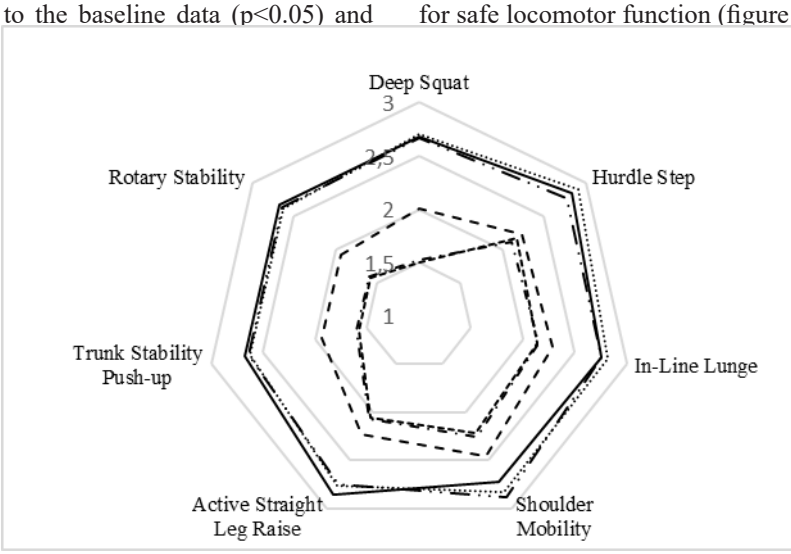

Fig.2. Changes in the motor stereotype in females according to the FMS results (scores) under the influence of the physical therapy program (* – p<0.05 – statistically significant difference between the corresponding parameters of CG and GP;

° – p<0.05 – statistically significant difference between the corresponding parameters at the initial and repeated examinations;

● – p<0.05 – statistically significant difference between the corresponding parameters of GP1 and GP2).

The results of the repeated assessment of the motor stereotype in GP2 showed that the developed functional training program within the rehabilitation program led to statistically significant improvement in the performance of all tests, both relative to the baseline data (p<0.05) and relative to the GP1 indicators (p<0.05), and reached the level of the CG (p>0.05). The restoration of the motor stereotype indicates the normalization of the postural musculature, dynamic coordination abilities, which are the basis for safe locomotor function.

Strength qualities are a clear indicator demonstrating the progress of rehabilitation intervention: therapeutic exercises and functional training contributed to the increase in the strength of back muscles and the grip. The results of the hand dynamometry in boys from GP2 improved by 38.9%, and in girls by 36.5%. The hand dynamometry indicators showed better dynamics by 30.6% and 14%, respectively. The obtained parameters were statistically significantly better than the baseline results and the indicators of GP1. Students from the GP1 group also showed improvement in strength qualities.

A clear indicator of the effectiveness of the developed physical therapy program is the dynamics of quality of life according to EQ-5D-5L (table 8). Improvement in physical qualities such as flexibility, strength, coordination, and the performance of functional exercises adapted to daily activities led to an improvement in the quality of life of students in GP2, as measured by the mobility scale – by 31.2%, self-care – by 16.5%, usual daily activities – by 69%, pain/discomfort – by 48.2%, anxiety/depression – by 56.7%.

The overall improvement on the EQ-VAS scale was 17.6%. For all subscales, the presented indicators were statistically significantly better than the baseline results and the parameters of GP1, and for the scales «usual daily activities» and «anxiety/depression,» the indicators reached the level of CG ($p<0.05$).

Table 8.

Dynamics of Quality of Life according to EQ-5D-5L under the influence of the FT program (± S)

Scale, Points	CG (n=30)		GP1 (n=30)		GP2 (n=30)	
	Initial examination	Repeat examination	Initial examination	Repeat examination	Initial examination	Repeat examination
Mobility	1,00± 0,00	1,00± 0,00	2,88± 0,42*	2,92± 0,11*	2,69± 0,13*	1,85± 0,05*°●
Self-care	1,00± 0,00	1,00± 0,00	3,25± 0,35*	3,15± 0,07*	3,33± 0,08*	2,78± 0,08*°●
Usual daily activities	1,28± 0,05	1,00± 0,00	3,38± 0,18*	3,25± 0,12*	3,23± 0,06*	1,00± 0,00°●
Pain/Discomfort	1,28± 0,05	1,00± 0,00	3,65± 0,09*	3,75± 0,08*	3,59± 0,08*	1,86± 0,07*°●
Anxiety/Depression	1,36± 0,04	1,41± 0,05	3,01± 0,24*	2,89± 0,15*	2,91± 0,12*	1,26± 0,05°●
EQ-VAS	84,08 ±2,45	80,11± 3,60	60,08± 4,22*	65,5± 3,51*	63,03± 3,17 *	74,11± 2,26*°●

Note: *– $p<0.05$ – statistically significant difference between corresponding parameters of CG and GP; ° – $p<0.05$ – statistically significant difference between corresponding parameters at initial and follow-up examinations; ● – $p<0.05$ – statistically significant difference between corresponding parameters of GP1 and GP2.

Dynamics of Parameters Characterizing the State of Fat Tissue

The implementation of the rehabilitation program under the supervision of a physical therapist led to a reduction in body weight in students of both gender groups in GP2, bringing it to the level of overweight according to BMI. The weight reduction during the observation period was 9.09 kg for girls (on average 1.5 kg per month) and 11.12 kg for boys (1.85 kg per month). In the GP group, the body weight of girls decreased by 2.12 kg, while the boys' weight remained virtually unchanged.

The waist circumference of the students in GP2 also significantly decreased, which can be explained by the reduction of adipose tissue in the abdominal area, reduced bloating, the elimination of stagnant phenomena, and improved tone of the anterior abdominal wall. At the same time, in both gender groups, the waist-to-hip ratio (WHR) decreased, indicating a reduction in the severity of dangerous abdominal obesity ($p<0.05$). In GP1, no statistically significant changes in anthropometric parameters were found compared to baseline data and CG parameters ($p>0.05$). The effectiveness of the kinesitherapy program in students of GP2 was confirmed by the statistically significant increase in muscle mass content in both male and female students of GP2.

The visceral fat content in individuals from GP2, although reduced, did not reach the level of CG and did not fall within the normal range of indicators. The overall fat content decreased by 14% in boys of GP2, and by 12.1% in girls of GP2, reaching the absolute gender levels of the upper limit of normal body fat content (Table 5.7). Another confirmation of both the reduction in fat tissue and normalization of the state of peripheral tissues was the normalization of the percentage of water content in the body of individuals from GP2.

Dynamics of the Functional Reserve Indicators of Spinal Tissues Improvement in spinal flexibility in GP students indicates improved functional capacity (table 9); in individuals with postural disorders, this suggests an expansion of the functional reserves of the spine, facilitating the development of an optimal movement stereotype, contributing to posture normalization, and easing the performance of daily life activities. In individuals with excessive fat tissue development, improved flexibility is, to some extent, an indicator of a reduction in subcutaneous fat deposits.

Table 9.

Dynamics of the Results of Spinal Flexibility Tests in Students with Postural Disorders, Flat Feet, and Obesity under the Influence of the FT Program (± S)

Test	CG (n=30)		GP1 (n=30)		GP2 (n=30)	
	Initial examination	Repeat examination	Initial examination	Repeat examination	Initial examination	Repeat examination
Chin to Sternum						
Male	0,72±0,07	0,81± 0,07	2,07± 0,07*	1,92± 0,06*	1,98± 0,07	1,04± 0,05*°●
Female	0,61±0,05	0,58± 0,04	1,77± 0,09*	1,65± 0,09*	1,62± 0,08	1,07± 0,08*°●
Ott						
Male	4,28± 0,06	4,03± 0,08	3,08± 0,10*	3,12± 0,12*	3,10± 0,08*	4,10± 0,08°●
Female	4,86± 0,07	4,92± 0,05	2,89± 0,08*	2,76± 0,11*	2,92± 0,10*	4,37± 0,32°●
Seddina						
Male, Forward Bend	7,12± 0,12	6,92± 0,08	4,59± 0,12*	4,73± 0,12*	4,45± 0,12*	6,07± 0,103*°●
Female, Forward Bend	7,82± 0,10	7,59± 0,15	4,47± 0,10*	4,15± 0,10*	4,37± 0,13*	6,17± 0,19*°●
Male, Backward Bend	5,03± 0,05	5,11± 0,10	3,20±0,09*	3,43± 0,11*	3,37± 0,10*	4,28± 0,07*°●
Female, Backward Bend	5,90± 0,10	5,75± 0,09	3,75± 0,10*	3,80± 0,10*	3,81± 0,09*	4,63± 0,14*°●
Schober						
Male	6,22± 0,15	6,07± 0,10	3,87± 0,14*	3,93± 0,11*	4,07± 0,12*	4,96± 0,13*°●
Female	6,68± 0,11	6,75± 0,12	4,45± 0,13*	4,50± 0,17*	4,13± 0,10*	5,71± 0,15*°●
Tomayer						
Male	3,11± 0,16	3,28± 0,11	8,31± 0,15*	8,53± 0,16*	8,51± 0,12*	5,62± 0,17*°●
Female	1,52± 0,09	1,65± 0,12	6,82± 0,18*	6,67± 0,17*	6,77± 0,12*	4,96± 0,15*°●

Note: *– $p<0.05$ – statistically significant difference between corresponding parameters of CG and GP; ° – $p<0.05$ – statistically significant difference between corresponding parameters at initial and follow-up examinations; ● – $p<0.05$ – statistically significant difference between corresponding parameters of GP1 and GP2.

The test results in representatives of GP2 were significantly more favorable than the results of the corresponding tests conducted in GP1. This indicates the significant and positive impact of controlled and therapist-created interventions on the health status of young individuals with obesity, postural disorders, and flat feet.

Dynamics of Indicators Characterizing Functional Reserves of the Foot and Balance Status. The combined influence on the foot through physical exercises, massage, and kinesiology taping led to an improvement in the arch height of the foot. During the follow-up examination, individuals with normal foot arch height, according to Friedland's index (up to 30%), were identified among students of GP2, due to a reduction in the number of individuals with flat feet and a decrease in the severity of flat feet in most cases where it had been more persistent (in the group with pronounced flat feet, the number of individuals decreased from 25% to 6.3%).

At the same time, there were no positive changes observed in GP1 representatives. Similar trends were observed in female students: in the GP2 group, there were also individuals with normal arch height of the foot (28.7%, no girls with pronounced flat feet were found).

It should be noted that the limited effect of physical therapy interventions on foot arch height can be explained by the presence of resistant forms of flatfoot (which did not meet the inclusion and exclusion criteria), as well as the relatively short period of time for rehabilitation training, which may not be sufficient for forming the arch of the foot. Furthermore, despite the reduced weight-bearing load on the feet, students still exhibited excessive fat deposition, which contributed to the flattening of the foot.

The improvement in balance during the performance of the FMS test movements (figures 1, 2), which is an indicator of stability, balance, and the strength of trunk and limb muscles, as a result of the active component of the developed physical therapy program, contributed to better vertical position maintenance in students from the GP2 group, as established by the results of stabilometry (table 10).

The length of the stabilogram in the GP2 group decreased by 27.2% with eyes open and by 12% with eyes closed ($p<0.05$ relative to baseline results and GP1 parameters; with the eyes closed, the result achieved the control group level ($p>0.05$)) (table 5). The area of the stabilogram in GP2 decreased by 27.1% with eyes open and by 21% with eyes closed ($p<0.05$ relative to baseline results and the parameters of both the control group and GP1) (table 9). There was also an improvement in the frequency center of the center of pressure oscillation. The main frequency of oscillations of the center of pressure along the abscissa axis with eyes open decreased by 27.3%, and with eyes closed – by 23.6%. The oscillation along the ordinate axis was 35% and 33.3%, respectively ($p<0.05$ relative to baseline results and parameters of GP1 and the control group ($p>0.05$)) (table 9).

Table 10.

Dynamics of stabilometry results in students with postural defects, flat feet, and obesity under the influence of the physical therapy program (± S)

Parameter	CG (n=30)		GP1 (n=30)		GP2 (n=30)	
	Initial examination	Repeat examination	Initial examination	Repeat examination	Initial examination	Repeat examination
L (Length)						
Open Eyes	220,45± 11,13	227,14± 14,16	320,22± 16,12*	338,14± 0,18*	345,16± 12,13*	251,31± 15,22*°●
Closed Eyes	534,08± 12,52	520,08± 20,08	620,58± 15,26*	631,45± 11,12*	611,45± 15,26*	538,17± 13,46°●
S (Area)						
Open Eyes	105,19± 9,45	112,13± 10,16	160,13± 10,16*	148,1± 12,08*	158,16± 9,45*	115,23± 8,15*°●
Closed Eyes	220,08± 12,10	202,16± 16,18	287,16± 12,18*	294,13± 10,45*	280,42± 10,84*	227,08± 12,03*°●
FX (X Axis Frequency)						
Open Eyes	0,42±0,08	0,39±0,06	0,62±0,05*	0,68±0,08*	0,66±0,07*	0,48±0,05*°●
Closed Eyes	0,58±0,05	0,50±0,06	0,78±0,06*	0,80±0,07*	0,72±0,07*	0,55±0,03*°●
FY (Y Axis Frequency)						
Open Eyes	0,39±0,04	0,42±0,05	0,85±0,08*	0,88±0,07*	0,80±0,06*	0,52±0,07*°●
Closed Eyes	0,50±0,05	0,58±0,08	0,92±0,07*	0,89±0,05*	0,87±0,07*	0,58±0,08*°●
V (Velocity)						
Open Eyes	9,06± 0,12	9,18± 0,08	15,08± 0,10*	16,88± 0,12*	15,57± 0,12*	12,08± 0,11*°●
Closed Eyes	16,44± 0,16	17,20± 0,10	23,46± 0,15*	25,08± 015*	26,07± 0,14*	20,07± 0,15*°●

Note: *– $p<0.05$ – statistically significant difference between corresponding parameters of CG and GP; ° – $p<0.05$ – statistically significant difference between corresponding parameters at initial and follow-up examinations; ● – $p<0.05$ – statistically significant difference between corresponding parameters of GP1 and GP2.

Improvement in the speed of pressure center displacement was also observed: with open eyes, by 24.4%, and with closed eyes, by 23% ($p<0.05$ relative to the baseline and GP1 parameters ($p>0.05$)) (table 9). The implementation of the comprehensive physical therapy program resulted in improvements in the overall functional reserves of the body in students with flat feet, postural defects in the sagittal plane, and obesity. It also enhanced their anthropometric parameters and body composition, increased the functional reserves of the spine and foot tissues, and improved body balance, indicating the program's effectiveness.

Conclusions. The health status of young people with obesity is characterized by high risks of progression of already existing comorbid conditions (particularly musculoskeletal disorders) in the future, especially considering the student lifestyle. Given the social significance of this group's involvement in the development of Ukraine, it is important to develop a program for the recovery and maintenance of the health of young people with various diseases, particularly through physical therapy.

The subjective state of students with obesity, flat feet, and postural defects was characterized by complaints related to shortness of breath during physical exertion and

increased fatigue in all students, with somewhat less discomfort in the body and psycho-emotional suppression. The changes in their health condition were partly related to low physical activity—according to IPAQ, significantly less time was spent on vigorous and moderate physical activity compared to healthy peers, with prolonged sedentary time ($p<0.05$). Their weekly energy expenditure was defined as «low physical activity» and was 60% lower compared to the control group, which negatively affected their physical condition—students with pathology lagged behind their healthy peers in all standard exercises of the Functional Movement Screen. Strength indicators were low: in comparison groups, deadlift strength and handgrip strength were at low levels. A comprehensive reflection of changes in the body was the low quality of life, as measured by EQ-5D-5L (significantly worse across all subscales compared to healthy peers); according to EQ-VAS, it was 26% worse. Obesity was associated with high body weight and BMI, abdominal obesity based on the waist-to-hip ratio. The body composition of students showed excessive fat content, particularly visceral fat, and low muscle mass. The condition of the spine in students with obesity and related conditions was characterized by low flexibility, as determined by the chin-chest, Ott, Sediyna, Schober, Tomayer tests. The functional reserves of the feet were characterized by a decrease in arch height according to Friedland's index. There was a deterioration in stability in the processes of forming stability and body balance (according to stabilometry parameters). The pathological changes identified at this stage of the study in the students with obesity, postural defects in the sagittal plane, and flat feet (which reflected changes in all domains of ICF) justified the need for and served as a basis for developing a comprehensive physical therapy program that considers the combination of pathology and the student lifestyle.

The physical therapy program for students with postural defects in the sagittal plane, flat feet, and obesity, developed based on the results of determining the parameters of the body's functional reserves related to each pathological condition and its general functions, had a comprehensive nature and included elements such as kinesitherapy methods (therapeutic exercises of various orientations, functional training on «PROSEDOS» platforms), massage, kinesiology taping, dietary modification recommendations (nutritional education), and patient education. The comprehensive nature of the developed program aimed at addressing the identified disorders in all domains of ICF and focused on increasing participation in social life by improving their health status while considering students' social status.

The impact of the developed physical therapy program was reflected in the positive dynamics of the students' subjective state, which confirmed a decrease in complaints: they almost no longer experienced pain or discomfort and had no problems performing activities of daily living. The number of people complaining of psycho-emotional depression decreased by 56%, increased fatigue by 76.2%, and decreased overall performance by 56%. Increased physical activity led to an increase in weekly energy expenditure according to IPAQ due to high- and moderate-intensity activity, with a decrease in moderate-intensity activity. The expansion of students' functional physical capabilities under the influence of the physical therapy program was established based on the results of the Functional Movement Screen— all students from GP2 demonstrated a statistically significant improvement in all tests relative to baseline results and the GP1 parameters ($p<0.05$). The improvement in physical condition was also evident in the increase in muscle strength (according to deadlift and hand dynamometry results, $p<0.05$). Quality of life according to EQ-5D-5L improved in all subscales, and according to EQ-VAS, it increased by 17.6% (statistically significantly better compared to baseline results and GP1 parameters).

The positive effect on the state of adipose tissue resulted in a decrease in overall body weight, BMI—reaching the level of excess weight, and a reduction in the degree of abdominal obesity. The body composition was characterized by a statistically significant increase in muscle tissue and a reduction in subcutaneous and visceral fat in both male and female students ($p<0.05$). An improvement in flexibility in all sections of the spine was determined based on the results of chin-chest, Ott, Sediyna, Schober, and Tomayer tests ($p<0.05$ relative to baseline and GP1 parameters). The functional reserves of the feet in GP2 were characterized by a dynamic improvement, with the appearance of normal arch height and a decrease in the number of people with high degrees of flatfoot. Stability during stabilometry was noted, which also indicated improvement in overall coordination and strength of trunk and limb stabilizer muscles, as well as the vestibular apparatus.

The improvement in indicators in the GP1 group may be associated with independent visits to the gym, self-training, and dietary corrections due to lectures. However, the absence of a comprehensive, systematic approach to improving health led to positive changes only in physical state indicators, not overall quality of life. Their overall quality of life did not improve, which indicates the need for systemic comprehensive rehabilitation for combined pathology.

The conducted studies on the effectiveness of the physical therapy program for students with postural defects in the sagittal plane, flat feet, and obesity, tested on a sufficient number of individuals, provide confirmed data and can serve as a basis for the practical application of this program in institutions involved in the rehabilitation of patients with orthopedic and endocrinological profiles.

Prospects for futher research. Further prospects involve the study of other comorbidities in students and their effective correction using physical therapy methods.

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ОЖИРІННЯ ЯК ПРЕДИКТОР РОЗВИТКУ ПЛОСКОСТОПОСТІ Й ПОРУШЕНЬ ПОСТАВИ ТА ЇХ КОРЕКЦІЯ МЕТОДАМИ ФІЗИЧНОЇ ТЕРАПІЇ

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Резюме. У дослідженні описано вплив ожиріння як фактора, що сприяє розвитку плоскостопості та порушень постави, а також представлено програму фізичної терапії для їх корекції. Обстежено 90 осіб, які були розподілені на 3 групи: 30 студентів з нормальною масою тіла, правильною поставою та без плоскостопості. Групу порівняння склали 60 студентів з ожирінням, порушеннями постави та плоскостопістю, які були розподілені на дві групи.

Групу порівняння 1 (КГ1) склали 30 студентів, які були проінформовані про ризики, пов'язані з ожирінням, порушеннями постави, плоскостопістю та загальною гіподинамією. Їм були надані рекомендації щодо основ зба-

лансованого харчування за ВООЗ та принципів зниження гіподинамії.

Групу порівняння 2 складали 30 студентів, яким проводили відновні втручання за програмою фізичної терапії.

За результатами анкетування стан студентів з ожирінням характеризувався задишкою при фізичному навантаженні, підвищеною втомлюваністю, дискомфортом у тілі, психоемоційною пригніченістю. За даними IPAQ, вони продемонстрували менше часу, витраченого на інтенсивну та помірну фізичну активність, порівняно зі своїми здоровими однолітками. Тижневі енерговитрати були на рівні низької фізичної активності. Згідно з дослідженнями ФМС, люди з ожирінням відставали від здорових однолітків. Сила рук і ніг у них була на низькому рівні. Якість життя за допомогою опитувальника EQ-5D-5L виявилася низькою. Ожиріння було пов'язане з високою масою тіла та індексом маси тіла (ІМТ), а також наявністю абдомінального ожиріння. Стан хребта характеризувався низькою гнучкістю в підборідно-грудних пробах Отта і Шобера, Сєдіна, Томайера. Стопи характеризуються зменшенням висоти склепіння, про що свідчить індекс Фрідланда. Діагностовано погіршення стійкості та рівноваги.

Розроблено програму фізичної терапії, тривалістю 6 місяців, яка включала такі елементи: методи кінезотерапії, масаж, кінезітейпування, рекомендації щодо корекції харчування та навчання пацієнтів. Комплексний характер програми був спрямований на вирішення виявлених розладів у всіх областях ICF (Міжнародної класифікації функціонування, інвалідності та здоров'я) і зосереджений на активізації участі в соціальному житті шляхом покращення здоров'я учасників.

Вплив розробленої програми фізичної терапії відобразився на позитивній динаміці суб'єктивного стану студентів. Щотижневі витрати енергії зросли згідно з IPAQ, розширені фізичні можливості були встановлені за допомогою FMS, м'язова сила покращилася згідно з результатами динамометричних тестів для ніг і рук, а якість життя покращилася згідно з опитувальником EQ-5D-5L. У 2 групі порівняння спостерігалося зниження маси тіла та ІМТ (до рівня надлишкової ваги), зменшення абдомінального ожиріння, збільшення вмісту м'язової тканини, зменшення жирової тканини. Гнучкість у всіх відділах хребта покращилася за результатами підборідно-грудних пробах Отта і Шобера, Сєдіна, Томайера. Відзначено покращення функціональних резервів стоп, у студентів спостерігається нормальна висота склепіння стопи та зменшення кількості осіб із високим ступенем плоскостопості. Стабільність під час стабілометрії покращилася, що вказує на кращу загальну координацію та силу м'язів кору та стабілізаторів кінцівок, а також вестибулярної системи.

Ключові слова: фізична терапія, МКФ, фізична терапії в ортопедії, ожиріння, порушення постави, плоскостопість, метаболічний синдром, якість життя.

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