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EFFECTIVENESS OF A PHYSICAL THERAPY PROGRAM ON THE MANIFESTATIONS OF ASTHENIA AND CANCER-RELATED FATIGUE IN PATIENTS WITH THE CONSEQUENCES OF ONCOLOGIC KNEE JOINT ENDOPROSTHETIC REPLACEMENT

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Background. Oncologic joint endoprosthetic replacement imposes increased demands on rehabilitation, as patients, in addition to orthopedic sequelae, frequently experience asthenia and cancer-related fatigue encompassing physical, emotional, and cognitive components, which significantly reduces quality of life.

Aim. To evaluate the effectiveness of a developed physical therapy program in patients with the consequences of oncologic knee endoprosthetic replacement based on indicators of asthenia and parameters of cancer-related fatigue.

Materials and Methods. The study included 7 participants who underwent surgery for osteosarcoma of the distal femur. The physical therapy program was implemented for 12 weeks (strength exercises for extremities and trunk, gait training, correction of individual functional impairments). Outcomes were assessed using the six-minute walk test, handgrip and deadlift dynamometry, and the EORTC QLQ-FA12 questionnaire (European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire cancer-related FAtigue (12 items)). Parametric statistical methods (the Student's t-test) were applied for normally distributed variables, whereas the Wilcoxon signed-rank test was used for non-normally distributed data. The study constitutes a component of the research project «Improvement of Functional Status, Quality of Life, and Correction of Pathological Conditions of Various Origins by Means of Therapy and Rehabilitation», State Registration No.0123U01534, conducted at Vasyl Stefanyk Carpathian National University (2023–2026).

Research Ethics. The study was conducted in accordance with the principles of the World Medical Association Declaration of Helsinki (1964–2024), with informed consent obtained from all participants. The study protocol was approved by the institutional bioethics committee.

Results. Following the physical therapy program, the distance covered in the six-minute walk test increased by 23.3% ($p<0.001$), while the median fatigue level according to the Borg scale decreased by 30.8% ($p<0.05$). Handgrip strength increased by 6.7 kg in males and by 6.3 kg in females ($p<0.001$). Deadlift strength increased by 19.6 kg in males ($p<0.05$) and by 8.2 kg in females ($p<0.001$). According to the QLQ-FA12 questionnaire, a reduction in symptoms was observed across all domains; the total score decreased from 81 to 59 (27.2%; $p<0.05$).

Conclusions. A functionally oriented physical therapy program is effective in reducing cancer-related fatigue and asthenia in patients after oncologic knee endoprosthetic replacement, improving exercise tolerance and muscle strength while decreasing the impact of fatigue on daily life.

Keywords: *physical therapy and rehabilitation, orthopedics and traumatology, malignant tumor, muscle weakness, lower limb, gait impairment.*

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Цитуйте українською: Аравіцька МГ, Лапковський ЕЙ, Шеремета ЛМ, Михайлюк ІО, Остапяк ЗМ. Ефективність програми фізичної терапії за проявами астенії та онкологічної втоми у пацієнтів з наслідками онкологічного ендопротезування колінного суглоба. Експериментальна і клінічна медицина. 2025;94(3):9с. In press. https://doi.org/10.35339/ekm.2025.94.3.als

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Introduction

In modern oncological practice, there are increasing demands on the quality of rehabilitation following surgical interventions. One of the important goals after oncological treatment is to restore the functions of the affected joint, especially in conditions of endoprosthetics, for example, of the knee joint. Patients after oncological endoprosthetics face not only orthopedic problems but also a wide range of systemic symptoms, among which asthenia and Cancer Related Fatigue (CRF) stand out [1–3].

Asthenia is characterized by general weakness, rapid onset of fatigue, and decreased performance, all of which occur even with minimal exertion. Cancer-related fatigue is a multidimensional phenomenon that includes physical, cognitive and emotional components, which does not disappear after a short rest. In many cancer patients, this symptom persists for a long time after the end of treatment and significantly reduces the quality of life. According to scientific data, about 49% of cancer patients report fatigue at various stages of the disease or after treatment [4].

Research on the effects of motor rehabilitation interventions suggests that a combination of aerobic and strength exercises can reduce the manifestations of CRF, improve functionality, muscle strength, and the general condition of patients after cancer treatment [5; 6]. In particular, the study by Dimeo F. et al. (2008) [7] showed that a three-week exercise program led to a significant reduction in physical and psychological fatigue in cancer patients.

However, most of the available works do not actually describe the group of patients who have undergone oncological knee arthroplasty, especially taking into account long-term consequences and functional recovery [8]. In these cases, the load on the musculoskeletal system, postoperative movement restrictions, and changes during rehabilitation define additional challenges for the health care system, in particular for the activities of physical therapists.

In addition, the dynamics of asthenia and CRF manifestations at different time points after endoprosthetics remains insufficiently studied: whether fatigue increases or decreases over time, what factors (age, comorbidities, intensity of physical therapy) determine its trajectory are questions that require systematic research.

In this regard, it is advisable to apply a physical therapy program as an intervention aimed at alleviating asthenic symptoms and CRF, and to trace its effect on the course of these manifestations in patients with oncological knee joint endoprosthetics. The theoretical prerequisites for the use of this type of rehabilitation intervention are its proven effectiveness in correcting the signs of both specific motor disorders of various genesis and non-specific action in overcoming the phenomena of asthenia, sarcopenia, etc. [9; 10].

Thus, the topic under study is relevant, combining the issues of oncology, orthopedics, and rehabilitation, and may have both theoretical and practical significance for improving the health and quality of life of cancer patients.

The **aim** of this study was to evaluate the effectiveness of the developed functionally directed physical therapy program in patients with the consequences of oncological knee arthroplasty on indicators of asthenia and parameters of cancer-related fatigue.

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Materials and Methods

The study involved 7 people (4 men, 3 women) who underwent surgery for a tumor lesion of the distal femur (osteosarcoma). The average age of the patients was [37.0±3.2] years (25–52 years).

In order to form a homogeneous group and obtain the most reliable results, the following inclusion criteria were determined: the presence of primary malignant lesions of the femur; polychemotherapy according to the appropriate protocol in patients with primary malignant tumors requiring preoperative conservative treatment; the presence of an extensive defect in the distal femur; removal of the tumor with a wide margin; primary knee arthroplasty; follow-up period – at least 12 months from the moment of surgical treatment; the use of modular oncological and revision endoprostheses.

The physical therapy program was implemented for 12 weeks. Patients attended motor sessions three times a week, consisting of a set of therapeutic exercises, functional training and gait training (the frequency of classes was determined by the need for recovery after classes due to fatigue). The classes were divided into two parts – mandatory (40 minutes – exercises common to all patients to strengthen the muscles of the upper and lower extremities, torso (with dumbbells and weights weighing 0.5–1–1.5 kg), gait training on a treadmill, obstacle course with BOSU platforms and surfaces of different heights, densities, and stability 5 m long) and variable (20 minutes – functional training that corrected individual motor disorders and was aimed at solving individual rehabilitation goals). During the training, a PROCEDOS® floor and wall platform complex was used, which allowed the correction of identified dynamic motor disorders in a conventional 3D-marked floor system by visual self-control and control by a physical therapist. Fall risk was monitored throughout the session; training intensity did not exceed [40–50]% of the age-predicted maximal heart rate. The main tasks were to restore the normal gait pattern as much as possible, improve static and dynamic balance, improve endurance, and facilitate the performance of activities of daily living.

The condition of the patients was assessed by parameters characterizing physical weakness and fatigue.

The severity of fatigue during physical exertion was determined by the results of a 6-minute test (distance covered, level of fatigue according to the Borg scale (6-20 points)).

Strength as an indirect indicator of asthenia and physical weakness was assessed by the results of hand and deadlift dynamometry.

The level of Cancer related Fatigue, which is primarily associated with muscle weakness, and its impact on various activities (interference with daily life, social sequelae) was determined by the European Organization for Research and Treatment of Cancer (EORTC) QLQ-FA12 questionnaire (Quality of Life Questionnaire Cancer Related FAtigue with 12 questions) [11].

Despite the postoperative period being at least 12 months, we consider the identified fatigue as cancer-related in accordance with current understanding of the duration of this phenomenon. According to Bower J.E. (2014) [4], cancer-related fatigue can persist for many years after completion of treatment, which confirms the appropriateness of applying this term to our cohort of patients who received polychemotherapy and underwent surgical intervention.

Statistical processing of the results was carried out using the SPSS Statistics 26.0 (IBM Corp., USA). The nature of the data distribution was previously checked using the Shapiro–Wilk test. For indicators with a normal distribution, parametric statistical methods were used, in particular, the Student's paired-samples test (t-test). The results were presented as the mean and standard deviation ($\bar{x}\pm S$). For variables with a distribution that differed from normal, nonparametric methods were used – the Wilcoxon paired-samples test. The data are presented as the median with the interquartile range (Me [25; 75]). The level of statistical significance was set at $p<0.05$.

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Research Ethics

The study was conducted taking into account the principles of the World Medical Association Declaration of Helsinki "Ethical principles of medical research involving human subjects". Informed consent to participate in it was obtained from all patients included in the research project. The study was approved by the Bioethics Commission of the Vasyl Stefanyk Carpathian National University (Protocol No.4 of December 24, 2024).

Results

The results of the 6-minute walk test indicate a significant improvement in functional indicators (*Table 1*). The average distance covered by patients increased after completing the program by 69 m (23.3%, $p<0.001$). At the same time, a significant decrease in the level of subjective fatigue according to the Borg scale was found: the median decreased by 4 points (30.8%, $p<0.05$). Thus, the physical therapy program had a positive effect on both tolerance to physical exertion and the severity of cancer-related fatigue.

Table 1. Dynamics of the results of the 6-minute walk in patients with the consequences of oncological knee arthroplasty after the physical therapy program

Assessment criterion	Primary assessment	Re-assessment	p
Distance, meters (x±S)	296.4±15.6	365.4±10.47	p<0.001
Severity of fatigue according to the Borg scale (6–20), points (Me [25; 75])	13 [9; 16]	9 [7; 11]	p<0.05

Analysis of strength indicators based on the results of hand dynamometry and deadlift dynamometry also demonstrated a significant improvement in strength qualities in both male and female participants in dynamics before and after the physical therapy program (*Table 2*).

According to hand dynamometry, the average values in male increased by 6.7 kg (18.9%, $p<0.001$). In women, the indicators increased by 6.3 kg (25.9%, $p<0.001$), which indicates a more pronounced improvement in handgrip strength in females after the rehabilitation program.

Table 2. Dynamics of the results of measuring strength qualities in patients with the consequences of oncological endoprosthesis of the knee joint after a physical therapy program

Assessment criterion	Primary assessment	Re-assessment	p
Handgrip dynamometry. kg			
Male	35.4 [29.6; 40.8]	42.1 [36.4; 45.3]	p<0.001
Female	24.3 [18.5; 30.7]	30.6 [26.4; 35.2]	p<0.001
Deadlift dynamometry. kg			
Male	89.9 [80.3; 102.6]	109.5 [104.1; 117.3]	p<0.05
Female	56.8 [53.2; 64.5]	65.0 [57.4; 72.7]	p<0.001

Deadlift dynamometry also showed positive dynamics. In men, the results increased by 19.6 kg (21.8%, $p<0.05$). In women, the strength of the back extensor muscles increased by 8.2 kg (14.4%, $p<0.05$).

This result indicates an improvement in local muscle strength of the upper limbs and general muscle strength of the trunk and lower limbs, which confirms its effectiveness in restoring functional reserves of patients after oncological endoprosthesis and is a prerequisite for improving general motor functioning and facilitating the performance of activities of daily living.

According to the results of the analysis of the parameters of EORTC QLQ-FA12, a statistically significant decrease in the severity of symptoms was recorded for all scales (*Table 3*). The total final fatigue score according to the FA12 module decreased from a median of 81 to 59, which is a difference of 22 points, or approximately 27.2% compared to the initial indicator. The results obtained indicate the high effectiveness of the proposed physical therapy in reducing the symptoms of cancer-related fatigue in the postoperative period. The greatest clinical effect was observed in the domains of cognitive fatigue, daily activity and social consequences, which may have a positive impact on the overall quality of life of patients.

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Table 3. Dynamics of cancer-related fatigue according to QLQ-FA12 in patients with the consequences of oncological knee arthroplasty after the physical therapy program

Symptom scales	Primary assessment	Re-assessment	p
Physical fatigue	3 [3; 4]	2 [2; 3]	p<0.05
Emotional fatigue	3 [2; 3]	2 [2; 3]	p<0.05
Cognitive fatigue	2 [1; 3]	1 [1; 2]	p<0.05
Interference with daily life	3 [2; 3]	1 [1; 2]	p<0.001
Social sequelae	2 [2; 3]	1 [1; 2]	p<0.05
Total score	81 [75; 88]	59 [53; 66]	p<0.05

Note: QLQ-FA12 – Quality of Life Questionnaire cancer-related FAtigue with 12 questions.

Discussion

The results obtained are consistent with the literature, according to which physical exercise is one of the most effective non-pharmacological approaches to the managing of CRF. The meta-analysis of Mustian K.M. et al. (2017) [12] indicated that regular physical activity significantly reduces the level of fatigue in patients with various forms of cancer both during treatment and in the post-therapeutic period. Similar conclusions are presented in the systematic review of Penna G.B. et al. (2023) [13], which emphasized the positive effect of a combination of aerobic and strength training on CRF.

A feature of our study is the use of a modular physical therapy protocol adapted to the individual level of motor disorders, with an emphasis on training gait, balance and functional skills. This coincides with the recommendations of Khan et al. (2012), who indicated the feasibility of a personalized approach in the rehabilitation of cancer patients, which allows achieving longer and more sustainable results [14].

The 27.2% reduction in the total QLQ-FA12 score and the improvement in cognitive fatigue, interference with daily life, and social consequences after the intervention underscore the effectiveness of the intervention – not only in the physical but also in the psychosocial aspect. This supports the thesis of the multidimensionality of CRF, in which physical, cognitive, and emotional components are involved [1; 4; 15].

Conclusions

1. In patients with the consequences of oncological knee arthroplasty, CRF is a clinically significant symptom that encompasses physical, emotional, and cognitive components and has a negative impact on daily activities and quality of life.

2. The implementation of a 12-week physical therapy program that includes strength exercises, functional training, and gait training significantly reduces the manifestations of asthenia and CRF, as confirmed by the results of the 6-minute test, Borg scale, dynamometry, and QLQ-FA12 questionnaire (a 27.2% reduction in the total fatigue score).

3. The most pronounced improvement after the intervention program was observed in the domains of cognitive fatigue, interference with daily life, and social consequences, indicating a positive impact not only on the physical but also on the psychosocial state of patients.

4. The obtained results demonstrate the potential effectiveness of the proposed personalized physical therapy program for reducing cancer-related fatigue in patients after oncologic knee endoprosthetic replacement. They substantiate the feasibility of conducting further studies with a more rigorous design (randomized controlled trials) to confirm these data and determine the contribution of individual intervention components.

Declarations

Conflict of interest is absent.

All authors have given their consent to the publication of the article on the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License and a public agreement with the publisher, to the processing and publication of their personal data.

The authors of the manuscript state that in the process of conducting research, preparing, and editing this manuscript, they did not use any generative AI tools or services to perform any of the tasks listed in the Generative AI Delegation Taxonomy (GAIDeT, 2025). All stages of work (from the development of the research concept to the final editing) were carried out without the involvement of generative artificial intelligence, exclusively by the authors.

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Authors' Contributions

Contribution / Authors	A	B	C	D	E	F
Aravitska M.G.	+		+			+
Lapkovskyi E.Y.	+			+		+
Sheremeta L.M.	+			+		+
Mykhailiuk I.O.		+			+	+
Ostapyak Z.M.		+			+	+

Notes: A – concept;
B – design;
C – data collection;
D – statistical processing and interpretation of data;
E – writing or critical editing of the article;
F – approval of the final version for publication and agreement to be responsible for all aspects of the work.

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ЕФЕКТИВНІСТЬ ПРОГРАМИ ФІЗИЧНОЇ ТЕРАПІЇ ЗА ПРОЯВАМИ АСТЕНІЇ ТА ОНКОЛОГІЧНОЇ ВТОМИ У ПАЦІЄНТІВ З НАСЛІДКАМИ ОНКОЛОГІЧНОГО ЕНДОПРОТЕЗУВАННЯ КОЛІННОГО СУГЛОБА

Актуальність. Онкологічне ендопротезування суглобів висуває підвищені вимоги до реабілітації, оскільки пацієнти, окрім ортопедичних наслідків, часто мають астенію та рак-пов’язану втому, що охоплює фізичні, емоційні та когнітивні компоненти й істотно знижує якість життя.

Мета. Оцінити ефективність розробленої програми фізичної терапії у пацієнтів з наслідками онкологічного ендопротезування колінного суглоба за показниками астенії та параметрами втоми, пов’язаної з раком.

Матеріали та методи. До дослідження включено 7 осіб, оперованих з приводу остеосаркоми дистального відділу стегнової кістки. Програма фізичної терапії впроваджувалась упродовж 12 тижнів (силові вправи для кінцівок і тулуба, тренування ходи, корекція індивідуальних порушень). Результати оцінювали за шестихвилинним тестом ходьби, кистьовою й становою динамометрією, опитувальником якості життя Європейської організації з дослідження та лікування раку для оцінювання рак-пов'язаної втоми (EORTC QLQ-FA12, European Organisation for Research and Treatment of Cancer Quality of Life Questionnaire cancer-related FAtigue (12 items)). Для нормально розподілених показників застосовували параметричні методи (t-тест Стьюдента), для ненормального розподілу – непараметричний критерій Вілкоксона. Робота є фрагментом дослідження

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Карпатського національного університету імені Василя Стефаника «Покращення функціонального стану, якості життя та корекція патологічних станів різного походження засобами терапії та реабілітації» (2023–2026) № державної реєстрації 0123U01534.

Етика дослідження. Дослідження проводилося з урахуванням принципів Гельсінської декларації Всесвітньої медичної асоціації (1964–2024), з отриманням інформованої згоди на участь у ньому; протокол затверджений комісією з біоетики.

Результати. Дистанція при виконанні 6-хвилинного тесту під впливом фізичної терапії зросла на 23,3 % ($p<0,001$), медіана втоми за шкалою Борга зменшилася на 30,8 % ($p<0,05$). Кистьова сила підвищилась на 6,7 кг у чоловіків і на 6,3 кг у жінок ($p<0,001$); станова – на 19,6 кг у чоловіків ($p<0,05$) і на 8,2 кг у жінок ($p<0,001$). За QLQ-FA12 зафіксовано зниження симптомів за всіма доменами; загальний бал зменшився з 81 до 59 (27,2 %; $p<0,05$).

Висновки. Функціонально спрямована програма фізичної терапії є ефективною для зменшення рак-пов'язаної втоми та астенії у пацієнтів після онкологічного ендопротезування коліна Вона покращує толерантність до фізичного навантаження та м'язову силу, а також знижує вплив втоми на повсякденне життя.

Ключові слова: *фізична терапія та реабілітація, ортопедія та травматологія, злоякісна пухлина, м'язова слабкість, нижня кінцівка, порушення ходи.*

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