

# THE INFLUENCE OF PHYSICAL THERAPY ON INDICATORS OF LOCOMOTIVE SYNDROME IN ELDERLY PERSONS WITH OSTEOARTHRITIS OF THE KNEE AND OBESITY

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## Summary

**Aim:** to assess the effectiveness of the developed physical therapy program on locomotive syndrome parameters in elderly people with osteoarthritis of the knee and obesity.

**Materials and methods.** 93 elderly people were examined. The control group consisted of 31 people without osteoarthritis of the joints, with no obesity. The main group 1 consisted of 33 people who received rehabilitation according to the general principles of osteoarthritis correction. Representatives of the main group 2 (31 people) were engaged in a physical therapy program using functional training on the «Prosedos» platform, therapeutic exercises, Proprioceptive Neuromuscular Facilitation; massage, kinesiological taping, nutritional correction, patient education. The effectiveness of the program was evaluated according to the dynamics of the Short Physical Performance Battery, Functional Gait Assessment, Tinetti-test (Performance-Oriented Mobility Assessment), 25-question Geriatric Locomotive Function Scale.

**Results.** Elderly patients with osteoarthritis of the knee and obesity were found to have impaired balance (Short Physical Performance Battery), altered gait stereotype (Functional Gait Assessment), risk of falling when performing activities of daily living (Tinetti-test) at the level of locomotive syndrome II degree (25- question Geriatric Locomotive Function Scale). The developed program of physical therapy in persons of the main group 2 revealed a statistically significantly better effect on the components of the locomotive syndrome compared to the initial examination in all studied parameters ( $p < 0.05$ ). Elderly patients who underwent rehabilitation according to the standard program for the correction of osteoarthritis achieved a statistically significant improvement compared to the initial state according to the studied parameters ( $p < 0.05$ ), but less pronounced compared to the tested program.

**Conclusions.** Elderly patients with osteoarthritis of the knee joints and obesity need to develop physical therapy programs taking into account and correcting the specifics of each condition, the presence of static and dynamic balance disorders and the risk of falling, which will increase the overall effectiveness of rehabilitation measures.

**Key words:** physical therapy, old age, gerontology and geriatrics, obesity, osteoarthritis.

## INTRODUCTION

According to the classification of the World Health Organization, people aged 60 to 74 years are considered elderly people, those aged 75 to 90 years are considered people. The monthly increase in the number of the population in these older age groups in the world is 1.9 million people. At the same time, by 2050, a double increase of these layers of the population is expected, which currently amounts to 11% [1]. In Ukraine, the

social role of the elderly is growing as a result of military operations and the involvement of a large number of young people in their direct management, which occurs against the background of the need for the functioning of not only the life of the civilian population, but also the intensive work of rear military structures.

In 2007, the Japanese Orthopedic Association proposed a new concept – locomotive syndrome – to characterize unstable balance and impaired mobility due to structural

and functional damage to the organs of the musculoskeletal system responsible for mobility in elderly patients [2]. Locomotive syndrome is an unsatisfactory condition of patients over 60 years of age who need or may need outside help in the near future due to functional deterioration of the musculoskeletal system, which includes pathology of bone tissue, joints, muscles, and nervous tissue [2, 3].

Morbidity in the age category of 60–74 years is 2 times higher, at the age of 75 years and older – 6 times higher, than in young people, because the number of diseases, especially chronic ones, gradually accumulates, the possibilities of adaptation to exogenous and endogenous influences decrease [1, 4]. The number of diseases of the musculoskeletal system, including osteoarthritis, osteoporosis, sarcopenia, is increasing, and falls with negative consequences for health are becoming more frequent [4, 5, 6].

Locomotive syndrome is included in the structure of frailty (senile asthenia), characterized by the appearance of chronic pain, limitation of joint mobility, balance disorders, falls, difficulty walking, kinesophobia [3]. Mortality increases by 57% in patients over 60 years old with chronic joint pain [5]. As a result of the evolution of locomotive syndrome in patients of older age groups, there is a progressive decrease in activity in everyday life, a deterioration in the quality of life, an increasing need for medical assistance and outside care, and social isolation is formed [6].

Among the numerous forms of diseases of the musculoskeletal system, degenerative-dystrophic diseases of the spine and joints are the most common, affecting from 8 to 12% of the population of different countries [5]. Osteoarthritis occurs in 10% of men and 20% of women in older age groups, and is the main cause of disability in patients over 60 years of age [7]. It is associated with constant pain with limitation of mobility and/or loss of joint function, as a result of which the quality of life of patients decreases; chronic musculoskeletal pain in patients with locomotive syndrome is associated with an increased incidence of adverse outcomes, including functional impairment, falls, depression, and sleep disturbances [3]. Osteoarthritis of any type is characterized by a loss of muscle strength, which eventually leads to the development of sarcopenia [5, 7].

Obesity affects not only the development, but also the progression of diseases of the musculoskeletal system, including osteoarthritis, inflammatory joint diseases, and pain in the lower back [8]. The connection between obesity and the prevalence and severity of osteoarthritis of the knee, hip, and hands has been demonstrated [7]. Obesity often precedes the development of knee osteoarthritis and increases the risk of progression of radiological changes in them due to mechanical overload of the joint and the occurrence of local proinflammatory changes [7, 8]. In old age, excessive development of adipose tissue is a factor of high risk of

cardiovascular disasters, reduces already low physical activity, acquiring the character of sarcopenic obesity [9].

The problem of drug therapy of elderly patients with locomotive syndrome is relevant for all countries of the world, especially in the context of the development of polypharmacy. Elderly and senile patients often take a large number of drugs, in particular those that have undesirable effects on the functioning of the musculoskeletal system. Therefore, the use of physical therapy is of great importance, which with proven effectiveness have a positive multidirectional effect on the functioning of the body of patients with obesity [9], inflammatory and traumatic lesions of the musculoskeletal system [5], and also contribute to improving the quality of life of the elderly [10].

**The aim of the study is** to evaluate the effectiveness of the developed complex program of physical therapy on the parameters of locomotive syndrome in elderly people with osteoarthritis of the knee joints and obesity.

## MATERIALS AND METHODS

93 elderly people participated in the longitudinal prospective study.

The control group (CG) consisted of 13 men and 18 women aged  $67.7 \pm 1.0$  years, who were not diagnosed with knee osteoarthritis and obesity.

The main group (OG) consisted of 27 men and 35 elderly women ( $66.3 \pm 0.7$  years old) diagnosed with primary osteoarthritis of the knee in the acute stage and obesity, who received drug therapy according to the «Clinical protocol for providing medical care to patients with osteoarthritis». They were divided into two subgroups by a blind randomized method. The main group 1 (MG1) consisted of 14 men and 19 women who received rehabilitation according to the general principles of osteoarthritis correction [11]. The main group 2 (MG2) consisted of 13 men and 16 women who underwent a physical therapy program, the results of which are presented in this work.

Inclusion criteria: advanced age according to the criteria of the World Health Organization (60–75 years); knee osteoarthritis II–III degree according to the radiological classification of Kellgren–Lawrence; obesity, defined by body mass index ( $\geq 30$ ); consent to active participation in the implementation of recommended restorative interventions and / or examinations. Exclusion criteria: secondary knee osteoarthritis; hip osteoarthritis; the presence of severe somatic accompanying pathology (in particular, neurological, traumatological); exacerbation of an existing chronic pathology at the time of the study; non-compliance with the inclusion criteria.

The developed program of physical therapy lasted 3 months. Its purpose was: reduction of pain and discomfort; improvement of the amplitude of movements

in the joints; optimization of general mobility and motor stereotype; decrease in body weight; facilitating activities of daily living; improvement of the psycho-emotional state, and – as a result – improvement of the quality of life.

The approved program of active functional physical therapy included kinesitherapy, Proprioceptive Neuromuscular Facilitation of the lower limbs and lower back; massage, kinesiological taping of knees and lower back; patient education (principles of a balanced diet, prevention of the risk of falling, independent management of pain and movement disorders, maintenance of optimal movement activity).

The basis of kinesitherapy was performing therapeutic exercises of various orientations (for the development of strength, flexibility, endurance, coordination qualities, balance), working out the skills of normal motor stereotype and gait; functional training on the «PROSEDOS» platform, taking into account limitations caused by osteoarthritis, obesity and age-related changes. Rehabilitation movement classes were held three times a week; first in a rehabilitation center, then in the format of telerehabilitation with periodic monitoring. In the physical therapy program, patients underwent massage courses: lower limbs and back, the purpose of which was to improve blood supply and trophic of soft tissues to speed up the overcoming of muscle weakness; improvement of elasticity of muscles, ligaments, tendons; reduction of unpleasant sensations after rehabilitation training; improvement of psycho-emotional state. To reduce discomfort, swelling, and instability of the knee joint, kinesio taping of knee structures and thigh muscles was performed. Training on the principles of nutrition included recommendations taking into account the specific needs of older age groups with sarcopenia and obesity: increase protein consumption to 1-1.5 g per kg of body, consume vitamin D, receive additional insolation; increase the consumption of vegetables and fruits, reduce the amount of carbohydrates. Patients were also taught the principles of fall risk prevention (creating a safe environment), self-monitoring of their health. The aim of the training will be to develop a clear understanding of health problems in patients and their adherence to tactics for long-term independent correction of health problems. In the process of physical therapy, the set individual short- and long-term rehabilitation goals were gradually achieved.

The condition of the examined patients of the main group was evaluated dynamically before (pre-test) and after (post-test) the approbation of the developed physical program according to indicators that characterize the locomotive syndrome. In order to assess balance, motor control and the presence of sarcopenia and senile asthenia, motor testing of patients according to the Short Physical Performance Battery (SPPB) was performed [12]. The risk of falling due to balance disorders was determined

by the Functional Gait Assessment (FGA), which is used to assess postural stability during various walking tasks [13]. Motor activity from the positions of risk of falling during activities of daily life was evaluated according to the Tinetti-test (Performance-Oriented Mobility Assessment) [14]. The overall assessment of locomotive syndrome severity was performed using the 25-question Geriatric Locomotive Function Scale (GLFS-25) [15].

The study was conducted taking into account the principles of the Helsinki Declaration of the World Medical Association «Ethical principles of medical research involving a person as an object of research». Informed consent to participate in the study was obtained from all persons included in the study. The research protocol was discussed and approved at the meeting of the Bioethics Commission of Vasyl Stefanyk Precarpathian National University.

The correspondence of the results to the law of normal distribution was checked by the Shapiro-Wilk test. For the results of the indicators, which in all three groups corresponded to the law of normal distribution, the mean value and standard deviation ( $M \pm SD$ ) were calculated, and for the others, the median ( $Me$ ) and the upper and lower quartiles (25%; 75%) were calculated. In the presence of differences between groups, Mann-Whitney group comparisons were used. Reliability  $P=95\%$  (probability of error 5%), i.e. significance level  $p=0.05$ , was accepted. Data processing was carried out using Statistica 10 (StatSoft, USA).

## RESULTS

The initial examination of elderly people with knee osteoarthritis and obesity revealed in them muscle weakness, static and dynamic balance disorders, risk in performing activities of daily life, which can collectively be considered as signs of locomotive syndrome [3, 4].

The results of the SPPB test can be considered from two points of view: as an indicator of static and dynamic balance and as a criterion for the presence of senile asthenia and sarcopenia. During the initial examination, elderly people with osteoarthritis and obesity on average lagged behind the indicators of the control group according to the SPPB balance subscale by 51.5%, the walking speed subscale by 20.7%, getting up from a chair by 65.8%; the total lag in the total SPPB score was 44.4% ( $p < 0.05$ ) (Table 1).

Violation of the normal stereotype of gait due to the limited capabilities of the knee against the background of physical muscle weakness and balance disorders led to a high risk of falling. According to the results of FGA, a high risk of falling in terms of its absolute digital value and a statistically significant lag in CG parameters ( $p < 0.05$ ) in both groups by almost a third were found in people with osteoarthritis and obesity (Fig. 1).

Table 1

**Dynamics of SPPB results in elderly people with knee osteoarthritis and obesity under the influence of a physical therapy program (M±SD)**

| Tests, points            | CG (n=31)  | MG1 (n=31)   |               | MG2 (n=29)   |               |
|--------------------------|------------|--------------|---------------|--------------|---------------|
|                          |            | MG1 pre-test | MG1 post-test | MG2 pre-test | MG2 post-test |
| Balance assessment tests | 3,19±0,13  | 1,62±0,19*   | 1,86±0,14*    | 1,50±0,14*   | 2,31±0,17*°□  |
| Gait speed tests         | 3,58±0,10  | 2,86±0,09*   | 3,07±0,13*    | 2,81±0,11*   | 3,50±0,2°□    |
| Rise-from-a-chair test   | 3,65±0,09  | 1,31±0,16*   | 1,90±0,16*°   | 1,19±0,15*   | 2,62±0,17*°□  |
| Overall score            | 10,42±0,18 | 5,79±0,23*   | 6,83±0,21*°   | 5,46±0,25*   | 8,42±0,27*°□  |

Notes (here and later in the text): \* – p<0.05 – statistically significant difference between the corresponding parameters of CG and OG; ° – p<0.05 – statistically significant difference between the relevant parameters of examinations before and after physical therapy; □ – p<0.05 – statistically significant difference between the corresponding parameters of OG1 and OG2

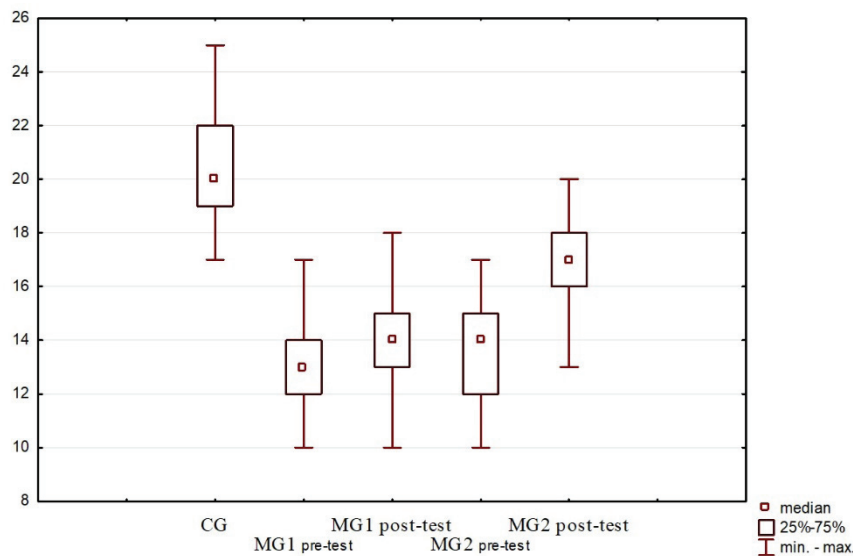


Figure 1. Dynamics of FGA (points) in elderly people with knee osteoarthritis and obesity under the influence of physical therapy, Me (25%; 75%)

A sufficient level of motor activity is a prerequisite for maintaining physical qualities, household and (if necessary) professional activity, and reducing the risk of falling. Accordingly, impaired performance of simple movements according to SPPB and deterioration of balance according to FGA in elderly people of the main

groups also led to an increase in the risk of falling to a moderate level according to the results of determining static and dynamic balance according to the Tinetti-test and a statistically significant lag behind the corresponding parameters of representatives of the control group. in which a slight risk of falling was found (Table 2).

Table 2

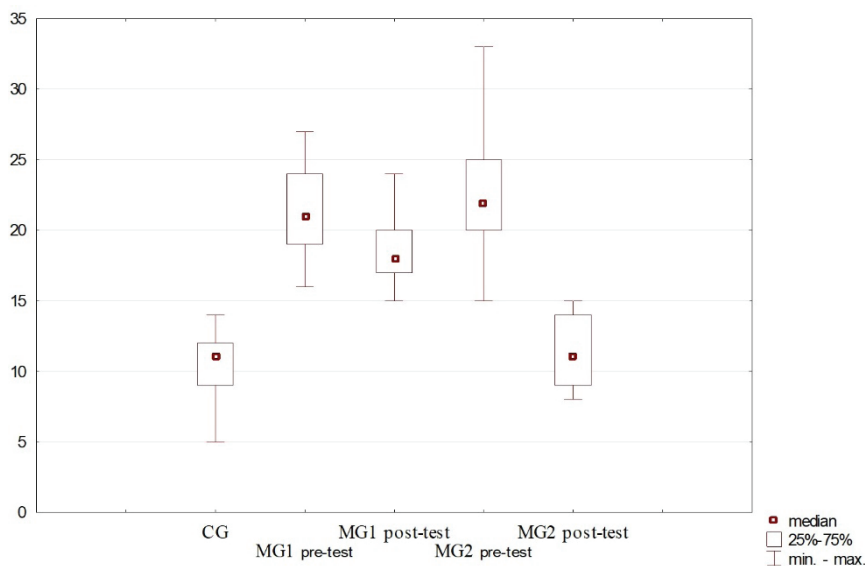
**The dynamics of the results of the assessment of the risk of falling according to the Tinetti-test in elderly people with knee osteoarthritis and obesity under the influence of the physical therapy program, Me (25%; 75%)**

| Tests, бали     | CG (n=31)         | MG1 (n=31)         |                    | MG2 (n=29)         |                    |
|-----------------|-------------------|--------------------|--------------------|--------------------|--------------------|
|                 |                   | MG1 pre-test       | MG1 post-test      | MG2 pre-test       | MG2 post-test      |
| Balance Section | 13,0 (11,0; 14,0) | 10,0 (9,0; 12,0)*  | 12,0 (11,0; 14,0)* | 12,0 (9,0; 12,0)*  | 14,0 (13,0; 15,0)° |
| Gait Section    | 10,0 (10,0; 11,0) | 8,0 (7,0; 10,0)*   | 9,0 (8,0; 10,0)*   | 8,0 (7,0; 9,0)*    | 10,0 (9,0; 12,0)*° |
| Overall score   | 23,0 (21,0; 25,0) | 19,0 (17,0; 22,0)* | 21,0 (20,0; 23,0)* | 19,0 (17,0; 22,0)* | 24,0 (23,0; 26,0)° |

Note: the comparison was made according to the Mann-Whitney test

GLFS-25 testing, which directly determines the presence of locomotive syndrome and its degree of severity, became the generalizing result of changes in static and dynamic balance, activity disturbances (mediated signs of locomotive syndrome), revealed during the examination. It was established that the subjects of the control group also showed subjective

signs of locomotive syndrome (despite the compliance with the research criteria and diagnosed marked changes during our examinations), but its severity was more significant in patients with osteoarthritis and obesity (Fig. 2). The absolute numerical GLFS-25 indicators of the main groups lagged behind the control group by almost two times (p<0.05).



**Figure 2. Dynamics of locomotive syndrome according to GLFS-25 (points) in elderly people with knee osteoarthritis and obesity under the influence of physical therapy, Me (25%; 75%)**

According to the results of the primary examination, the representatives of the main groups were comparable, as their results did not differ statistically significantly ( $p > 0.05$ ). This made it possible to conduct the next study aimed at correcting the detected signs of locomotive syndrome.

Re-examination of patients with osteoarthritis and obesity after the implementation of the physical therapy program showed the following result.

When re-examined according to the SPPB tests, individuals of the main group 2 managed to statistically significantly improve the initial result, go from the level of asthenia to the lower level of preasthenia according to the absolute digital indicator, which confirms the effectiveness of functional training and motor training, improvement of physical qualities, but indicates the need for a long-term correction program. Compared to the initial data, the results of the Balance assessment tests improved in MG2 individuals by 54%, Gait speed tests – by 24.6%, Rise-from-a-chair test – more than twice, the overall result – by 54% (Table 1).

A decrease in the severity of muscle weakness, improvement in motor control of movements and physical qualities led to a decrease in the risk of falling: according to the FGA, the improvement of gait parameters in MG2 individuals was 19.7% (Fig. 1).

The improvement of the physical status led to a decrease in the risk of falling to a slight one (according to the Tinetti-test), which demonstrated an improvement in static-dynamic coordination qualities, which is also evidence of a decrease in muscle weakness (Table 2).

In accordance with the listed positive changes, in MG2 patients, the severity of locomotive syndrome symptoms decreased (by 48%,  $p < 0.05$  compared to the initial result and the parameters of the main group 1),

although it did not reach the parameters of the control group ( $p > 0.05$ ) (Fig. 2).

According to all the studied data, upon re-examination, MG2 individuals showed a statistically significant improvement relative to the initial indicator ( $p < 0.05$ ) and repeated parameters of MG1 ( $p < 0.05$ ), reaching the level of the control group only according to the Tinetti-test ( $p > 0.05$ ), which asserts the need for long-term correction of the phenomena of sarcopenia and motor consequences of osteoarthritis and obesity.

During the re-examination of MG1 individuals who underwent recovery under the general polyclinic rehabilitation program, an improvement was also established relative to the initial condition according to the studied indicators ( $p < 0.05$ ), but less pronounced compared to the tested program.

## DISCUSSION

Today, it is believed that the correction of locomotive syndrome symptoms should be long-term, necessarily include complex support of muscle tissue, balance training, cognitive-behavioral therapy with the aim of awareness of lifestyle changes associated with chronic pathology, and their independent daily correction [2, 3].

The main goal of locomotive syndrome therapy is to improve the patient's physical functioning, overcome addictions in everyday life, and increase the autonomy of an elderly person. Solving these tasks is related to increasing physical activity and mobility, overcoming fear of movement, solving the patient's social problems, eliminating environmental safety defects, reducing the risk of falls, preventing fractures – in fact, all these tasks are solved with the participation of physical therapy [6, 10].

The formation of an individual plan of rehabilitation care for the patient is based on the patient's individual risks identified during the examination.

Physical activity is an essential component of locomotive syndrome therapy, as physical activity increases the ability of muscle tissue to synthesize protein [10]. A decrease in physical activity is directly related to a decrease in work capacity and an increase in the frequency of premature death. Therefore, for this contingent of patients, it was useful to use exercises within the framework of the physical therapy program created by us, aimed at increasing strength and developing other physical qualities. From the point of view of pathogenetic interrelationships [3, 4], it was expedient to identify and correct the interdependence of sarcopenia and the risk of falling, imbalance – components of the locomotive syndrome, by influencing the etiopathogenetic processes of the combined pathology. Based on the data of the literature [2, 7, 8] and our own experience, we believe that when a comorbid pathology associated with impaired motor functions is detected in the elderly, it is necessary to create optimal conditions for maintaining their functional status, autonomy, and quality of life. The main principle of locomotive syndrome therapy is long-term, restorative intervention should include comprehensive support of muscle tissue (kinesitherapy, diet, intake of certain micronutrients), which is also confirmed by the works of other authors [6, 10].

## CONCLUSIONS

1. In elderly patients with osteoarthritis of the knee and obesity, signs of locomotive syndrome were detected in the form of imbalance when performing simple movements (according to SPPB), violation of the normal gait stereotype and the resulting risk of falling (according to FGA), in particular when performing activities of daily living (according to the Tinetti test). The general level of movement disorders corresponded to locomotive syndrome of II degree (according to GLFS-25).

2. A tested complex program of physical therapy with the use of functional training, therapeutic exercises

of various directions, Proprioceptive Neuromuscular Facilitation; massage, kinesiological taping, nutrition correction, patient training taking into account individual rehabilitation goals revealed a statistical improvement in the condition of patients due to the influence on the components of the locomotive syndrome due to the improvement of static and dynamic balance and gait parameters, reducing the risk of falling compared to the initial indicators for all the studied parameters ( $p < 0.05$ ).

3. Elderly patients with osteoarthritis of the knee and obesity, who underwent rehabilitation according to the standard program for the correction of osteoarthritis, achieved a statistically significant improvement compared to the initial state according to the studied indicators ( $p < 0.05$ ), but less pronounced compared to the tested program.

4. Elderly patients with knee osteoarthritis and obesity need to develop physical therapy programs taking into account and correcting the specifics of each condition, the presence of physical status disorders and the risk of falling, which will increase the overall effectiveness of rehabilitation measures.

Prospects for further research consist in the practical determination of the impact of the developed physical therapy program on fall risk indicators in elderly patients with osteoarthritis and obesity.

## FUNDING AND CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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*Резюме***ВПЛИВ ФІЗИЧНОЇ ТЕРАПІЇ НА ПОКАЗНИКИ ЛОКОМОТОРНОГО СИНДРОМУ У ОСІБ ПОХИЛОГО ВІКУ З ОСТЕОАРТРОЗОМ КОЛІННИХ СУГЛІВ ТА ОЖИРІННЯМ****Марія Г. Аравіцька, Олеся В. Саєнко**

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**Мета:** оцінити ефективність розробленої програми фізичної терапії на показники локомоторного синдрому у осіб похилого віку з остеоартрозом колінного суглоба та ожирінням.

**Матеріали та методи.** Обстежено 93 людини похилого віку. Контрольну групу склали 31 особа без остеоартрозу суглобів, без ожиріння. Основну групу 1 склали 33 людини, які проходили реабілітацію за загальними принципами корекції остеоартрозу. Представники основної групи 2 (31 особа) займалися за програмою фізичної терапії з використанням функціонального тренування на платформі «Prosedos», терапевтичних вправ, пропріоцептивної нервово-м'язової фасилітації, масажу, кінезіотейпування, корекції харчування, навчання пацієнтів. Ефективність програми оцінювали за динамікою Short Physical Performance Battery, Functional Gait Assessment, Tinetti-test (Performance-Oriented Mobility Assessment), 25-question Geriatric Locomotive Function Scale.

**Результати.** У пацієнтів похилого віку з остеоартрозом колінного суглоба та ожирінням виявлено порушення рівноваги (Short Physical Performance Battery), змінений стереотип ходи (Functional Gait Assessment), високий ризик падіння під час виконання активностей повсякденного життя (Tinetti-тест) на рівні локомоторного синдрому II ступеня (25-question Geriatric Locomotive Function Scale). Розроблена програма фізичної терапії в осіб основної групи 2 виявила статистично достовірно кращий вплив на компоненти локомоторного синдрому порівняно з первинним обстеженням за всіма досліджуваними показниками ( $p < 0,05$ ). Пацієнти похилого віку, які проходили реабілітацію за стандартною програмою корекції остеоартрозу, досягли статистично значущого покращення порівняно з вихідним станом за досліджуваними показниками ( $p < 0,05$ ), але менш вираженого порівняно з апробованою програмою.

**Висновки.** Пацієнти похилого віку з остеоартрозом колінних суглобів та ожирінням потребують розробки програм фізичної терапії з урахуванням та корекцією особливостей кожного стану, наявності порушень статичної та динамічної рівноваги та ризику падіння, що підвищить загальну ефективність реабілітаційних заходів.

**Ключові слова:** фізична терапія, похилий вік, геронтологія та геріатрія, ожиріння, остеоартроз.