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# Assessment of Home-based Physical Therapy in Stroke Patients

Ocena fizykoterapii w warunkach domowych u pacjentów po udarze

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#### SUMMARY

Introduction: Stroke is one of the most serious health problems of the modern society.

Aim: The aim of the study was to assess the effects of 6-month home-based rehabilitation in stroke patients.

**Material and Methods:** The study included 37 patients (35% were women and 65% were men) after ischaemic stroke. Study patients received 6-month home-based physical therapy in Kielce County (Gmina Chęciny and Gmina Łopuszno). The study used the Barthel Index, the Timed Up and Go Test and the Modified Rankin Scale. Physical therapy included kinesiotherapy methods (such as active and assisted exercises), physiotherapy methods (electrotherapy, laser therapy) and special methods (PNF and kinesiotaping).

**Results:** The study showed significant differences in the results between the pre- and post-rehabilitation assessments. Before rehabilitation, the majority of study patients (22 people, 60%) scored between 21 and 85 points according to the Barthel Index, which suggests moderately severe disability. After rehabilitation, this number was reduced to 20 patients (54%). With respect to the Timed Up and Go Test, most study patients (25 people, 68%) both before and after rehabilitation needed 10 to 19 seconds to perform the test, indicating limited functional mobility. The degree of disability according to the Modified Rankin Scale was 4 in 23 study patients (62%) before rehabilitation and in 27 study patients (73%) after rehabilitation. A total of 8 study patients (22%) before rehabilitation had very severe disability with a result of 5 according to the Modified Rankin Scale; only 3 study patients (0.1%) did not show any improvement after rehabilitation.

**Conclusions:** 1. Home-based physiotherapy performed over a period of 6 months had a very beneficial influence on increasing independence in stroke patients. 2. A significant gait quality improvement was seen in stroke patients. 3. The degree of disability in study patients was considerably reduced.

Key words: stroke, disability, home-based rehabilitation, physical therapy, electrotherapy, laser therapy

Słowa kluczowe: udar, niepełnosprawność, rehabilitacja domowa, fizykoterapia, elektroterapia, laseroterapia

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## INTRODUCTION

Stroke is considered to be a lifestyle disease. It usually occurs in people over the age of 60 years and is the second leading cause of death after cardiovascular disease. The European Statistical Office reported that cerebrovascular disease caused approximately 436,000 deaths in 2018, which constituted 8.7% of all deaths in Europe [1-6].

In the PolSenior study conducted in 2012 in elderly people living in Poland, 7.8% of the survey respondents confirmed they had experienced a stroke. The study did not reveal any correlation between the place of residence, sex and stroke, showing only that the incidence of stroke increased with age.

Patients after stroke are at risk of disability. Some patients lose their independence partly or completely for the rest of their lives. The risk of stroke in the Polish population increases every year. The contributing factors include population aging, poor diet, not enough physical activity and other issues. In order to counteract this increase in the number of stroke cases, the risk factors need to be eliminated and the access to modern and effective treatment and rehabilitation methods should be as easy as possible. Health education among patients is also important [7-15].

Every year, an estimated 15 million people experience stroke worldwide; a third of those cases are fatal. Stroke is the third leading cause of death after cardiovascular disease and cancer. Stroke is the main cause of disability in adults, leading to serious social and economic consequences.

According to epidemiological forecasting, the number of stroke patients will gradually increase in the next decades. The number of new cases is expected to increase by approximately 40% by 2025.

Risk factors for stroke, which influence its incidence, can be divided into non-modifiable factors that cannot be changed and modifiable factors that can be changed using preventive measures. The non-modifiable risk factors for stroke include age, sex, ethnicity and genetic factors. The modifiable risk factors for stroke include hypertension, atherosclerosis and diabetes.

Hypertension is the most important risk factor for both ischaemic and haemorrhagic stroke. The estimated proportion of adults with hypertension is over 30% and hypertension is present in two-thirds of people over the age of 65 years.

Apart from pharmacotherapy and surgery, stroke prevention focuses on lifestyle changes. The most important modifiable lifestyle factors include smoking, alcohol consumption, physical activity and body weight [15-18].

Ischaemic stroke is the most common form of stroke. In Europe, approximately 80% of all stroke cases are ischaemic strokes, with the other cases being haemorrhagic, arachnoid, venous or spinal cord strokes [11-15].

Rehabilitation should be initiated as soon as possible, once the clinical condition of the patient has been stabilised [19-25].

Apart from good positioning and breathing exercises, stroke patients also need passive exercises of the upper and lower limbs.

Kinesiotherapy should be introduced once the cardiovascular and respiratory function has been stabilised, as long as the patient does not show any neurodynamic dysfunction.

Restoring normal muscle tone contributes to easier passive and active mobilisation and helps prevent tendon and muscle contractures. Moreover, it reduces the development of muscle and ligament pathologies. Patient verticalisation is performed as often as possible, even several times a day, on the patient's bed. It is important to monitor the patient's condition, wellbeing and blood pressure during verticalisation attempts. Successful verticalisation is followed by gait training. Kinesiotherapy should by adjusted individually to the needs of every patient, irrespective of the method used. Stroke patients do poorly during group sessions, which affects effective rehabilitation.

During the chronic period, stroke patients usually continue rehabilitation at home. The aim of home-based rehabilitation is to maintain the treatment effects that have already been achieved, i.e. the range of mobility and muscle strength. Another aim is to prevent pressure ulcers and contractures. Regular exercises and appropriate preventive measures reduce the risk of another stroke. In order to achieve this, the stroke patient, their family members and the members of their stroke recovery team have to work together [22-25].

Stroke patients require orthopaedic aids, such as a sling or an arm splint for the upper limb or appropriate boots for the lower limb. Patients with foot drop use a polyethylene brace and those with talipes equinus or talipes equinovarus use an orthopaedic shoe with a fibular splint.

Apart from kinesiotherapy and physical therapy, rehabilitation in stroke patients should involve individual psychotherapy and speech therapy sessions.

## AIM

The aim of the study was to assess the effects of 6-month home-based rehabilitation in patients after stroke.

Research questions:

- 1. Did home-based rehabilitation performed over a period of 6 months influence the level of independence in stroke patients?
- 2. Did physical therapy influence gait quality and the degree of disability?

## **MATERIAL AND METHODS**

The study included patients after ischaemic stroke and was conducted in Kielce County (in Gmina Chęciny and Gmina Łopuszno). Study patients underwent home-based rehabilitation. The study assessed 37 patients, including 13 women and 24 men. The patients were divided based on their sex, age and disease duration. They were examined three times a week over a period of 6 months, during homebased rehabilitation.

Study patients were assessed with the following tools: • Barthel Index

- Timed Up and Go Test
- Modified Rankin Scale

The Barthel Index is used to assess the degree of independence in stroke patients with respect to activities of daily living on a scale from 0 to 100 points.

All the activities are scored in two or three categories.

86-100 points = mild functional impairment;

21-85 points = moderately severe functional impairment;

0-20 points = severe functional impairment.

The Timed Up and Go Test (TUG) is used to assess gait quality. The test starts with the subject sitting in a chair. The task is to walk a distance of 3 metres, turn around 180 degrees, walk back to the chair and sit down. The test is performed in both directions, meaning that patients complete 180-degree turns to the right and to the left. If the patient uses orthopaedic aids, those aids are used during the test. The result is counted from the moment the patient gets up from the chair to the moment they sit back down.

The results are interpreted as follows:

<10 seconds = normal functional mobility, low risk of falls;

10-19 seconds = limited functional mobility, moderate risk of falls;

>19 seconds = significantly limited functional mobility, high risk of falls.

The Modified Rankin Scale is a widely used 6-point disability scale.

The 6-months rehabilitation conducted in study patients included kinesiotherapy, physiotherapy and special methods. Patients performed free active exercises, active weight-bearing exercises, assisted exercises and gait training, both with orthopaedic aids and unassisted. Physiotherapy included laser therapy, electrotherapy, tonolysis; PNF and kinesiotaping were also used.

#### RESULTS

The results were statistically analysed with a chi-squared test used to determine correlation between two variables. The study showed a correlation between the sex of study patients and the results of the individual tests.

The majority of study patients were men (65%), with women constituting 35%. The study group was also divided based on age (Table 1).

Table 2 shows study patients divided based on disease duration. The largest group of study patients (19 individuals) were people with a disease duration of 2-5 years, 10 patients had a disease duration of 0-1 year and 8 patients belonged to the longest disease duration category.

Table 3 shows Barthel Index results obtained before rehabilitation according to sex. Before rehabilitation, most study patients scored between 21 and 85 points (moderately severe functional impairment). A total of 5 study patients (1 woman, 20%; 4 men, 80%) scored between 0 and 20 points (severe functional impairment).

After rehabilitation (Table 4), the number of patients who scored between 21 and 85 points was still the highest, but there were 2 fewer patients in that category (7 women, 35%; 13 men, 65%). The number of patients who scored between 86 and 100 points increased to 13 (5 women, 38%; 8 men, 62%) and the number of patients who scored between 0 and 20 points was 4 (1 woman, 25%; 3 men, 75%).

There is a correlation between the patients' sex and the Barthel Index results obtained before rehabilitation.

There is a correlation between the patients' sex and the Barthel Index results obtained after rehabilitation.

Table 5 shows Timed Up and Go Test results obtained before rehabilitation according to sex. Before rehabilitation, a score of 10 to 19 seconds was found in 25 patients, including 9 women (36%) and 16 men (64%). A score of under 10 seconds was seen in 9 patients, including 3 women (33%) and 6 men (67%), and a result of over 19 seconds was recorded in 3 patients, including 1 woman (33%) and 2 men (67%).

After rehabilitation (Table 6), a score of under 10 seconds was reported in 10 patients, including 5 women (50%) and 5 men (50%). A score of 10 to 19 seconds was found in 25 patients, including 7 women (28%) and 18 men (72%), and a score of over 19 seconds was seen in 2 patients, including 1 woman (50%) and 1 man (50%).

According to the chi-squared test, the difference between the pre- and post-rehabilitation results was not statistically significant.

There is a correlation between the patients' sex and the results obtained using the Timed Up and Go Test before rehabilitation.

#### Table 1. Study patients divided into age categories

Ago catogorios	Wo	men	M	Overall	
Age categories	N	%	N	%	N
51–60 years	3	33	6	67	9
61–70 years	5	30	12	70	17
71–80 years	5	46	6	54	11
Overall	13	109	24	191	37

#### Table 2. Study patients divided into disease duration categories

Disease duration	Wo	men	M	Overall	
	N	%	N	%	N
0—1 year	4	40	6	60	10
2–5 years	7	37	12	63	19
6–10 years	2	25	6	75	8
Overall	13	102	24	198	37

Table 3. Results before	6-month rehabilitation	according to the	Barthel Index
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Score	Wor	nen	Me	Overall	
	N	%	N	%	N
0–20	1	20	4	80	5
21–85	9	40	13	60	22
86–100	3	30	7	70	10
Overall	13	90	24	210	37

Statistical analysis showed the following:,  $x^2$  calc. = 0.94 <  $x^2$  = 5.991, df = 2, p<0.05

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#### Table 4. Results after 6-month rehabilitation according to the Barthel Index

Score	Wor	nen	Me	Overall	
	N	%	N	%	N
0–20	1	25	3	75	4
21-85	7	35	13	65	20
86–100	5	38	8	62	13
Overall	13	98	24	202	37

Statistical analysis showed the following:  $x^2$  calc. = 0.24 <  $x^2$  = 5.991, df = 2, p<0.05

#### Table 5. Results before 6-month rehabilitation according to the Timed Up and Go Test

Timo	Wo	men	Me	Overall	
Time	N	%	N	%	N
<10	3	33	6	67	9
10–19	9	36	16	64	25
>19	1	33	2	67	3
Overall	13	102	24	198	37

Statistical analysis showed the following:,  $x^2$  calc. = 0.02 <  $x^2$  = 5.991, df = 2, p<0.05

#### Table 6. Results after 6-month rehabilitation according to the Timed Up and Go Test

Time	Wor	nen	M	Overall	
	N	%	N	%	N
<10	5	50	5	50	10
10–19	7	28	18	72	25
>19	1	50	1	50	2
Overall	13	128	24	172	37

Statistical analysis showed the following:  $x^2$  calc. = 1.72 <  $x^2$  = 5.991, df = 2, p<0.05

#### Table 7. Results before 6-month rehabilitation according to the Modified Rankin Scale

Score -	Wor	nen	Me	Overall	
	N	%	N	%	N
3	2	33	4	67	6
4	8	35	15	65	23
5	3	38	5	62	8
Overall	13	106	24	194	37

Statistical analysis showed the following:  $x^2$  calc. = 0.02 <  $x^2$  = 5.991, df = 2, p<0.05

#### **Table 8.** Results after 6-month rehabilitation according to the Modified Rankin Scale

Score	Wor	nen	Me	Overall	
	N	%	N	%	N
3	2	29	5	71	7
4	10	37	17	63	27
5	1	33	2	67	3
Overall	13	99	24	201	37

Statistical analysis showed the following:  $x^2$  calc. = 0.17 <  $x^2$  = 5.991, df = 2, p<0.05

There is a correlation between the patients' sex and the results obtained using the Timed Up and Go Test after rehabilitation.

Table 7 presents Modified Rankin Scale results obtained before rehabilitation. Only scores of 3 to 5 are shown in the

table since home-based rehabilitation is available only for patients with a score of 3 or higher. Before rehabilitation, the results showed mostly a disability score of 4 (23 patients, including 8 women [35%] and 15 men [65%]). A score of 5 was seen in 8 patients, including 3 women (38%) and 5 men

(62%), and a score of 3 was recorded in 6 patients, including 2 women (33%) and 4 men (67%).

The results changed after rehabilitation (Table 8). A total of 3 patients, including 1 woman (33%) and 2 men (67%), had a score of 5 on the Modified Rankin Scale. After rehabilitation, the largest group of patients still had a score of 4 (27 patients, including 10 women [37%] and 17 men [63%]). The number of patients with a disability score of 3 also increased after rehabilitation (7 people, including 2 women [29%] and 5 men [71%]).

According to the chi-squared test, the difference between the pre- and post-rehabilitation results was not statistically significant.

There is a correlation between the patients' sex and the results obtained using the Modified Rankin Scale after rehabilitation.

## DISCUSSION

Stroke is a life-threatening condition that constitutes the third leading cause of death worldwide, after heart disease and cancer. An estimated 5.5 million people die every year due to stroke. Stroke is one of the most important causes of permanent disability and loss of independence in everyday life among adults [1-10]. According to Polish epidemiological studies, stroke symptoms develop in 60,000 people every year, with one half dying within one year and the other half suffering from permanent disability.

Immediately after stroke, almost all study patients were partially or completely dependent when it came to getting dressed and self-care activities related to using the toilet. The majority were either unable to walk from the bed to a chair or wheelchair or needed a lot of help with those activities.

The aim of the study was to assess the effects of 6-month home-based rehabilitation in patients after ischaemic stroke. The study analysed the level of independence in study patients with respect to activities of daily living according to the Barthel Index, the quality of gait according to the Timed Up and Go Test and the degree of disability according to the Modified Rankin Scale. The Barthel Index scores were divided into three levels. Before rehabilitation, most study patients (22 patients, 60%) scored between 21 and 85 points, which indicates moderately severe functional impairment. After rehabilitation, this number decreased to 20 patients (54%). The smallest group of study patients (5 patients [14%] before rehabilitation and 4 patients [11%] after rehabilitation) scored between 0 and 20 points, which indicates severe functional impairment. The Timed Up and Go Test showed that the majority of study patients both before and after rehabilitation (25 patients, 68%) completed the task in 10 to 19 seconds, which reflects limited functional mobility. Differences were seen after rehabilitation with respect to the other scores: the number of patients who completed the test in under 10 seconds was 9 (24%) before rehabilitation and 10 (27%) after rehabilitation, whereas the number of patients who took over 19 seconds to complete the test was 3 (0.08%) before rehabilitation and 2 (0.05%) after rehabilitation. According to the Modified Rankin Scale, a disability score of 4 was

seen in a considerable proportion of study patients before rehabilitation (23 patients, 62%) and after rehabilitation (27 patients, 73%). The number of patients with a disability score of 5, indicating very severe disability, changed from 8 patients (22%) before rehabilitation to 3 patients (0.1%) after rehabilitation. The study showed that sex had a significant influence on the test results.

Access to comprehensive rehabilitation remains limited; consequently, it is necessary to educate people and warn them that rehabilitation should be initiated soon after stroke.

The results of the study confirm the efficacy of rehabilitation in stroke patients and prove that the treatment had an adequately positive beneficial influence on the quality of life.

The results show that 6-month home-based physical therapy increased the level of independence in stroke patients, improved their quality of gait and reduced their disability.

## CONCLUSIONS

- 1. Home-based physical therapy conducted over a period of 6 months had a very beneficial influence on increasing independence in stroke patients.
- 2. A significant gait quality improvement was seen in stroke patients.
- 3. The degree of disability in study patients was considerably reduced.

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## **Conflict of interest:**

The Authors declare no conflict of interest

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A – Research concept and design, B – Collection and/or assembly of data,C – Data analysis and interpretation, D – Writing the article, E – Critical review of the article, F – Final approval of article

Info

## POLISH ASSOCIATION OF HEALTH RESORT PATIENTS

On the initiative of Professor Irena Ponikowska, the Polish Association of Health Resort Patients was established in 2019. The Association aims to integrate patients using health resort treatment, increase the availability of health resort treatment for subjects in need, improve the quality of services provided in the health resort treatment sector, cooperate with doctors and health resort treatment facilities, and involve in patient education.

Each member of the Association will be able to benefit from discounts in fees for stay and treatment, during commercial stays in selected health resort treatment facilities, and take part in conferences, workshops, and consultations organized by the Association.

Natural and legal persons may be members of the Association. Membership in the Association for natural persons is free, whereas legal persons may become supporting members.

We invite both patients and companies operating in the field of health resort medicine to work together.

Please visit the website of the Association udrowiskowi.eu where you will find more information as well as a declaration of joining the Association.

The Board of the Polish Association of Health Resort Patients

# Assessment of Effectiveness of Usage Complex Manual Therapy in Patients with Lumbar Flexion Dysfunction After Discectomy, in Comparison to Standard Physiotherapy Based on Physical Therapy, Balneotherapy and Sensorimotor Exercises

Ocena skuteczności zastosowania kompleksowej terapii manualnej u pacjentów z dysfunkcją zgięciową kręgosłupa lędźwiowego po discektomiiw porównaniu ze standardową fizjoterapią obejmującą fizykoterapię, balneoterapię i ćwiczenia sensomotoryczne

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## SUMMARY

Aim: The purpose of this study was to asset the effectiveness of complex manual therapy usage in patients with lumbar flexion dysfunction after discectomy, in comparison to standard physiotherapy based on physical therapy, balneotherapy and sensorimotor exercises.

**Material and methods:** The study was conducted in the participation of 40 patients attending outpatient rehabilitation at ORNR "Krzeszowice" SP ZOZ. Participants were divided into two groups (control and experimental) each one including 20 people. The average patients' age was  $52.75 (\pm 11.58)$ . The patients had been medically examined before the rehabilitation process implementation and after its completion. The test was carried out using the patient's card, Laitinen's scale and mobility tests with a plurimeter. Rehabilitation has taken place for four weeks daily. The exercises of the patients from the experimental group were based on comprehensive manual therapy meanwhile the control group underwent a standard package of physical therapy, balneotherapy and sensorimotor exercises.

**Results:** Two statistically significant phenomena were observed in both groups: decrease of pain in the lower spine and the range motion improvement, nevertheless, both results were significantly greater in the experimental group.

Conclusions: Both therapeutic programs indicate an advantageous impact in terms of reducing pain and functioning in everyday life, but the manual therapy is much more effective.

Key words: discectomy, comprehensive manual therapy, balneotherapy, sensory exercises, lumbar spine pain syndrome

Słowa kluczowe: discektomia, kompleksowa terapia manualna, balneoterapia, ćwiczenia sensomotoryczne, zespół bólowy kręgosłupa lędźwiowego

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## INTRODUCTION

The current technological progress limits human physical activity, which indicates a negative effect on the body, causing diseases of the locomotor system. Nowadays, continuous, static and usually sedentary work and lifestyle dominate. Limited physical activity in combination with being in forced positions, often overloads or reduces mobility of our spine. Hypokinesia increases the need for treatment and rehabilitation of patients with lumbar spine pain syndrome [1].

Lower back pain is a very common issue that affects people of all ages. It is believed, that the cost of treatment

and the incidence of disability will continue to increase over the upcoming decades [8]. It is not only a motor and functional dysfunction, but it might be also considered as a global biopsychosocial problem [7]. Significant changes in the biomechanics of the torso are noticed while examining people with pain in the lumbar region. As well, reduced movements and muscle activity changes in flexion positions are observed caused by fear of pain[6] comparing to healthy people [11]. It seems that activities requiring forward flexion are most often reported as the ones causing pain [9]. Forces acting on the anatomical structures of the spine, occurring in flexion movement are one among the most important risk factors for the emergence of the described problems in people who perform frequent flexion [10].

Discectomy is one of the most common surgical procedures performed in patients with back pain [12], but a less invasive method, that damages the surrounding tissues to a limited extent, and enables the fastest recovery is microdiscectomy [4]. There are many studies confirming the low invasiveness of the method and quick recovery after the procedure [5]. The challenge for the surgical treatment and subsequent recovery after surgery is pain relapse and hernia renewal [12]. The other risk is the scar formation, the size of which is directly related to the severity of symptoms [13].

Considering discectomy and microdiscectomy procedures, it is crucial to remember that they are undertaken to remove the intervertebral disc material, that compresses the nerve structures. However, this may be a temporary solution as the changes in the intervertebral disc are not reversed [14]. Introducing rehabilitation after discectomy is necessary to ensure, that the patient returns to efficient functioning in everyday life, but studies on the rehabilitation programs used are incoherent [15]: some studies indicate, that rehabilitation using manual therapy techniques reduces pain in the lower spine [16]. Among the commonly used procedures in the field of manual therapies, such as: mobilization, mobilization with impulse, soft tissue techniques we might also distinguish movement mobilizations according to Mulligan's. His concept includes insertion of patient's active movement into therapist's manual action [17].

In the literature on the subject, you can find proposals for movement improvement programs in patients after discectomy, however, they are not randomized- only 8 randomized have been found. The programs differ in terms of the time of introducing kinesiotherapy, the type of exercise used, intensity and frequency. Usage of exercises to strengthen the muscles that stabilize the joints of the spine are strongly recommended by many authors [2, 3]. However, there is no research indicating, which improvement programs and exercise techniques are the most effective. The main complication after discectomy surgery is limited spine mobility. Patients often start their rehabilitation process even many months after the surgery. Unfortunately due to lack of therapy, serious difficulty with mobility occurs. This problem affects the majority of treated patients, especially after the age of 60. The flexion dysfunction syndrome is characterized by atypical spine deformities and limits in movement. The posture is usually inappropriate. Some movements cause pain, that disappear after returning to the initial position. Mentioned issue arises, as a result of the resistance of pathologically contracted tissues, pain appears when the final range of motion is reached. Above all, limited are bending and coupled movements for bending the lumbar spine, so the lateral bend and rotation in the same direction.

A patient with flexion dysfunction, regardless of age, reports a pain problem as well as a functional problem related to everyday activities such as bending down, washing hair, putting on shoes, etc. Arising pain increases muscle tension, which also reduces the pain-free range of motion. The pain can be local, but in more severe cases, even diffuse, or radiating. It happens, that a patient wakes up at night in order to change sleeping position.

The purpose of this study, was to asset the effectiveness of complex manual therapy usage in patients with lumbar flexion dysfunction, in comparison to standard physiotherapy based on physical therapy, balneotherapy and sensorimotor exercises.

## **MATERIAL AND METHODS**

The study group consisted of 40 patients of the Musculoskeletal Rehabilitation Center in Krzeszowice ( the treatment was performed under the contract with the National Health Fund). The study participants were qualified by a physical rehabilitation physician on the basis of an interview, physical examination and additional examinations at the Center for Rehabilitation of the Movement Organ in Krzeszowice SP ZOZ. The patients were divided into 2 groups of 20 people each, to ensure the homogeneity of the groups, purposeful selection by the pairing method was used.

The first group of patients – the experimental group - consisted of 12 women and 8 men, average age of 50, 25 years. The second group – the control group - consisted of 16 women and 4 men, average age of 55, 25 years. The average age of the patients overall is 52.75 years. Patients have been treated on an outpatient basis for 4 weeks with 20 treatment sessions at regular intervals.

In the experimental group, only manual treatment was used, including manual techniques of soft tissues and structural mobilization. Rehabilitation procedures were performed painlessly and were well tolerated by the treated patients, who did not report any significant complaints.

The following methods were used:

- Manual mobilization of paraspinal tissues: 10 movements held for 10 seconds each on the painless side and 20 movements held for 10 seconds on the painful side.
- 2. Post-isometric relaxation of the dorsal extensor muscles, with additional consideration of the painful side. Performed 2 times; 10 seconds of tension and 5 seconds of relaxation. Additionally, the technique performed once on the painful side.
- 3. Non-specific and specific manual mobilization of the lumbar spine. Non-specific mobilizations included techniques in lying on the side mobilized towards flexion, lateral flexion and rotation, each position performed 10 times in pulses and then held for 30 seconds. The specific mobilizations were rotational on blocked 2-3 segments, starting with 15 oscillations made by pulsing, and then with position held for 30 seconds.

4. Manual traction of the lumbar spine not specific in the supine position. First, pulsating for two minutes, then constant for 3 minutes with the use of the therapist's hands and the belt if needed.

In control group used standard physical therapy, balneotherapy and stabilization exercises using the Stabilizer Biofeedback Pressure with the balloon filled up to 20. In each of the following positions 3 exercises were performed:

- 1. In the supine position.
- 2. In the front lying position.
- 3. In a sitting position.
- 4. In a sitting position.
- 5. Standing against the wall.

Before starting the exercises, the patients had been taught how to contract the transverse abdominal muscle appropriately starting from the supine position. Exercise instruction with explanations had been conducted by a physiotherapist before treatment started and was not included in it. During the exercises, a few patients reported pain, that did not require stopping the exercises. It also did not cause any discomforts, that arose during their performance to persist after their completion.

The following patients were excluded: with organic psychosyndrome, with neurological diseases, significantly obese, with numerous comorbidities, patients with endoprostheses, with acute radiculopathy, with acute syndromes with deviation of the torso as well as people with serious abdominal diseases after surgical procedures. The treatment was supervised by a rehabilitation specialist.

The procedures were performed on the basis of an order from a rehabilitation physician defined as Special Methods of Physiotherapy. All techniques were performed by experienced Physiotherapists, additionally trained in Orthopedic Manual Therapy, as well as in the basic techniques of osteopathic treatment.

The research was conducted as a part of extensive research considered by the Bioethics Committee of the Jagiellonian University (Opinion No. 122.6120.342.2016 of April 28<sup>th</sup>, 2017). It was also supported by a positive opinion of the Scientific Research Team of the Locomotor System Rehabilitation Center in Krzeszowice (Opinion No. 2/2017 of March 27<sup>th</sup>, 2017). Patients participating in the study had been previously informed about the conducted experiment and had agreed to participate in it. Each participant had also received relevant guideline. The research was carried out during a four-week outpatient rehabilitation from January 19<sup>th</sup> to March 27<sup>th</sup> 2018.

In both groups of tested patients, two tests were carried out: before and after the end of the therapy. The spine movement range was checked in terms of forward bending and lateral bends (left, right). Spinal mobility was measured with a Rippstein plurimeter.

Soreness before and after the procedure, effects durability and improvement of function in relation to everyday activities (bending down, tying shoes, reaching, standing up).Pain was assessed using the Laitinen scale.

## RESULTS

The results of the tests carried out on patients are summarized in the tables below and concern both: the experimental group in which selected techniques of complex manual therapy were used and the control group in which physical therapy, balneotherapy and sensorimotor exercises were used.

#### TYPE AND LOCATION OF THE PAIN

When analyzing the results of the studies shown in Table 1, it was noticed that during the first examination in the experimental group, permanent pain occurred in case of 12 patients (60%), while the non-permanent one occurred in case of 8 patients (40%).

During second examination , the number of patients with permanent pain was decreased from 12 to 4 patients. Whereas non-permanent pain occurred in case of the remaining 16 patients (80%). Statistically significant difference between examined groups was detected.

Initial examination of the control group, indicated that the presence of permanent pain was noticed in case of 9 patients (45%), while the non-permanent one appeared in case of 11 patients (55%). The number of patients with permanent pain was reduced from 9 to 2 patients, and non-permanent pain occurred in the remaining 18 patients (90%).

Statistically significant difference between examined groups was detected.

#### MOTION RANGE

Both analysis (I and II) of the experimental group concerning the range of motion in the forward and side bends, which are essential functional movements, on examination I indicated the mean value of forward bends of 70.5 ° and on examination II – an increase of 12,2 ° was noted, which is 17.3% of the relative increase. The difference is statistically significant (p <0.0001).

The analysis of the side bends values indicated significant difference between examinations. On the examination I mean value of left bending was  $24.5 \,^{\circ}$  while in the case of examination II it increased to  $34.4 \,^{\circ}$ . In this instance the relative increase is very high and equals 40.2%. The difference is also statistically significant (p <0.0001).

Values of the range of motion in the case of right bend are similar (Table 2). The range value for the right and left bend is 46°. The analysis of the individual results of the I and comparative II tests allows us to conclude that there are no simple connections between them and they are varied, which requires a larger sample to be tested.

Analysis of the control group for changes in the location of pain before the start of therapy , showed the presence of specific pain in all patients during examination I. On examination II, no pain occurred in case of 4 patients. Local pain on examination I occurred in case of 5 patients (25%), and on examination II in case of 9 patients (45%) which is 1.8 times greater. Radiation pain on examination I occurred in case of 6 patients (30%), and on examination II after physical therapy in case of 3 patients. The number of patients decreased twofold. Patients with diffuse pain constituted the largest

<u>_</u>				-	-								
Experimental group													
Pain type Pain location													
Examination	Ν	Perm	ament	Non-pe	rmament	No pain	occurence	Lo	cal	Dif	fuse	Radi	ating
		n	%	n	%	Ν	%	n	%	n	%	n	%
I	20	9	45	11	55	0	0	5	25	9	45	6	30
II	20	2	10	18	90	4	20	9	45	4	20	3	15
Statistical significance	χ <sup>2</sup> =4.514					χ²=8.06							
					Contro	ol group							
			Pa	in type					Pain loca	tion			
Examination	N <sub>1</sub>	Perm	ament	Non-pe	rmament	No pain	occurence	Lo	cal	Dif	fuse	Radi	ating
		n	%	n	%	Ν	%	n	%	n	%	n	%
1	20	12	60	8	40	0	0	3	15	7	35	10	50
	20	4	20	16	80	2	10	8	40	2	10	8	40

#### Table 1. Changes in the pain type and its location in examined groups

Table 2. Average values of the spine movement ranges in the forward and lateral bends (in degrees) in experimental and control groups

χ<sup>2</sup>=5.104; p=0.024

Experimental group							
Divertion	Examin	Examination I		ation II	Statistical significance	Relative increment	
Direction	X ± S	min - max	X±S	min – max			
Forward	70.5 ± 34.7	0 - 118	82.7 ± 34.1	26 - 134	12.2*	17.3%	
To the left	24.5 ± 10.4	10 - 50	34.4 ± 10.9	20 - 66	9.9*	40.2%	
To the right	25.6 ± 10.9	9 - 50	35.5 ±11,1	18 - 64	9.9*	38.7%	
	Control group						
Direction	Examin	ation I	Examin	ation II	Statistical significance	Relative increment	
Direction	X±S	min - max	$X \pm S$	min – max			
Forward	70.4 ± 28,5	23 – 110	72.1 ± 28.5	26 - 110	1.7*	2.4%	
To the left	$26.2\pm6.6$	14 - 38	$28.3\pm6.5$	16 - 40	2.1*	8.0%	
To the right	26.5 ± 6.8	15 - 40	29.0 ± 6.2	18 - 42	2.6*	9.4%	

\*-p<0.001

Statistical

significance

group- 9 people (45%), on examination II the number of these patients decreased to 4 (20%), therefore the difference of 25% appeared. This makes the difference between examination I and II statistically significant chi - square = 8.06. The data are presented in Table 2.

## DISCUSSION

As per updated Cochrane's review assessing the effectiveness of active rehabilitation after intervertebral disc surgery, no significant differences between exercise programs or an increase in the frequency of reoperations were found. The authors noted that the quality of the data in the analyzed studies was very low [18]. Moreover, A. Rushton et al.in a systematic review of randomized study on a group of 1336 people, did not find the effect of introducing physiotherapy on improving the range of flexion motion or reducing pain in patients after the first discectomy. Only one out of sixteen studies was rated as having a low risk of statistical error meanwhile eight were classified as high risk. Demonstrated variety of studies made the choice of rehabilitation procedure

χ<sup>2</sup>=7.273; p=0.083

unclear [22]. However, systematic review by N. Atsidakou et al. showed that the use of exercise has a positive effect on pain reduction, disability and general quality of life. It also shortens the time needed to return to normal activity [25].

Moreover, AC Johansson et al., conducting comparative studies of the effectiveness of home training for rehabilitation in clinical conditions, three and twelve months after discectomy surgery, determined that the training at home is beneficial in terms of reducing pain and improving the quality of life, provided that the physical therapist carefully instructs and controls the patient [30]. Also G. R Ebenbichler et al. noticed positive, long-term effects of postoperative rehabilitation. Performing the examination 12 years after the surgery, the group participating in postoperative physiotherapy achieved a much better result on the lower back pain assessment scale. However the conclusions are ambiguous [28]. S. Demir et al. using and controlling dynamic lumbar stabilization exercises confirmed positive effects in both pain relief and improving the range of motion [26]. Even rehabilitation based on aerobic exercise improved the functional status of patients after microdiscectomy [27]. JJ Hebert et al., examining the impact of various programs in the group of patients undertaking directional and general exercises, noticed an improvement in most of the measured parameters in both groups. Nonetheless, they emphasize that the previously examined individual characteristics of the patient and the experience of the therapist should determine the choice of therapy [31].

Considering the prevalence of lower back pain and frequency of discectomy and microdiscectomy procedures, there is a need to create appropriate guidelines for rehabilitation after the mentioned surgeries. In a review of the studies, RW Ostelo et al. noticed the benefits of early introduced activity and no effect on possible complications. However, it is not clear what the rehabilitation should look like and when it should begin [29, 34]. In the conducted study, it was found that the manual techniques used resulted in a statistically significant pain reduction. Improvement was also observed in the control group where sensorimotor exercises and physical therapy were used. Scientists point out the role of muscles in stabilizing the motor units of the spine, where their recruitment depending on the organism needs, increases the stability and supports the passive system [23, 24]. S Metel et al. in their studies indicated a statistically significant effect of sensorimotor exercises on the back muscles strength increase. Mentioned exercises were performed under the supervision of a physiotherapist and adjusted individually to each patient. In order to introduce an element of instability of the base elastic bands, balls and rehabilitation pillows were used. This resulted in forcing the activity of deep stabilizing muscles [33].O.F Aure et al. reached similar conclusions comparing manual therapy and exercise therapy in patients with lower back pain, showing the advantage of manual therapy over exercise one, although in both groups they noted significant improvement both in the short-term and long-term [19]. J.R. Danielsen et al. tested the impact of an active rehabilitation program which contained exercises stabilizing the lumbar spine by comparing it to a control group conducted with a gentle program of 2-3 home exercise. Assessing the results after six and twelve months, they also noticed a reduction in pain in patients after discectomy who performed rehabilitation exercises, although ultimately no clear differences between the studied groups could be found [20]. O Ulger et al. testing the effect of spine stabilization exercises and manual therapy on pain reduction and improvement of function in patients with chronic low back pain, found a positive effect of both therapies on the above-mentioned parameters [35]. G Carpino et al. provided preliminary evidence of increased range of motion in patients with lower back pain after mobilization and manipulation [32]. The study also indicated a statistically significant increase in the range of motion of lateral and forward bends in the experimental and control group, however in patients who underwent sensorimotor exercises and physical therapy, this change was significantly smaller than in the experimental group. Also A. Sharma et al. noted a similar greater improvement in the range of motion in patients who used manual techniques for therapy than in those who performed strengthening and stretching exercises [21]. A. Radzimińska et al., Examining the effectiveness of physical therapy in the treatment of chronic lumbosacral pain, showed a statistically significant difference in improving the condition of patients based on the Oswestry Disbility Index. They used peloidotherapy, sonotherapy and magnetotherapy for treatment, where sonotherapy was the most effective among them [36]. Also M. Weber-Rajek et al. Presented the beneficial effect of peloidotherapy on the treatment of pain syndromes of the lower spine [37].

While analyzing the literature, it can be concluded that there are few studies on rehabilitation treatment of lower spine pain syndromes, detailing rehabilitation after discectomy and microdiscectomy, also in relation to the observed flexion dysfunction. Research includes both statistical reviews and meta-analysis, as well as typical research works, however, there are few randomized. They concern a variety of procedures, however, the dominant practice is to use spine stabilization exercises and manual therapy. Rehabilitation still rarely includes sensorimotor exercises, much more often it is based on strengthening and stabilizing. Accurate manual techniques and exercises should be distinguished to systematize the therapeutic program.

It is planned to conduct further comparative studies with a larger test and control group, and to compare single manual techniques with separate physical therapy, balneotherapy and exercises.

#### CONCLUSIONS

Manual therapy is a beneficial method of treating flexion dysfunction, which improves: the range of motion of the lumbar spine, reduces pain and changes its location.

Manual therapy might be an effective and safe method of treating patients. It can be also used in case of elderly people and those who suffer from other diseases.

Manual therapy is more effective than standard methods based on physical therapy, balneotherapy and sensorimotor exercises. Manual therapy as well as other methods have a positive effect on reducing pain, however, manual therapy is definitely necessary to increase the range of motion in postoperative dysfunctions. Which has a positive effect on the functional state.

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## **Conflict of interest:**

The Authors declare no conflict of interest

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Info

## IV EDYCJA OGÓLNOPOLSKIEJ KONFERENCJI NAUKOWO-EDUKACYJNEJ SENIOR CARE 2022

## 8 PAŹDZIERNIKA 2022 R., WROCŁAW

Konferencja jest dedykowana kadrze zarządzającej oraz pracownikom placówek świadczących całodobową opiekę długoterminową/domom seniora. Ta kolejna już edycja, cieszącego się bardzo dużą frekwencją wydarzenia, odbędzie się w tym roku 8 października 2022 roku we Wrocławiu (Congress Center Haston City Hotel\*\*\*\*) i zgromadzi przedstawicieli prawie 200 placówek senioralnych z całej Polski, reprezentowanych przez ponad 450-osobową kadrę zarządzającą i opiekuńczą. Do udziału w konferencji zaproszeni zostali przedstawiciele instytucji oraz firm których działalność, usługi oraz produkty dedykowane są szeroko rozumianej branży opieki senioralnej.

Wydarzenie to będzie miało szczególny wymiar, bowiem poprzedzone zostanie w dniu 7 października 2022 r. spotkaniem organizacyjnym Krajowej Izby Domów Opieki KIDO, zrzeszającej wiodące placówki opiekuńcze z obszaru całego kraju. Izba pełni rolę rzecznika oraz reprezentanta placówek opieki długoterminowej wobec urzędów i organów administracji państwowej a także opiniuje i przeprowadza audyty produktów oraz usług kierowanych do tej grupy odbiorców. Idea utworzenia Izby spotkała się z bardzo pozytywnymi reakcjami środowiska holistycznie pojętej opieki senioralnej a jej dotychczasowe dokonania potwierdzają słuszność podjęcia tej inicjatywy.

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# Comparison of the Effects of Systemic Cryotherapy and Kinesiotaping on the Trunk Muscles of Men Practising Targeted Physical Training

Porównanie wpływu krioterapii ogólnoustrojowej i kinesiotapingu na mięśnie tułowia u mężczyzn uprawiających ukierunkowany trening fizyczny

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#### SUMMARY

**Aim:** was to compare the effects of systemic cryotherapy and kinesiotaping on the flexibility and strength of trunk muscle of men practising, due to their job, targeted and specialized physical training. They were members of special groups: Government Protection Bureau, Anti-Terrorist Organization Bureau and Grom group.

**Materials and Methods:** The study group consisted of 30 men [age 27-55 (AVG 40 +/-7)]. Motor fitness assessment recognized in the Healthrelated fitness system: flexibility – measured by the depth of the trunk forward bend from a straight sit. A positive result was defined as a value measured in centimeters below the toes, and a negative result, when the subject did not reach the toes, the better result from two attempts was accepted for analysis. Dynamic strength of the abdominal muscles – this feature was determined by the number of scull sit-ups performed from the supine position within 30 seconds Taping of the rectus abdominis muscle was performed using the supine position muscle method. Base – above the pubic symphysis (above the hairline), abdominal tension through inhalation, tail to the cartilage of the fifth rib, parasternal. On the other side , the same way of application, then the test was performed. Taping of the dorsal extensor muscle, using the muscle method – standing position, base – on the sacrum, bending the torso forward, tape tails along the spine, then the test was performed. After a week's break, each subject received a series of 10 treatments at -130°C, each treatment lasted2 minutes. Treatments took place once a day – from Monday to Friday, excluding Saturdays and Sundays. After each cryostimulation treatment, the patient exercised on a stationary cycloergometer for 20 minutes.

**Results:** The use of kinesiotaping and systemic cryostimulation improves flexibility. The increase of the motoric feature was greater after the treatments at the applied cryogenic temperature -130°C. The dynamic strength of the abdominal muscles increased after both types of therapy, i.e. Kinesiotaping and systemic cryotherapy. Statistically significantly more sculling sit-ups were performed after cryostimulation treatments.

**Conclusions:** The conducted pilot studies showed statistically significant differences in flexibility and dynamic strength of abdominal muscles after the taping and systemic cryostimulation. It is reasonable to continue research that varies in terms of the number of treatments and cryogenic temperatures. Studies of other human motor characteristics should also be carried out.

Key words: systemic cryotherapy, kinesiotaping, strength, flexibility

Słowa kluczowe: krioterapia ogólnoustrojowa, kinesiotaping, siła, gibkość

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## **INTRODUCTION**

Kinesiology taping is a popular method used by physiotherapists. Taping, depending on the needs, is used in the prevention of injuries of the musculoskeletal system, as well as supports primary treatment. Numerous scientific publications on kinesiotaping are based on research conducted among sick people as well as healthy people training various sports [1-4]. Systemic cryotherapy is also a recognized therapeutic method, with new scientific studies constantly being published, proving the effectiveness of this treatment method [5-9].

The treatment is very often used as part of the biological regeneration of athletes or people who, due to their profession, practice constant, specialized and targeted physical training [10, 11]. First of all, systemic cryostimulation accelerates the athlete's

post-workout regeneration, but its preventive effect is also used in overloading the musculoskeletal system, treating chronic fatigue, increasing the body's immune resistance, improving mood and well-being. An important aspect is supporting endurance and strength training [10, 11]. An example of the effect is the influence on the improvement of motor characteristics at specific cryogenic temperatures, as shown in our study [12, 13]. Variability of such characteristics as flexibility, balance, speed and dynamic strength of the abdominal muscles was observed. Cryostimulation is also used in the treatment of both acute and chronic injuries in athletes [10, 11]. It is worth emphasizing that, if the safety rules are followed and after proper qualification, the procedures can be repeated many times and are safe [5, 6].

## AIM

The aim of this study was to compare which of the methods works better on selected motoric traits in people practising specialised continuous physical training in connection with their occupation. Economic aspects should also be taken into account.

## **MATERIALS AND METHODS**

The study was carried out at the Department of Treatment Improvement of the Central Teaching Hospital of the Ministry of Internal Affairs and Administration in Warsaw. The study group consisted of 30 men aged 27-55 (AVG 40 +/- 7) belonging to special units. Two human motoric traits were tested: strength and flexibility Flexibility was measured by the depth of the forward trunk bend from sitting up straight dynamic strength of abdominal muscles – the characteristic was determined by the number of sculling sit-ups from the supine position in 30 seconds.

Taping of the rectus abdominis muscle and the back extensor muscle was performed using the muscle method, followed by testing After a one-week break from the performed applications, and before the series of systemic cryotherapy treatments, the same tests of motor characteristics were performed on the men again. The systemic cryostimulation treatments are a permanent element of training in special units, therefore each of the examined men underwent them several times and knew the methodology of the procedure. The series consisted of 10 cryostimulation treatments (-130°C, 2 minutes, 5 treatments per week). After each treatment, according to the methodology of their performance, all participants exercised for 20 minutes on a stationary cycloergometer (80-100W, 1W/kg bw). After completing the series of treatments, the subjects again performed the same tests of motor characteristics, and these were compared.

## RESULTS

Flexibility statistically significantly increased after applying dynamic patching. The mean values of the depth of the forward bending of the trunk changed from 9 to 16 cm. (Figure 1). The dynamic strength of the abdominal muscles statistically significantly increased after kinesiotaping. The mean number of sculling sit-ups increased from 43 to 48 (Figure 2).

Flexibility statistically significantly increased after 10 systemic cryostimulation treatments. The mean depth of forward trunk bending changed from 9 to 18 cm. (Figure 3). The dynamic strength of the abdominal muscles statistically

significantly increased after cryotherapy. The mean number of sculling sit-ups increased from 43 to 50 (Figure 4).

The use of kinesiotaping and systemic cryostimulation improves flexibility (Table 1).



Figure 1. Flexibility after dynamic slicing – mean values (p <0.001, Wilcoxon test) Rycina 1. Gibkość po zastosowaniu dynamicznego plastrowania – wartości średnie (p<0,001, test Wilcoxona).



Figure 2. Dynamic abdominal muscle strength after kinesiotaping – mean values (p <0.001, Wilcoxon test)





Figure 3. Flexibility after 10 treatments of systemic cryostimulation – mean values (p <0.001, Wilcoxon's test)

**Rycina 3.** Gibkość po 10 zabiegach kriostymulacji ogólnoustrojowej – wartości średnie (p<0,001, test Wilcoxona).

**Table 1.** Flexibility. The depth of the forward bend of the trunk from a straight sit (cm)

	Range	Average+/-
Initial values	-20 do 23	9cm +/-9cm
After taping	-3 do 27	16cm +/-7cm
After cryotherapy	-3 do 28	18cm +/-6cm



Figure 4. Dynamic strength of abdominal muscles after cryotherapy – mean values (p <0.001, Wilcoxon test)

The increase in the motor trait was greater after the treatments at the applied cryogenic temperature of -130°C (Table 2).

Table 2. Flexibility. Increase In relation to initial values

	Range	Average +/-
After taping	-4 do 17	6cm +/-5cm
Po krioterapii	-2 do 17	7cm +/-5cm

The dynamic strength of the abdominal muscles increased after both types of therapy, i.e. kinesiotaping and systemic cryotherapy (Table 3). Statistically significantly more sculling sit-ups were performed after cryostimulation (Table 4).

**Table 3.** The dynamic strength of the abdominal muscles,

 the number of sculling sit-ups from the supine position in 30 seconds

Range	Average +/-
20 do 59	43 +/-11
22 do 60	48 +/-11
27 do 65	50 +/-9
	Range           20 do 59           22 do 60           27 do 65

**Table 4.** Dynamic strength of the abdominal muscles. Increase.

 In relation to initial values

	Range	Average +/-
After taping	-5 do 13	5 +/-4
Po krioterapii	-4 do 18	8 +/-5

## DISCUSSION

People practising professional sports or targeted, specialised physical training in connection with their profession (soldiers, policemen) are subject to very high physical and mental loads, hence the huge role of biological regeneration [14, 15].

Improving skills is the most important goal for players to achieve better results, therefore their organisms are very often overloaded [16]. Scientists are looking for methods that will be most effective for the regeneration of an organism burdened by physical effort, of course, economic considerations also play an important role. Contemporary sports physiotherapy has various methods of treating people who train, such as Kinesiology taping and systemic cryotherapy [17].Systemic cryostimulation is a procedure often used in biological regeneration, especially in

sportsmen. It causes a number of local and systemic reactions in the body that accelerate the return to full fitness, but also causes additional effects that make this procedure very popular in the world of sports [18-23]. Cryotherapy prevents the negative effects of training overloads, supports the treatment of injuries and contusions, and prepares the body for greater loads, which contributes to achieving better sports results. After exiting the cryochamber, the blood vessels dilate, causing a greater blood flow through tissues and organs. Congestion contributes to faster healing of injuries and inflammations, and has an anti-oedematous effect. The concentration of oxygen in muscles increases, the amount of lactates decreases, and the release of endorphins intensifies, whose the analgesic effect is stronger than that of morphine. Systemic cryotherapy increases the levels of hemoglobin, leukocytes, platelets and testosterone [24-26]. Muscle tension is reduced, and their strength increases. Kinesiotaping is one of the therapeutic methods that is also used in physiotherapy of training people. It consists in sticking a special patch on a selected part of the body. Using one of the 6 application techniques (muscular, ligament, fascial, corrective, lymphatic, functional), various effects are obtained (analgesic, anti-oedematous, stabilizing or corrective). According to the creators, the application is similar to human skin in terms of specific weight, thickness and extensibility (30-40% of the resting length). The tape is waterproof, air-permeable and has a sinusoidal acrylic adhesive layer, thanks to which the incidence of allergic reactions related to the K-Active application is reduced to a minimum [27-29]. By affecting the fascia, it restores the proper flow of fluids, facilitating the removal of inflammatory factors by the lymph. In the muscle technique, at the beginning of the application, the muscle attachments are maximally distanced from each other ; the tape is applied without tension, which causes the appearance of folds on the skin after the muscle returns to its resting position. In the ligament technique, the central part of the tape is stretched to the maximum, the ends of the application are glued without stretching, therefore the effectiveness of the application is also related to the skills and knowledge of the person performing the applications [30]. The results of studies available in the literature are sometimes contradictory. Various methods of application are used for various diseases, prophylactically, among people practising various sports. Interestingly, there has been no negative kinesiotaping effect reported.Low temperature therapy as well as kinesiotaping are used to support the body of the trainee, it is reasonable to compare different methods and techniques. It is important that the studies are-comparable in relation to the selected muscles, sports and the costs associated with it, in line with the guidelines of the World Confederation of Physiotherapy regarding high standards of research based on Evidence Based Practice (EBP).

## CONCLUSIONS

- 1. The conducted pilot studies showed statistically significant differences in flexibility and dynamic strength of the abdominal muscles after the application of taping and systemic cryostimulation.
- 2. It is reasonable to continue studies that vary in terms of the number of treatments and cryogenic temperatures.
- 3. Other human motor characteristics should also be tested

**Rycina 4.** Siła dynamiczna mięśni brzucha po krioterapii - wartości średnie (p<0,001, test Wilcoxona).

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# The Results of the Examination of Patients After Laparoscopic Cholecystectomy in the Acute Period of Rehabilitation Using the International Classification of Functioning

Wyniki badania pacjentów po cholecystektomii laparoskopowej w ostrym okresie rehabilitacji przy zastosowaniu międzynarodowej klasyfikacji funkcjonowania

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#### SUMMARY

**Aim:** Conduct an examination of patients after laparoscopic cholecystectomy (LCC) in the acute period of rehabilitation using the international classification of functioning (ICF). To analyze the functionality, activity, environmental factors in patients of this nosology, depending on age. **Materials and Methods:** The study included 382 patients with chronic calculous cholecystitis (CCC), who were in the surgical department. The assessors and patients were double-blinded during the interview, examination, and processing of the collected data. Performing the initial examination of patients, we used the ICF, formed a "Patient's Functional Profile" map, in which the existing disorders in the functions of the body, body structures, activity and participation, environmental factors at the time of the initial survey, examination of the patient, as a rule, are available in patients after LCC on acute stage of rehabilitation.

**Results:** It was found that in all groups there are dysfunctions, activities and participation of patients, the degree of impairment of which increases with age. The greatest degree of impairment was observed in elderly patients in the functions of muscle endurance, exercise tolerance and defecation functions. The environment of the clinic is positive for the stay after LCC of patients. A negative assessment of financial assets was in patients of retirement age.

**Conclusion:** The use of a functional profile map of a patient after LCC with ICF with a scoring criterion makes it possible to establish the level of impairment of functioning, activity, participation, environmental factors and plan a rehabilitation program.

Key words: assessment, functionality, activity, environmental factors

Słowa kluczowe: ocena, funkcjonalność, aktywność, czynniki środowiskowe

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## INTRODUCTION

The system of rehabilitation services in the field of health care in Ukraine is on the way. In Ukraine only in 2021 the Law of Ukraine "On Rehabilitation in the Field of Health Care" was introduced (https://zakon.rada.gov.ua/laws/show/1053-20#Text) which defines legal, organizational and economic principles of rehabilitation of a person with limitations of daily functioning in the field of health care in order to achieve and maintain the optimal level of functioning in his environment. Until now, only the International Classification of Diseases (ICD) has been guided in its rehabilitation interventions at various stages. In recent years, the rehabilitation system has begun to incorporate into its practice the use of the International Classification of Functioning, Restriction of Life and Health (ICF) alongside the ICD [1, 2].

Both classifications are considered and begin with a violation of the structures and functions of the body, which are usually part of the "disease process". However, the ICD uses disorders (signs and symptoms) as part of the constellation that forms the "disease", or sometimes as a reason to seek medical attention, while the ICF system uses them as problems of body functions and structures related to health. . [International Classification of Functioning, Life and Health Restrictions // World Health Organization 2001. https://physrehab.org.ua/wp-content/uploads/docs/5210preklad\_mkf\_dorosla\_v\_docx.pdf]. The ICF considers the following categories: Body functions, Body structures, Activity and participation, Environmental factors [2-4].

## AIM

Conduct an examination of patients after laparoscopic cholecystectomy in the acute period of rehabilitation using the international classification of functioning. To analyze the functionality, activity, environmental factors in patients of this nosology, depending on age.

## MATERIALS AND METHODS

The study included 382 patients with LCC who underwent laparoscopic cholecystectomy in the surgical department of the Ivano-Frankivsk Central City Clinical Hospital in 2019-2020. Patients were divided into 4 groups according to four age categories: group A aged 18 to 44 years – men (n=17) and women (n=96); group B – aged 45 to 59 years – men (n=22) and women (n=124); group C aged 60 to 74 years – men (n=17) and women (n=96); group D – aged 75 to 89 years – men (n=3) and women (n=7). Exclusion criteria: the presence of neuropsychiatric pathology in patients; refusal of patients to participate in the study; patient participation in another study.

Evaluators and patients were double-blinded in interviewing, examining, and processing the collected data. Survey on the presence of impairments in functioning, activity and participation, environmental assessment using the ICF (World Health Organization version 2001) was as an assessment tool. The assessment of the degree of violations according to the general classification of the ICF (Function/Structure/ Activity and participation, Environmental factors) was carried out according to the following criteria: 0 points: ABSENT violations (none, absent, insignificant, ...) 0-4%; 1 point: MILD impairments (mild, minor,...) 5-24%; 2 points: MODERATE violations (medium, significant, ...) 25-49%; 3 points: SEVERE violations (significant, intense, ...) 50-95%; 4 points: ABSOLUTE violations (total, ...) 96-100%. The criteria for assessing environmental factors are described in Table. 1. The evaluation was carried out on the second day after surgery - LCC. Methods of synthesis, analysis, mathematical statistics (the comparison method was carried out using Student's t-test in the number of days spent in the surgical department by each group).

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board. Informed consent was obtained from all subjects involved in the study. The used methods of the study were approved by the moral commission of the Ivano-Frankivsk Medical University (IFNMU) when planning a comprehensive research work, approved by the decision of the Academic Council of the IFNMU Protocol No. 19 of 12/20/2018. on the topic: "Development and improvement of the organizational and methodological foundations of physical therapy in patients with diseases of the abdominal cavity and nervous system" (state registration number 0119U000448) and a scientific study of the Institute of Health Sciences in the field of health care in the specialty 227 "Physical therapy": "Theoretical and methodological foundations of physical therapy of patients after laparoscopic cholecystectomy" (state registration number 01119 U 2951).

## RESULTS

Our study refers to the introduction of ICF into the rehabilitation process for patients with chronic calculous cholecystitis (CCC) after laparoscopic cholecystectomy (LCC) in the acute period of rehabilitation. Conducting a retrospective analysis of medical records in the acute period of rehabilitation of such patients, we found that the rehabilitation intervention was aimed at the following areas: increasing the psycho-emotional tone, maintaining confidence in the favorable outcome of the operation, reducing congestion in the respiratory, gastrointestinal and improving general and local blood circulation, lymph circulation, restoration of the impaired respiratory mechanism, prevention of postoperative complications (pneumonia, atelectasis, thromboembolism, intestinal paresis, flatulence, formation of compounds). Restoration of self-service skills, elimination of residual effects after operations and normalization of the function of the digestive organs, adaptation of the cardiovascular and respiratory systems to moderately increasing physical activity, improvement of the general functional state, preparation of the patient for everyday stress [5]. However, as you know, the rehabilitation process should be based on special principles. First of all, it is patient-centricity, which should include planning and conducting rehabilitation taking into account the needs, capabilities and wishes of the person receiving rehabilitation assistance, or his legal representative and members of his family, as well as direct participation in the development, implementation and amendment of an individual rehabilitation plan. Secondly - purposefulness - the organization of the rehabilitation process should be aimed at achieving long- and short-term goals. Thirdly - timeliness - rehabilitation should begin during the acute rehabilitation period or immediately after the stabilization of the state of health with a chronic course, the individual rehabilitation plan should change in accordance with the change in the functional state of the person who is provided with rehabilitation assistance. This process must be consistent - each subsequent stage of the rehabilitation process must be connected with the previous stage, be the basis for the next stage and take into account

the actual changes in the functional state of the person who is provided with rehabilitation assistance. Rehabilitation assistance should be aimed at achieving the optimal level of functioning and quality of life of the individual in his environment [International Classification of Functioning, Disabilities and Health [2].

Therefore, in order to comply with the above principles of rehabilitation when planning a rehabilitation intervention for patients with CCC after LCC, we used the ICF. In our opinion, this tool is by far the best for applying the biopsychosocial model in rehabilitation. This model characterizes the limitation of daily functioning/life activities as a result of the interaction of the individual with the environment, in particular physical, psychological and environmental factors, in order to ensure the ability of the individual to maintain the highest possible level of health and well-being, as well as to function most effectively in society [6]. The study presents the results of a primary study of patients. The survey was aimed at identifying the presence of dysfunctions in the following biopsychosocial categories: body functions (b), body structures (s), activity and participation (d), environmental factors (e). To indicate the nature of changes in the structure of the organism, in our case it was the gallbladder (s 570). To assess the physiological functions of body systems (including the psychological functions of the body), a general classifier was used with a negative scale to indicate the volume and magnitude of excitation.

Performing the initial examination of patients, we created a "Patient's Functional Profile" map, in which we entered the existing disorders in the functions of the body (b), body structures (s), activity and participation (d), environmental factors (e) at the time of the initial survey / examination patient , which, as a rule, are present in patients after LCC at the acute stage of rehabilitation Table 1.

The use of a map of the functional profile of the patient after LHH ICF with a score criterion allows the physical therapist, occupational therapist to set short-term goals and develop a physical therapy program in compliance with all principles of rehabilitation, and after rehabilitation in the acute period to assess the effectiveness of intervention.

The structure of groups (number of patients) is shown in Figure 1.

As can be seen, groups A, B, C are homogeneous in structure.

The number of days spent in the surgical department in patients of group A was  $4,25\pm0,14$  days, group B4,53  $\pm0,14$ , days, group C 4 C  $4,35\pm0,30$  days, patients group D  $5,50\pm0,78$  days.



Figure 1. Group structure

For each type of dysfunction, activity and participation of the patient in the card "Functional profile" was evaluated, depending on the degree: 0 points – no violations; 1 mild disorders (mild, minor) 5-24%; 2 moderate violations (medium, significant) 25-49%; 3 points severe violations (significant, intense) 50-95%; 4 points absolute violations (total) 96-100%.

Since we evaluated each type of impairment according to the detailed classification of the ICF, we calculated the assessment of each type of impairment by dividing the sum of points for all functions by the number of impaired functions. For example, patient M. in assessing "b 525 Function of defecation" received the following points: b 5251 Consistency of feces – (moderate violations) – 2 points, b 5252 Frequency of bowel movements – (moderate violations) – 2 points, b 5254 Flatulence (mild degree) – 1 point. Therefore, for "b 525 Functions of defecation" patient M. received (2+2+1)/3 = 1.67 points. The results of the evaluation of functional disorders of patients in points for the group are shown in Figure 2.

The results of the environmental assessment are shown in Figure 4

When assessing environmental factors, we took into account the conditions of hospital stay.







Figure 3. The results of evaluation of activity and participation of patients after LCC

## Table 1. ICF Patient Functional Profile Map

Criteria for assessing the degree of violations according to the general classification of the ICF 0 ABSENT violations (no, absent, insignificant, ...) 0-4% \* 1 LIGHT violations (mild, minor, ...) 5-24% 2 MODERATE violations (medium, significant, ...) 25-49% 3 SERIOUS violations (significant, intensive, ...) 50-95% 4 ABSOLUTE violations (total, ...) 96-100%

Function	The degree of violation			ion	
	0	1	2	3	4
b 134 Sleep functions					
b 152 Functions of emotions					
b 280 Feeling of pain					
b 2801 Pain in the body					
b 28012 Stomach or abdominal pain					
b 28013 Back pain					
b 440 Respiratory functions					
b 455 Functions of tolerance to physical activity					
b 4550 Overall physical endurance					
b 4551 Aerobic ability					
b 4552 Fatigue					
b 515 Digestion functions					
b 525 Defecation functions					
b 5251 The consistency of feces					
b 5252 Frequency of defecation					
b 5254 Flatulence					
b 535 Feelings associated with the digestive system					
b 5350 Feeling sick					
b 5351 Feeling bloated					
b 5352 Feeling of intestinal colic					
b 730 Functions of muscular strength					
b 7305 Torso muscle strength					
b 7350 Tone of isolated muscles and muscle groups					
b 7355 Torso muscle tone					
b 740 Functions of muscular endurance					
b 7401 Endurance of muscle groups					
b 7402 Endurance of all muscles of the body					
Activities and participation					
d 410 Mobility					
d 4100 Lying position					
d 4103 Sitting position					
d 4501 Walking long distances					
d 4602 Moving outside your home and other buildings					
d 4600 Moving within housing					
d 4601 Moving within other buildings					
d 510 Self-service					
d 5100 Washing body parts					
d 5101 Washing the whole body					
d 5102 Wiping and drying					
d 5204 Toenail care					
d 5402 Putting on the lower extremities					
d 5403 Removal from the lower extremities					
d 5701 Adherence to diet and fitness					

Assessment of environmental factors									
Criteria for assessing environmental factors	Facilitating factors		Barriers						
	+0 = NO mitigating factors +1 = WEAK facilitating factors +2 = MODERATE mitigating factors +3 = HEAVY mitigating factors +4 = FULL mitigating factors		0 = N0 barriers 0-4 - 1 = WEAK barriers 5-24% s - 2 = MODERATE barriers 25-49% - 3 = HEAVY barriers 50-95% - 4 = COMPLETE barriers 96-100%						
	+4	+3	+2	+1	0	-1	-2	-3	-4
e 1101 Medicines									
e 1201 Auxiliary products and technologies for personal internal and external mobility and transportation									
e 150 Design, construction and construction products and construction technologies for public use									
e 1650 Financial assets									
e 340 Care and assistance staff									



Figure 4. The results of the assessment of environmental factors

## DISCUSSION

Conducting a comparative analysis of the number of days spent by patients in the surgical department between groups, it was found that a statistically significant difference between group C and group A (p<0,001), as well as between group C and B ((p<0,01).That confirms our hypothesis that older patients after LCC require more recovery time.

The results of the assessment of functional disorders of patients in group A in the average scores for the group indicate that patients have moderate (medium, significant) 25-49% disorders only in the function of digestion (b 515) and sensations associated with the digestive system. b 535). All other functions are within the range of mild, minor impairments of 0-25%.

Analyzing the assessments of functional disorders of patients of group B in the average scores for the group, it was found that patients have moderate, (medium, significant) 25-49% disorders in the functions of digestion (b 515), sensations associated with the digestive system (b 535), as well as defecation functions (b 525). Other functions are in the range of mild, minor impairment 0-25%.

In group C, the presence of moderate (medium, significant) 25-49% disorders in the functions of digestion (b 515), sensations associated with the digestive system (b 535),

defecation function (b 525), muscle endurance function (b 740) and exercise tolerance function (b 455).

In group D, a mild, minor degree of 0-25% impairment is present in the functions of emotions b 152 and pain (b 280). Severe disorders (significant, intense) 50-95% were found in defecation function (b525), exercise tolerance function (b455) and muscle endurance (b740). Other functions in this group are at the level of moderate (medium, significant) 25-49% impairment.

The results of the assessment of the activities and participation of patients in group A after LCC in the acute period of rehabilitation indicate that activities such as mobility (d 410), walking long distances (d 4501), self-care (d 510), diet and physical fitness (d 5701) were mild, minor 0-25% impairment.

The results of group B were similar, except for diet and fitness activities (d 5701), which in this group reached the level of moderate, (medium, significant) 25-49% impairment, which clearly indicates the presence of already established dietary habits and lifestyle in patients aged 45-59 years.

Analysis of the results of the evaluation of the activities and participation of patients in group C found that activities such as mobility (d 410), walking long distances (d 4501), self-care (d 510 d), diet and fitness (5701) were moderate, (medium, significant) 25-49% of the degree of violations.

Patients in group D had a moderate (moderate, significant) 25-49% degree of impairment in activities such as mobility (d 410), diet and fitness (d 5701), and long-distance walking activities (d 4501) and self-care (d 510) were at the level of serious violations (significant, intensive) 50-95%.

A When assessing environmental factors in all groups, drugs (1101) were rated at the level as moderate factors that facilitate functioning, activities and participation.

Assistive products and technologies for personal internal and external mobility and transportation (e 1201) were used by Group C patients at the level of mild facilitators and by patients in Group D at the level of moderate facilitators of functioning, activities and participation. Group A patients did not use such products and technologies. Design, construction and construction products and building technologies for public use (e 150) were at the level of weak factors facilitating the functioning, activities and participation in group D. In all groups, the assessments in this category of environment were positive, which indicates the barrier-free conditions of stay in the surgical department of the medical institution.

Financial assets (e 1650) were assessed positively in patients of groups A and B, that is, persons of working age, with a negative assessment in groups C and D. The negative assessment of financial assets is due to the low income of patients of retirement age.

Care and assistance staff (e 340) was at the level of weak factors that facilitate the functioning, activities and participation in groups C and D.

## CONCLUSIONS

The use of ICF for patients with indigestion as an assessment tool for patients with chronic calculous cholecystitis after laparoscopic cholecystectomy allows to set short-term and long-term goals of rehabilitation, helps to form a rehabilitation prognosis.

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#### Info

On behalf of the Editorial Board and the Publisher of Acta Balneologica – the official journal of the Polish Society of Balneology and Physical Medicine (published since 1905), we cordially invite you to the new website www.actabalneologica.eu where, among others, we publish open access articles. We would like to remind you that Acta Balneologica is indexed in the Web of Science (ESCI) as well as EBSCO databases, has 20 MEiNSzW points, and has the permanent patronage of the Rehabilitation Committee of the Polish Academy of Sciences. At the same time, we encourage you to visit and like the Acta Balneologica profile on Facebook. facebook.com/actabalneologica. There, we place posts in the field of health resort medicine. And we will share information about treatment methods available in health resort stations. A natural consequence of our activities in the field of health resort medicine has been the establishment of the Polish Society of Health Resort Patients in 2019. You can find out more about the goals, tasks, and methods of operation of this Society on the website www.uzdrowiskowi.pl. You can also download the membership declaration here.

# Effectiveness of Physical Therapy in Middle-Aged Women with Alimentary Form of Obesity of the First Degree

Skuteczność fizjoterapii u kobiet w średnim wieku z otyłością I stopnia spowodowaną nadmierną podażą energii

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#### SUMMARY

**Aim:** The objective of the article is to demonstrate the research on the effectiveness of physical therapy in renewal of health of women with alimentary-constitutional type of I degree obesity. The task was also to study the initial level of obesity of women, to develop the structure of the therapeutic rehabilitation complex, to implement the developed programme of physical therapy and evaluate its effectiveness.

**Materials and Methods:** The study was conducted for six months on the basis of a sports and recreation complex, which includes a gym, aerobics and a swimming pool with professional equipment. It was attended by 40 people aged from 33 to 56, with overweight and obesity of I degree. They were divided into two groups: the main (20 people) and control (20 people). The maingroup used a set of strength physical exercises of aerobic and anaerobic types, diet therapy and constant online psychological support. The women in the control group performed the standard set of physical exercises that are usually offered in sports facilities and ate at their own discretion. We also used elements of therapeutic exercise to increase energy expenditure, reduce excess weight and strengthen muscles, restore and maintain physical and professional performance. There were no people with serious disorders of the cardiovascular, endocrine and other body systems among the participants of the study.

**Results:** During the therapeutic programme, we performed monthly control measurements of body parameters and body weight in order to monitor their dynamics and compare it with that in the control group, which was engaged in the standard complex. At the beginning of the study, the results in both groups were quite positive, after some time the rate of weight loss began to slow down, and in the control group, among some participants it even worsened – the weight returned. 6 months after the initial control, a final control of both groups of women of second adulthood was performed. When comparing the data obtained before and after rehabilitation measures, we observed a significant decrease in body weight in individuals of the study group in contrast to the control, where there was a decrease in body weight, but it was statistically insignificant. Analysis of the dynamics of monthly weight loss for the entire rehabilitation period showed that in the control group there was a decrease in body weight in the first and second months of the rehabilitation complex, relative to the main group, then the dynamics was marked by significant weight loss in the 1st, 2nd, 3rd month.

**Conclusions:** Based on the obtained results, we proved the high efficiency of the proposed therapeutic and rehabilitation complex (combination of diet therapy, exercises of aerobic and anaerobic directions) for the treatment of persons with I degree of obesity (significantly reduced body weight and reduced the size of body parts). Rehabilitation measures used in our study activate metabolic processes, increase energy expenditure, reduce excess body weight, strengthen the body. By following a healthy lifestyle, eating rationally, you can prevent a number of diseases, improve efficiency and general well-being, avoid premature aging. Physical therapy of obese patients requires a combination of dietary and physiotherapeutic methods (massage, physiotherapy, psychological training), which allows to achieve sustainable weight loss for a long period.

Key words: overweight, physiotherapy programme, health improvement

Słowa kluczowe: nadwaga, program fizykoterapii, poprawa stanu zdrowia

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## INTRODUCTION

Obesity is characterised by excess of adipose tissue and causes numerous chronic diseases and early mortality. This pathology attracts attention both nationally and internationally, as it is harmful to public health and has major negative economic consequences. For example, about 325.000 deaths from obesity are recorded among the non-smokers in United States each year [1].

Obesity causes serious diseases of the body and worsens quality of life. There is a study that shows how obesity affects the reduction of physical function in the elderly. Therapeutic actions for weight loss improve physical function, quality of life and health complications associated with obesity of the elderly. Therefore, physical therapy for weight loss, which minimizes the loss of muscle and bone tissue, is recommended for elderly people who are obese and have functional disorders or medical complications that may benefit from weight loss [2]. Overweight causes cardiovascular disease, stroke, cancer of the breast, endometrium, prostate and colon, respiratory problems, depression, etc. [1].

The effect of obesity on the development of type 2 diabetes [3] and chronic cardiovascular disorders in middle and old age [4], especially hypertension [5], was particularly studied. For our work we have chosen women of mature age, as this is the most productive age - the period of realisation of oneself as a person, the use of one's professional potential. But at the same time, modern conditions of daily life are increasingly creating a problem of prolonged emotional tension, leading to a progressive decline of health level. Overweight reduces a person's standard living, workability, complicates intellectual and physical activity, leads to early disability, premature aging, reduced lifetime. The alimentary form of obesity is predetermined by external causes: overeating, excessive consumption of foods rich in carbohydrates and fats, lack of physical activity and associated reduction in energy consumption. Thus, obesity is an urgent medical and social problem that has reached global scopes today.

The objective of the article is to demonstrate the research on the effectiveness of physical therapy in renewal of health of women with alimentaryconstitutional type of I degree obesity. The task was also to study the initial level of obesity of women, to develop the structure of the therapeutic rehabilitation complex, to implement the developed programme of physical therapy and evaluate its effectiveness.

## MATERIALS AND METHODS

The study used such methods as analysis of literature sources on this issue, questionnaires, use of the author's programme, which included: measurement of anthropometric data, observation, nalysis of human body composition using a special device-analyser, psychological support, rehabilitation measures, that included a complex of therapeutic physical exercises of aerobic and anaerobic orientation, diet therapy, ultimately, systematization, comparison, generalisation of the material.

The study was conducted for six months on the basis of a sports and recreation complex, which includes a gym,

aerobics and a swimming pool with professional equipment. It was attended by 40 people aged from 33 to 56, overweight and with obesity of the first degree. They were divided into two groups: the core (20 people) and control (20 people). The core group used a set of strength exercises of aerobic and anaerobic orientation, diet therapy and constant online psychological support. The women in the control group performed the standard set of physical exercises that are usually offered in sports facilities and ate at their own discretion. In the research, we also used elements of therapeutic physical exercises to increase energy expenditure, reduce excess weight and strengthen muscles, and recover and maintain physical and professional workability. There were not people with serious disorders of the cardiovascular, endocrine and other body systems among the participants of the study. An important activity in our therapeutic programme was diet therapy, which is part of a comprehensive programme for the treatment of overweight and obesity, was prescribed to members of the study group with a gradual reduction in daily calories. We prepared an individual diet for the participants of the study group. To do this, we calculated the daily nutritional intake of calories. We recommended eating small portions 4-6 times a day. In the first stage, we did not recommend severely limiting of the diet, as a severe change in food intake can cause a negative reaction. We also compiled a menu for each member of the study group, taking into account individual taste preferences and financial capabilities.

Whatever food a person consumed, the diet was as balanced as possible in terms of macro- and micronutrients and met all the principles of rational nutrition. Some foods were eliminated from the diet gradually. Later, a diet № 8 with low energy value under weight control was prescribed. In parallel with diet therapy, a set of exercises in therapeutic physical exercises was developed. The training was conducted with various degrees of intensity, three times a week for 1-2 hours. During the rehabilitation complex, we conducted ongoing monitoring of physical data of the participants of the study.

Data were measured using a height meter, meter tape and special scales analysers of body composition of "Tanita" company. This floor-standing electronic device works on the principle of different ability of tissues to resist the passage of electrical impulses. The person stands on metal plates, through which low frequency is supplied. Its impulses are almost imperceptible. They pass through the tissues of the body, each of them meets a certain resistance. The task of the computer, which is the main brain centre in the device, is to analyse the obtained data and provide indicators of body composition. If there is no fat or very little fat in the tissues, the pulse passes without any resistance due to the large amount of water. There is not enough water in adipose tissue, so the cells have a high resistance. The device compares indicators with weight of the person, and the level of water and fat in an organism is demonstrated on a board.

The accuracy of the device is achieved due to: correctly calculated location of the electrodes, the size of the electrodes, the accuracy of the formula used by the device for calculations.

Electronic weight analysers give reliable indicators of human body weight. Weight indicators cannot give information about how the body responds to diet and physical activity. Weights-analysers of body composition will not allow to miss any indicator. With such weights, you can always be sure that when you lose weight and fat deposits, not with water and muscle mass. According to the indicators of weightsanalysers, the norm of water of women of the second adult age is from 45 to 60%, the percentage of fat - from 22 to 37% - the norm, from 37 to 42% - excess fat, above 42% - obesity. The next method was to calculate the body mass index. It is the most common method of classifying overweight / obese patients; it is the distribution by body mass index (BMI), which is determined by the ratio of body weight to height squared. In the adult population, overweight is determined by BMI≥25,0 kg/m<sup>2</sup> and obesity is determined by BMI≥30,0 kg/m<sup>2</sup> regardless of gender. BMI is internationally recognized because there is a link between BMI and obesity, as well as the connection between BMI and disease risk and the connection between BMI and mortality [1]. We also used elements of therapeutic physical exercises to increase energy expenditure, reduce excess weight and strengthen muscles, and renew and maintain physical and professional workability. We used exercises for endurance, gymnastics for medium and large muscle groups in alternation with respiratory, which increased energy expenditure and oxygen uptake, contributed to the consumption of large amounts of carbohydrates, as well as the release of fats from the depot and their digestion. Therapeutic physical classes included a variety of general developmental exercises, walking, running, walking, swimming and aqua aerobics, exercises with equipment, aerobic and anaerobic fitness, movable and sports games. Exercises to strengthen the muscles of the torso and abdomen, corrective and breathing exercises attached great importance.

## RESULTS

At the beginning of the study, we selected and monitored the physical data of all members of the control and study groups. Data on the physical qualities of women of the second adult age of the initial control of the study and control groups are shown below in Table 1. The Table 1 of monitoring of the physical qualities of women in the study group shows that according to age periodization, all participants are women of the second mature age. The lowest metabolic age was 48 years, the highest – 74 years. The largest weight was 105 kg, and the smallest – 84 kg. The percentage of fat was very high – from 39 to 51%, and the percentage of water – on the contrary quite low – from 34 to 47%.

The smallest waist girth was 82 cm, and the largest – 100 cm, hip circumference – 100 cm, the smallest figure and 119 cm – the largest. At the initial control, the body mass index of 12 participants corresponded to overweight, and in 8 women according to BMI indicators, first-degree obesity was recorded.

Table 1 of the monitoring of physical qualities of women in the control group shows that at the initial control of the participants had the following data: according to age periodization, all participants also belong to women of the second mature age. The minimum metabolic age was 48 years, the largest – 75 years. The largest weight was 105 kg, and the smallest – 84 kg. The lowest percentage of fat – 32%, the highest – 52%. Only one participant had the normal percentage of water. The smallest waist girth was 77 cm, and the largest – 102 cm, hip girth – 97 cm, the smallest and 117 cm – the largest. At the initial control, BMI in 14 participants was overweight, and in 6 women, first-degree obesity was recorded.

At the beginning of the study, the results in both groups were quite positive, after some time the rate of weight loss began to slow down, and in the control group, in some participants even worsened – the weight returned. Six months after the initial control, a final control of both groups of second adult women was performed. We present the data of the final control of the study group in Table 2.

The final Table 2 of the study group of women of the second adult age shows that in six months, according to the body mass index of 8 women with firstdegree obesity, seven reached normal weight, and one participant remained without first degree of obesity, but with an indicator corresponding to excessive weight. Twelve participants who were overweight at the beginning of the study, had already normal indicators at the final control. In all participants, the percentage of fat

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Groups of women Indicators	Study group (20 women)	Control group (20 women)
Age (y)	43,3 ± 5,74	42,3 ± 4,52
Metabolic age (y)	58,7 ± 10,57	58,9 ± 10,16
Height (m)	1,71 ± 0,06	1,69 ± 0,07
Weight (kg)	94 ± 30,54	94 ± 6,22
Muscle weight (kg)	47,6 ± 4,09	42,1±6,04
% of fat	43,1 ± 5,04	43 ± 5,93
% of water	41,3 ± 4,95	41 ± 5,37
Waist girth (cm)	90,1 ± 7,49	91,7 ± 7,59
Hip girth (cm)	108,4 ± 6,62	108,7 ± 6,91
BMI (kg/m <sup>2</sup> )	27,5 ± 1,33	27,68 ± 1,24

Table 1. Monitoring of physical data of the study and control groups (initial control)

Groups of women Indicators	Study group (20 women)	Control group (20 women)
Age (y)	43,3 ± 5,74	42,3 ± 4,52
Metabolic age (y)	48,2 ± 10,11	55,6 ± 10,38
Height (m)	1,71 ± 0,06	1,69 ± 0,07
Weight (kg)	83,4 ± 7,75	90,2 ± 6,7
Muscle weight (kg)	50,4 ± 3,31	44,3 ±5,74
% of fat	33 ± 5,96	39,5 ±5,70
% of water	51,8 ± 4,34	42,6 ± 5,74
Waist girth (cm)	79,2 ± 8,23	88,8 ± 7,57
Hip girth (cm)	98,2±5,65	105,2 ± 6,18
BMI (kg/m²)	24,4 ± 1,89	26,7 ± 1,32

Table 2. Monitoring of physical data of the study and control groups (final control)

decreased significantly – from 1 to 15%, and the percentage of water increased from 6 to 16%. The body weight of women decreased to a maximum of 17 kg during the study period, and muscle mass increased from 1 to 4 kg.

We can see that the results of the study group are very positive, we want to note that with a decrease in body weight there was an increase in muscle mass and water percentage, so weight loss in the study group was due to loss of fat. The same studies were conducted with ten women in the control group six months after the initial monitoring of physical data. Table 2 of the control group of women of the second adult age shows that in six months according to the body mass index of six women with first degree obesity, only two participants achieved overweight, and the other four participants remained with first-degree obesity. Of the fourteen participants who were overweight at the beginning of the study, only four had normal indicators at the final control, and ten participants remained overweight. The percentage of fat in the control group decreased from 1 to 11%.

Changes in the percentage of water were very small, the percentage of water decreased from 1 to 4%. Women's body weight decreased to 10 kg during the study period. The results of the control group differ significantly from the study group. Of the 14 participants who were overweight, only 4 participants achieved the norm, and of the 10 participants with first-degree obesity, only four lost obesity and remained overweight. In addition, the indicators show that even some participants who recorded positive results, lost weight not due to loss of fat, but due to loss of water and muscle mass.

## DISCUSSION

During the therapeutic programme, we performed monthly control measurements of body parameters and body weight in order to monitor their dynamics and compare it with that in the control group, which was engaged in the standard complex. At the beginning of the study, the results in both groups were quite positive, after some time the rate of weight loss began to slow down, and in the control group, among some participants it even worsened – the weight returned. 6 months after the initial control, a final control of both groups of women of second adulthood was performed. When comparing the data obtained before and after rehabilitation measures, we observed a significant decrease in body weight in individuals of the study group in contrast to the control, where there was a decrease in body weight, but it was statistically insignificant.

Analysis of the dynamics of monthly weight loss for the entire rehabilitation period showed that in the control group there was a decrease in body weight in the first and second months of the rehabilitation complex, relative to the main group, then the dynamics was marked by significant weight loss in the 1st, 2nd, 3rd month.

Obesity interferes with the aerobic functions of the body and the ability to make physical exercises [1, 11]. This fact was taken into account when selecting physical exercises and organizing classes for our patients. According to the results of our study, the selected set of aerobic and anaerobic strength exercises was chosen, diet therapy and constant psychological support are quite effective for use in the fight against women's overweight. This is confirmed by other studies [6], which show the positive effects of intervention in four components: physical activity, nutrition and healthy eating, social support and the connection between mind and body. It is also known that from 40% to 60% of the adult population in the Western world is actively trying to lose weight, with higher rates of overweight/obesity of women. Treatment of obesity regarding to behaviour or lifestyle are the most commonly used programmes and are recommended for almost all overweight/obese people who are trying to lose weight, regardless of their level of obesity. For people who have successfully lost weight, maintaining a new weight is often a problem for life [7]. Our programme of physical therapy for mature women with alimentary-constitutional type of obesity of the first degree allows to maintain their normal weight for much longer, as the rehabilitation programme is comprehensive.

Therapeutic physical exercises in combination with dietary restrictions have a positive effect on blood lipid composition and its effectiveness for obese women was proven [13]. We did not conduct a blood test for lipids content. But lowering the percentage of fat and increasing the percentage of water in the body also indirectly indicate this. Therefore, there is a positive therapeutic effect of therapeutic exercises in general on all body systems of women. There are studies that indicate a positive effect of quite available methods in the fight against overweight – nordic walking. In obese women, this method can increase the intensity of exercises and adhere to a training programme without increasing the perception of effort, which leads to increased aerobic capacity [8, 9]. Therefore, in the future we can supplement our set of therapeutic exercises with nordic walking.

## CONCLUSIONS

Based on the obtained results, we proved the high efficiency of the proposed therapeutic and rehabilitation complex (combination of diet therapy, exercises of aerobic and anaerobic directions) for the treatment of persons with I degree of obesity (significantly reduced body weight and reduced the size of body parts).

Rehabilitation measures used in our study activate metabolic processes, increase energy expenditure, reduce excess body weight, strengthen the body. By following a healthy lifestyle, eating rationally, you can prevent a number of diseases, improve efficiency and general well-being, avoid premature aging. Physical therapy of obese patients requires a combination of dietary and physiotherapeutic methods (massage, physiotherapy, psychological training), which allows to achieve sustainable weight loss for a long period.

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## **Conflict of interest:**

The Authors declare no conflict of interest

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## The Effect of Pilates Exercises on Anxiety and Job Stress of COVID-19 Nurses. A Quasi-experimental Study

Wpływ ćwiczeń pilates na stopień niepokoju i stresu u pielęgniarek związany z COVID-19. Badanie quasi-eksperymentalne

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#### SUMMARY

Aim: To determine the effect of Pilates exercises on nurses' job anxiety and stress during COVID-19 pandemic.

**Results:** The results of the present study showed that 63.3% of subjects had moderate to severe job stress and 30% had severe job stress. In the intervention group, the mean (standard deviation) of anxiety was 13 (8.35) before intervention, which reached 8.33 (5.87) after the intervention (p=0.062). Moreover, the mean (standard deviation) of job stress in the control group decreased from 188.67 (28.98) to 176.46 (28.84) (P=0.530).

**Conclusions:** The results showed that Pilates exercises alone do not affect the anxiety and job stress of nurses and other supplements are needed in stressful environments.

Key words: nurse, pilates, anxiety, job stress, COVID-19

Słowa kluczowe: pielęgniarka, pilates, lęk, stres w pracy, COVID-19

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## INTRODUCTION

Stress is one of the major current medical and social issues [1]. One of the most important sources of stress is job and job stress has become a common and costly issue in the workplace today [2]. COVID-19 pandemic has also worsened the conditions today for more nurses [3]. Nurses are the main element of care in the treatment team, and also the first group on the front line of fight against the COVID-19 pandemic. Nurses' work environment leads to long prolonged stresses [4]. National Institute for Occupational Safety and Health [NIOSH] has announced nursing as one the top 12 most stressful professions and is probably one of the most stressful occupations among health careers [5]. In addition, job stress has been shown to impose 300-400 million dollars on health care workers [6]. Anxiety is also a general and vague exciting feeling of anxiety that is accompanied by one or more physical symptoms [shortness of breath, palpitations, high blood pressure] and, if persistent, other psychological problems [7]. Nursing is one of the occupations and nurses are always confronted with various stressors in their workplace [8]. According to a study by Augermeier et al., nurses are one of the occupational groups that experience stress and psychological problems and depression, anxiety

and fatigue are common problems in this group [9]. Smith believes that nurses experience a lot of stress and anxiety in their workplace, which can affect their mood and make them depressed [10]. To help reduce stress and anxiety in nurses, researchers have suggested various methods, one of which is exercise. The exercise method that has been considered by exercise and rehabilitation specialists in recent years and is becoming widespread is Pilates [11, 12]. Pilates was first created by Joseph Pilates in 1880, and include a series of specialized exercises that engage the body and brain in a way that affects the body's strength, endurance, and flexibility. Unlike most other exercises that pay attention only to the physical dimension of the person, Pilates pays attention to both the mental and physical dimensions of the person and is based on body-mind coordination because body-mind balance promotes physical and physiological health of individuals [13]. Joseph Pilates showed that Pilates consists of six general principles: relaxation, concentration, accuracy, coordination, movement, and breathing [14]. This exercise is performed in static positions [lying, sitting, standing] and without travelling any distance, and jumping [15]. In a study entitled " the effect of Pilates on the general health and physical condition of women over 40 in the United States" Freerra showed that

Pilates can improve general health and physical conditions [16]. Other research has shown that Pilates reduces stress, anxiety, and fatigue, and improves mood, motivation, and progress [17, 18]. Considering the foregoing and the benefits of Pilates exercises, as well as various searches in databases showed that no studies have been done in the field of nurses' work. Studies also showed that these exercises were more effective on anxiety, but with regard to job stress, due to the high impact of this stress on nurses' work efficiency and, consequently, the quality of services and dissatisfaction in patients, Pilates exercises can play an important role in eliminating this stress and improving the quality of nursing services. Therefore, we decided to conduct a study entitled "Determining the effect of Pilate's exercises on job stress and anxiety of nurses working at COVID-19 ward.

## AIM

The aim of the present study was to determine the effect of Pilates exercises on nurses' job anxiety and stress during COVID-19 pandemic.

## MATERIALS AND METHODS

This is a quasi-experimental study [pre-test post-test] was conducted on 30 nurses working at a covid-19 ward at a teaching hospital of Zabol city at south of Iran from January 10, 2020 to 10 July 2020. The reason for choosing male nurses is the existence of the same sex instructor and researcher, as well as the lack of conditions and facilities for including female nurses in the study. The sample size was estimated 30 people (n=15 per group) using the sample size formula according to the difference between the means based on the study by Abdollahi and Firoozkoohi. Initially, 50 nurses were selected through purposive sampling [19]. From them, 30 eligible people were selected and 20 people were excluded from the study. The remaining 30 patients were randomly divided into control (n=15) and experimental (n=15) groups. Inclusion criteria included a minimum of 6 months and a maximum of 20 years of work experience, consent to participate in the study, no prohibition on exercise, having a healthy physical condition, an anxiety score above 20, being able to perform trained exercises, and male sex. Exclusion criteria included dissatisfaction with continuing to participate in research, transfer and discharge from hospital for any reason, use of anti-anxiety and depression medications, exposure to a stressful event (death, divorce, bankruptcy), inactivity in training sessions and movements during the ore-determined time. Before the intervention, sufficient explanations were given to the subjects regarding the research objectives and stages of the, and their informed consent was obtained. The subjects were also assured of the confidentiality of the information. Questionnaires were completed in self-reporting manner by nurses and the results were provided to the control group after completion of the study. One month before the start of the study, the researcher, along with a respected Pilates exercise expert, taught Pilates exercise techniques to each of the nurses due to the COVID-19 epidemic. The subjects then performed these exercises once to ensure that the movements were performed correctly.

First, the two groups completed the demographic characteristics questionnaire including questions on age, work experience, type of shift, ward, history of previous exercise, marriage, and then Beck's anxiety inventory and job stress questionnaire as a pre-test due to COVID-19 pandemic via e-mail, WhatsApp. Beck's anxiety inventory consisted of 21 items answered based on a 4-point Likert scale ranging from 0 to 3. The range of anxiety scores was 0 to 63. This questionnaire has achieved high internal stability and the range of its inter-item correlations was 0.30 to 0.71 (average= equal 0.60). The results also showed 1-week test-retest reliabilities of 0.87 (r=0.75). Results also revealed that its Persian version had acceptable validity (r = 0.72), reliability (r = 0.83), and internal stability (0.92) and there is 0.48 correlation between the results of this test with Beck's anxiety test [20].

Osipow' job stress questionnaire consists of 60 items, and is scored based on a 5-point Likert scale ranging from 1 (Never) to 5 (most of the time). The possible score range of this questionnaire is 60 and 300, with lower scores indicating lower stress. Osipow' job stress questionnaire was used by Osipow and Spokan in 1987 and its test-retest reliability was confirmed by Cronbach's alpha of 89%. This instrument has been used in many studies on job stress in Iran home and abroad. Its validity and reliability have been confirmed [21].

The first session in the experimental group was conducted in person by the relevant instructor and the general Pilates principles were taught. Then, a training CD in which Pilates exercises were taught was given to each individual in the experimental group and they were asked to do the same exercises daily for one month and ten minutes each session before doing their jobs. At the beginning of each session, the preliminaries of the training session including checking the physical condition (including the pelvis and spine), and breathing control were taught using the related CD. Then, stretching exercises, Pilates exercises, and cool-down exercises were performed. The number of movements started from 10 repetitions and gradually increased [22]. The instructor demonstrated the exercise in the first session and then repeated it verbally with the help of the researcher to ensure the accuracy of the learning. He then supervised the performance of the nurses and provided necessary instructions. All exercises were also taught to nurses in a slow and controlled manner in order to increase coordination and facilitate the learning process in the first session. Exercises started at a low level and gradually increased to upper levels until the subjects were able to tolerate the exercise. Subjects were told to do the exercises as long as they did not feel uncomfortable and to also have a 10-second break after each movement. If subjects lost control during the movements or could not perform the technique correctly, they were advised to go one step back to reach baseline, which helped the researcher to notice the individual differences of the subjects and prevent their frustration. Nurses were told to have simple carbohydrates such as chocolate or dates and raisins in case of hypoglycemia during exercise. They were also reminded that they must have a complete breakfast on the day of exercise and perform exercises after having breakfast before going to work. All the

above-mentioned trainings were included in CD for practice and repetition purposes and were given to the subjects. The samples were also checked once every few sessions so that there is no problem and the work process continues.

The control group nurses had their own working conditions and daily life. In order to motivate the subject during the study, they were recommended to perform simple exercises that causing no harm to them before starting their work. Considering COVID-19 pandemic conditions, the program was taught to them virtually via WhatsApp in order to motivate them to participate in the study [22]. Finally, after one month of training, all nurses in the experimental and control groups virtually recompleted BAI and job stress questionnaires as a post-test. Finally, the data were entered into SPSS ver. 22 and analyzed using descriptive statistics, paired t-test and ANCOVA.

## RESULTS

The results of the study showed that the mean age of the intervention and control groups was 30 (6) and 26 (6) years, respectively. Most of the intervention group (53.3%) and the control group (73.3%) were single and married, respectively. Moreover, all individuals of the control group (100%) and majority of the intervention group (66.7%) held a bachelor's degree or higher. Also, the majority of people in both control and intervention groups (73.3%) had rotating work shifts. Due to COVID-19 pandemic conditions, the level of job stress and anxiety was high in both groups. The results of the analysis showed that 63.3% of the subjects had moderate to severe job stress and 30% had severe job stress [Table 1].

Also, about anxiety the mean (standard deviation) of pre-intervention and post-intervention anxiety in the control and intervention groups was 14.20 (10.88), 15.40 (12.79) (P=0.737), and 13 (8.35), 8.33 (5.87) (P=0.062), respectively. Independent t-test did not show a statistically significant difference between the control and intervention groups in terms of the mean pre-anxiety and post-anxiety scores (P> 0.05) [Table 2].

Also, about job stress the mean (standard deviation) of pre-intervention and post-intervention stress in the control and intervention groups was 177.20 (24.52), 169.60 (30.34) (P=0.252), and 188.67 (28.98), 176.46 (28.84) (P=0.530), respectively. [Table 2] Independent t-test did not show a statistically significant difference between the control and intervention groups in terms of the mean pre- and post-anxiety scores (P>0.05).

## DISCUSSION

The results of the present study, which aimed to determine the effect of Pilates exercise on job anxiety and stress of hospital nurses, showed that since control and intervention nurses were working in hospital during COVID-19 pandemic, almost 90% of nurses had moderate to severe stress. In this regard, according to results of a study by Sarvabadi et al. 2020 on depression, stress, and anxiety of Torbat Heydariyeh nurses during COVID-19 pandemic, most of the research subjects had moderate anxiety levels [23]. Consent with the results of the current study, in a study on physicians and hospital nurses in Wuhan, China during COVID-19 pandemic, Lai et al. show that medical care workers experienced a high degree of depressive (50.4%) and anxiety symptoms (44.6%) [24]. Exposure to COVID-19 pandemic may be the cause of an increase in stress and anxiety of nurses.

The results of the present study also showed that the mean (standard deviation) of nurses' anxiety in the intervention reduced from 13 (8.35) before Pilates exercises to 8.33 (5.87) after the intervention (p=0.062). Although the results were statistically insignificance, which was probably related to the working conditions of the nurses during the COVID-19 pandemic, it decreased compared to the control group, therefore, it can be said that Pilates exercises cannot completely control the nurses' anxiety because they suffer from moderate to severe anxiety. Pilates reduces anxiety through increasing body energy, increasing sleep quality, eliminating negative thoughts, relaxing the body, reducing the respiratory rate,

Variable	Number	Percentage
Low stress	2	6.7
Moderate to severe stress	19	63.3
Severe stress	9	30
Total	30	100

Table 1. Distribution of stress frequency in research subjects

Table 2. Comparison of mean and standard deviation of anxiety and stress before and after the intervention in the control and intervention groups

Variable	Mean (standa	P-value		
	Con	i value		
Pre-intervention Anxiety	14.20(10.88)	13(8.35)	0.737	
Post-intervention Anxiety	15.40(12.79)	8.33(5.87)	0.062	
Pre-intervention job stress	177.20(24.52)	188.67(28.98)	0.252	
Post-intervention job stress	169.60(10.88)	176.46(28.84)	0.530	

increasing attention and concentration, improving blood circulation and ventilation, and blood supply to the brain, and muscle relaxation. If the anxiety level of is high, its effect will be less [17]. Consistent with the results of the current study, in their study on the effect of Pilates on the mood of non-athlete women, Lashgari et al. (2018) showed no significant difference in stress and anxiety levels in the Pilates and TRX intervention groups with the control group. They attributed it to the complexity of the relationship between physical activity and the mood components, i.e. stress and do not consider the intervention to be sufficient to affect stress [25]. Lipamaki believes that high levels of physical activity can have a positive effect on stress, anxiety, and depression [26] and these conditions did not exist in the current study and similar studies. In another study, McNeil et al. stated that exercise interventions only affected moderate mental disorders and could not control severe stress, anxiety, and depression [27]. Jago et al. also studied the effect of Pilates on the body composition of young girls. They showed that the four-week Pilates had no significant effect on psychological changes such as stress and anxiety of young girls [28].

In another study on the effect of Pilates on some psychological factors of inactive obese women, Kheirandish et al. showed that Pilates had a better effect on women with mild to moderate anxiety and stress than women with severe anxiety and stress [29]. Carter also believes that Pilates eliminates tension and anxiety in the daily life of ordinary people [30]. In a study on effect of Pilates on older men, Q also showed that Pilates did not affect their stress and anxiety, which is consistent with the results of the current study. Although the samples are not comparable here either, which is probably due to different physical conditions and the environmental impact [31]. However, the results of a study by Abavisani et al., which measured the effect of Pilates on the anxiety of emergency medical students, showed a significant decrease in anxiety after Pilates, which is inconsistent with the results of this study. This discrepancy is probably due to the fact that their study population included students who were not regarded as key personnel with direct responsibility for patients and do not experience severe anxiety, and Pilates has been able to reduce their anxiety [32].

The results of the present study also revealed Pilates had no significant effect on nurses' job stress. In this regard, Abedian et al. investigated the effect of exercise on midwives' job stress. The results of their study showed the least change in job stress, which may be attributed to the stressful midwifery job, which is consistent with the results of the present study [33]. Salmani-barouq et al. also concluded that coping techniques cannot reduce the level of job stress in stressful environments [34].

In a study of the effect of communication skills training on job stress of experts, Sultan-ali et al., showed that the job stress of the experimental group did not decrease significantly compared to the control group after the experimental intervention, which indicates that some risk factors are not dependent on the individual and cannot be influenced by performing intervention on the individual [35]. Because factors affecting employee stress, such as the COVID-19 pandemic situation, could not be controlled in the present study.

In a study on factors affecting midwifery-related stress and burnout, Ritavanen et al. found that midwives who never exercised felt more stressed about their daily work with clients as compared to midwives who had regular exercise per week [36]. The results also showed an insignificant increase in the stress level of the control group as compared to the intervention group, which is probably due to the effect of Pilates. Roberts also states that while performing interventions on employees in an organization, the organizational climate as the first and most important factor affects the results of the study [37]. In their study of effect of Pilates on inactive older women, Mokhtari et al. showed that Pilates reduced anxiety and stress only by 20%, which is considered to be due to environmental conditions [38].

## CONCLUSIONS

The findings of the present study showed that Pilates cannot reduce anxiety and job stress among nurses. So it needed to some alternative methods to decrease the anxiety and stress among nursed. Also more studies need to determine better effect of Pilates exercise on psychological aspects of patients.

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The Authors declare no conflict of interest

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# Strengthening the Physical and Mental Health of Students During Swimming Classes

## Wzmocnienie zdrowia fizycznego i psychicznego studentów podczas zajęć z pływania

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#### SUMMARY

**Aim:** The aim is to investigate the impact of swimming training sessions on the dynamics of somatic and mental health indicators of students of special medical groups.

**Materials and Methods:** The research involved 50 1st and 2nd year female students who had diseases of various etiology and were assigned to a special medical group. The students' somatic health was examined according to the indicators of weight, lungs vital capacity, wrist dynamometry, heart rate, arterial blood pressure, Stange test and Genchi test. The mental health was assessed by method of "Well-being, activity and mood". **Results:** The experiments conducted within the EG revealed an improvement in all studied indicators of both somatic and mental health. At

the end of the research, the vital index, the Robinson index, the Stange and Genchi tests, the level of somatic health, well-being, and mood in the EG were significantly better than in the CG.

**Conclusions:** Regular swimming training sessions help to improve the health of female students of special medical groups in general, strengthen their musculoskeletal, cardiovascular and respiratory systems as well as increase metabolism. In addition, swimming has a positive effect on the nervous system, relieves stress and improves the well-being of female students, increases their activity and mood.

Key words: somatic and mental health, students, swimming

Słowa kluczowe: zdrowie somatyczne i psychiczne, studenci, pływanie

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#### INTRODUCTION

The research results of many scientists [1, 2] shows that the health of student youth is deteriorating. The efforts of many scientists are aimed at solving this problem by improving the system of physical education in higher educational institutions (HEI), the introduction of modern technologies to strengthen students' health, improve their physical fitness, motivation to exercise and play sports [3-5]. Physical education in HEI, as a part of the general educational system, provides the basis and development of somatic and moral health of students, a comprehensive approach to the formation of mental and physical qualities of the individual, improving their physical and psychological preparedness for active life, priority of health-improving activities, optimization of the learning

process with extensive use of various measures and forms of physical improvement and continuity of this process [6-8].

Swimming is one of the main health-preserving measures of physical education for students. According to scientists [9-11], swimming is one of the effective health measures for drug-free rehabilitation and an important preventive measure to avert accidents on the water. In addition, swimming significantly increases the physical, mental and intellectual development of the individual and raises his/her social status, adapting to life [12, 13]. Swimming is especially important in improving the health of students of special medical groups while studying at HEI. Acquiring the vital ability to swim for students of special medical groups is a priority, because the health function of swimming is that the physical properties of the aquatic environment are very different from the properties of the air environment, familiar to humans [14, 15]. The health role of swimming in comparison with other types of physical activity lies in the various effects of water on the human body, which is associated with the physical, thermal, chemical and mechanical properties of the aquatic environment [16]. It is important that in case of many diseases, adequately dosed physical activity in the water slows down the course of pathological processes, which contributes to faster recovery of body functions. Physiological processes are activated, the body structure is improved, the activity of all organs and systems is enhanced, efficiency is increased and health is strengthened under the influence of physical activity in the water [17]. A large number of scientific papers have been devoted to the impact of swimming on the body of people of different ages, and in most cases swimming is used to remedy and heal people only within the system of medical and preventive facilities as well as organized recreation areas [12, 15, 18]. However, the research of the effect of swimming on improving the health of students of special medical groups in HEI has remained without sufficient attention of scientists.

#### AIM

The aim is to investigate the impact of swimming training sessions on the dynamics of somatic and mental health indicators of students of special medical groups.

#### MATERIALS AND METHODS

The research was conducted in 2018-2021 at the educational and sports base of the National Pedagogical Dragomanov University (Kyiv, Ukraine). The research involved 50 1<sup>st</sup> and 2<sup>nd</sup> year female students aged from 17 to 21 and studying at various faculties (foreign philology, physical and mathematical education and computer science, natural and geographical education and ecology, correctional pedagogy and psychology), who had diseases of various etiology and were assigned to a special medical group. The study of medical records and complaints about the health of students based on the results of their examination by specialists of the clinic revealed the most common deviations in the health of students of special medical groups: posture disorders (mostly stooping, asymmetrical posture) – 38%; frequent acute respiratory diseases (complications in the form of bronchitis, pneumonia, etc.) – 29%; overweight – 12%; cardiovascular diseases – 16%; other diseases (various in their nosology) – 5%.

Two groups were formed: experimental (EG, n=25) and control (CG, n=25) groups. The EG students were engaged in swimming according to the author's method of load differentiation, the CG followed a modern type of fitness technology known as "cheerleading". The formation of the EG and the CG took place through questionnaires in order to study students' interests and desires at the beginning of their higher education (1st semester). All EG students were able to swim. The level of somatic and mental health in female students of the EG and the CG at the beginning of the experiment was significantly the same (p>0.05). The total number of hours of physical education training sessions per week and their duration (75 minutes) in the EG and the CG was identical. Training sessions in groups were held twice a week (one was conducted according to the schedule before noon and the second training sessions was held in the afternoon at a convenient time for students). The duration of the experiment is 2 years.

The basis of the author's method for conducting swimming training sessions with the EG female students made the principle of differentiation, which provided a certain focus of measures and methods of teaching swimming to students, due to the nature and severity of their disease. The methodical recommendation of the author's method of conducting swimming training sessions in the EG consisted in the involvement of a number of cyclic exercises. Evenly distributing the load when exercising in the water helps to involve all major muscle groups. In the water, the movements were performed smoothly, with large amplitude, without pressure of body weight on the musculoskeletal system, which reduces static muscle tension and eliminates the risk of traumatism, as well as improves respiratory and cardiovascular systems, including psychoemotional state.

The female students' somatic health level (SHL) was examined according to the indicators of weight, lungs vital

Indicators	Female students' somatic health levels									
	Low	Below average	Average	Above average	High					
Body mass index, kg/m <sup>2</sup>	16,9 i <	17,0-18,0	18,1-23,8	23,9-26,0	26,1 i >					
Points	-2	-1	0							
Vital index, ml/kg	40 i <	41-45	46-50	51-55	56 i >					
Points	-1	0	1	2	3					
Strength index, %	40 i <	41-50	51-55	56-60	61 i >					
Points	-1	0	1	2	3					
Robinson index, c.u.	111i>	95-110	85-94	70-84	69 i <					
Points	-2	-1	0	3	5					
HRR time, s	180 i >	120-180	90-120	60-90	59 i <					
Points	-2	1	3	5	7					
SHL, points	3i<	4-6	7-11	12-15	16-18					

Table 1. The evaluation of female students' somatic health level (in points) [19]

capacity, wrist dynamometry, heart rate, arterial blood pressure, Stange test (ST, respiratory arrest during inspiration), Genchi test (GT, respiratory arrest during exhalation). The health level was evaluated in points and it included the estimation of the body mass index (BMI, the ratio of body weight to body length), vital index (VI, he ratio of lung capacity to body weight), strength index (SI, the ratio of the wrist dynamometry to body weight), Robinson index (RI, a product of heart rate and systolic blood pressure) and heart rate recovery (HRR) time after a standard exercise (20 squats in 30 sec) [Table 1] [19].

The mental health of the female students was assessed by method of "WAM" (well-being, activity and mood). The method of "WAM" consists of 30 pairs of words that describe general conditions, the degree of emotional and physical activity and mood of a person. With the help of this method, it is possible to assess the student' mental state; identification of a psycho-emotional reaction to a mental load; determination of biological rhythms inherent in physiological and mental functions.

The methods of investigation: theoretical analysis of scientific and methodological literature (21 sources on the topic of the article from the databases PubMed, Scopus, Web of Science Core Collection and others were analyzed), pedagogical observation, medical examinations, psychological testing, experiment, methods of mathematical statistics. During the researches the authenticity of difference between the indicators of students of EG and CG by means of Student's t-test was determined. The significance for all statistical tests was set at p<0.05. All statistical analyses were performed with the SPSS software, version 22, adapted to medical and biological researches. This study followed the regulations of the World Medical Association Declaration of Helsinki – ethical principles for medical research involving human subjects. Informed consent was received from all individuals who took part in this research.

#### RESULTS

The analysis of BMI in EG and CG female students shows that the indicators of the groups did not differ significantly both at the beginning and at the end of the research (p>0.05). It was also found that there was a slight improvement of BMI during the research period in both groups, due to stabilization and weight loss (p>0.05). This indicates the effectiveness of both swimming and cheerleading, on the female body in the process of studying at HEI [Table 2]. The indicators of BMI at the beginning and end of the research, meet the age standards of female students.

Analyzing the VI, we found out that during the experiment there was a significant improvement of VI in both groups: in EG – for 8 ml/kg (p<0.001), and in CG – for 3.9 ml/kg (p<0.05). At the end of the experiment in EG the significantly

Table 2. The analysis of the indicators of somatic health of EG (n=25) and CG (n=25) female students during research period (Mean±SD)

,			5 1			
Studied indicators	Research stages	EG	CG	<b>p</b> <sub>2</sub>		
	Beginning	20.7±0.22	20.6±0.23	p>0.05		
Body mass index, kg/m <sup>2</sup>	End	20.2±0.20	20.4±0.21	p>0.05		
	p <sub>1</sub>	p>0.05	p>0.05			
	Beginning	49.1±1.25	48.8±1.27	p>0.05		
Vital index, ml/kg	End	57.1±1.28	52.7±1.29	p<0.05		
	p <sub>1</sub>	p<0.001	p<0.05			
	Beginning	27.4±1.05	29.1±1.02	p>0.05		
Stange test, s	End	44.7±1.24	39.3±1.18	p<0.01		
	p <sub>1</sub>	p<0.001	p<0.001			
	Beginning	15.1±0.37	14.9±0.36	p>0.05		
Genchi test, s	End	23.2±0.39	19.3±0.38	p<0.001		
	p,	p<0.001	p<0.001			
	Beginning	41.3±1.09	41.5±1.12	p>0.05		
Strength index, %	End	46.4±1.11	45.7±1.15	p>0.05		
	p <sub>1</sub>	p<0.01	p<0.05			
	Beginning	87.1±1.28	86.8±1.25	p>0.05		
Robinson index, c.u.	End	80.7±1.23	84.2±1.22	p<0.05		
	р <sub>1</sub>	p<0.01	p>0.05			
	Beginning	141.5±3.06	142.4±3.11	p>0.05		
HRR time, s	End	119.2±2.97	123.7±3.02	p>0.05		
	p <sub>1</sub>	p<0.001	p<0.001			
	Beginning	2.36±0.53	2.45±0.56	p>0.05		
Somatic health level, points	End	8.19±0.55	6.07±0.58	p<0.05		
	n	n<0.001	n<0.001			

 $Mean - arithmetical average, SD - standard deviation, p_1 - the significance of the difference between the studied indicators within groups at the beginning and the end of research, p_2 - the significance of the difference between EG and CG$ 

Studied indicators	<b>Research stages</b>	EG	CG	p <sub>2</sub>
	Beginning	4.3±0.19	4.4±0.20	p>0.05
Well-being, points	End	6.4±0.17	5.9±0.18	p<0.05
	p <sub>1</sub>	p<0.001	p<0.001	
	Beginning	4.7±0.21	4.8±0.23	p>0.05
Activity, points	End	5.6±0.22	5.7±0.23	p>0.05
	p <sub>1</sub>	p<0.01	p<0.05	
	Beginning	4.8±0.18	5.1±0.19	p>0.05
Mood, points	End	7.2±0.19	6.4±0.20	p<0.05
	р_	p<0.001	p<0.001	

Table 3. The analysis of the indicators of mental health of EG (n=25) and CG (n=25) female students during research period (Mean±SD)

Mean – arithmetical average, SD – standard deviation,  $p_1$  – the significance of the difference between the studied indicators within groups at the beginning and the end of research,  $p_2$  – the significance of the difference between EG and CG

better level of VI than in CG was found for 4.4 ml/kg (p<0.05). The indicators of the respiratory system of female students in both groups at the beginning of the experiment corresponded to the average level, and at the end in the EG – high, in the CG – higher than average. Evaluation of breath-holding indicators showed that the EG and the CG values did not differ significantly at the beginning of the experiment in both the Stange test and the Genchi test (p>0.05), and the EG values were significantly better at the end of the experiment than in the CG for 5.4 s and 3.9 s respectively (p<0.05). This emphasizes the positive impact of swimming training sessions on the functional state of the respiratory system of female students.

The strength indicators of female students, which were evaluated with the help of SI, significantly improved during the experiment in both groups: in EG – for 5.1 % (p<0.01), in CG – for 4.2 % (p<0.05). At the same time, SI in the EG and the CG students did not differ significantly both at the beginning and at the end of the research (p>0.05). The strength capabilities of the EG and the CG students corresponded to a lower than average level for the entire period of the experiment.

The comparison of the indicators of RI in EG and CG showed that they did not differ at the beginning of the experiment (p>0.05), and the EG revealed a significantly better level of functioning of the cardiovascular system at the end of the experiment than in the CG for 3.5 c.u. (p<0.05). The indicators of RI were improved in both groups during the experiment, with a significant improvement in the EG (for 6.4 c.u.; p<0.01), and insignificant in the CG (for 2.6 c.u.; p>0.05). This confirms the positive effect of swimming training sessions on the functionality of the cardiovascular system of female students. HRR time significantly improved during the experiment in both groups (p<0.001), but the indicators of EG and CG did not differ significantly at the beginning and the end of the research (p>0.05).

The level of somatic health of the EG and the CG female students at the beginning of the experiment corresponded to a low level and did not differ significantly (p>0.05). Health significantly improved in both groups during the experiment (p<0.001) and corresponded to the average level at the end of the research in the EG, and below average – in the CG. Herewith, the difference between the EG and the CG at the end of the research was significant and made 2.12 points (p<0.05).

The analysis of the indicators of female students' mental health showed that all three characteristics did not differ significantly between the EG and the CG at the beginning of the experiment (p>0.05). All mental health indicators significantly improved (p<0.05-0.001) in both groups during the research, but the EG indicators of well-being and mood turned out to be significantly better in comparison with the CG ones at the end of the experiment for 0.5 points and 0.8 points respectively (p<0.05) [Table 3]. This confirmed the more pronounced positive effect of swimming training sessions on the indicators of mental health of students of special medical groups.

#### DISCUSSION

The issue of health preservation and strengthening the physical potential of student youth is one of the main problems of today's developed European countries [4, 7, 20]. The essence of the problem is that more than 20% of the population of Ukraine is young students. From one year to the next there is a tendency towards increase in the number of students who make a part of special medical groups as a consequence of their health status (according to various scientists - from 30 to 40%), whose physical activity in groups of students of the main groups is contraindicated [14]. Therefore, swimming may be one of the main measures of rehabilitation and health improvement of students of special medical groups. According to research [18], it is swimming that is a unique means of correction and training of the cardiovascular and respiratory systems of the human body. Swimming measures also include a variety of content- and focus-related physical exercises performed in the water for the prevention and correction of health disorders, as well as treatment of diseases of various etiologies [14, 21].

The fact of increased heat transfer in the water is used to reduce body weight. Performing swimming movements in the water results in increased metabolism in the body. The uplifting power of water creates favourable conditions for performing various exercises by overweight people. At the same time, performing such exercises in the gym caused them some difficulties [15].

Scientists [21] recommend the use of swimming in orthopedics and traumatology for the rehabilitation of patients with pathology of the musculoskeletal system (correction of posture disorders), diseases of the respiratory, cardiovascular, endocrine systems and more. Features of circulatory dynamics facilitate blood circulation during intense muscular work in the process of swimming or performing movements and exercises in the water, which helps to strengthen the heart muscle, blood vessels become more elastic, blood pressure decreases [20]. Swimming stimulates the activity of hematopoietic organs, increases the number of leukocytes in the blood and reduces congestion in the internal organs. The functions of subcutaneous vessels improve under the influence of low water temperatures. Therefore, tempering by means of the aquatic environment plays a significant role in health improvement of the human body [16, 17].

Intense muscular work requires increased breathing in the process of swimming. The mechanism of positive effect of exercises in the water on the respiratory system lies in the active training of the respiratory muscles, increased chest mobility and enhanced pulmonary ventilation of gas exchange. Performing "breathing exercises" increases the volume of breath, enhances the vital capacity of the lungs and escalates blood oxygen consumption. Performing movements in the water requires deep breathing involving the most remote parts of the lungs, which prevents stagnation in them [11, 18].

According to the research [15], hydrostatic water pressure as a "universal acupuncturist" affects acupuncture points that are connected to internal organs and nerve nodes and stimulates their functioning. This effect increases metabolism and facilitates blood circulation strengthening the nervous system. Unloading of the musculoskeletal system is facilitated even by being in the aquatic environment, when a person experiences a state of hydrostatic weightlessness. This frees the musculoskeletal system from the pressure of body weight, creates conditions for the correction of posture disorders, the restoration of certain motor functions and the consequences of traumas received in everyday life [10, 13]. The results of our research confirm the findings of many scientists in this field and significantly expand them on the use of swimming to strengthen somatic and mental health of students of special medical groups in the process of studying at HEI.

#### CONCLUSIONS

1. The experiments conducted within the EG revealed an improvement in all studied indicators of both somatic and mental health. At the end of the research, the vital index (for 4.4 ml/kg), the Robinson index (for 3.5 c.u.), the Stange test (for 5.4 s), Genchi test (for 3.9 s), the level of somatic health (for 2.12 points), well-being (for 0.5 points), and mood (for 0.8 points) in the EG were significantly (p<0.05-0.001) better than in the CG.

- 2. It was found that regular swimming training sessions help to improve the health of female students of special medical groups in general, strengthen their musculoskeletal, cardiovascular and respiratory systems as well as increase metabolism. In addition, swimming has a positive effect on the nervous system, relieves stress and improves the well-being of female students, increases their activity and mood. An important feature of planning swimming training sessions in special medical groups is to take into account the nature of the disease of students, the coordination of loads with the level of their physical fitness.
- 3. Prospects for further research are to study the impact of swimming training sessions on the mental performance indicators of female students.

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### The Analysis of the Influence of Nutrition and Physical Activity on the Morphological and Functional Parameters of the Children's Spine During Adolescence

Ocena wpływu odżywienia i aktywności fizycznej na parametry morfologiczno-czynnościowe kręgosłupa u dzieci w wieku dojrzewania

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#### SUMMARY

**Aim:** Assessment of the impact of nutritional status and physical activity on body posture, including selected morphological and functional parameters of the spine, during children's adolescence. Analysis of selected aspects of everyday life that may affect disorders of the spine. Assessment of children's awareness of proper nutrition and the health-promoting role of physical activity.

**Material and Methods:** The study involved 41 children aged 10-13 years. A self-authored survey was used. A questionnaire of a modified method of scoring the assessment of body posture according to Kasperczyk was also used. Selected tests were performed, including: chin-sternum test, Otto's test, Tomayer's test, as well as measurement with skinfold calipers and a tape measure.

**Results:** The average daily time of performing activities by the studied children in sitting positions was more than 2 times longer than spent on various forms of physical activies. Waist Hip Ratio studies have indicated gynoid body proportions among boys and normal in girls. The calculated Body Mass Index shows that 10 girls (24%) and 6 boys (15%) had a deviation from the norm. Postural disorders were indicated in 100% of the subjects, including spinal mobility disorders in 24 people (59%). The majority of people (90%) undertook physical activity while showing insufficient knowledge of nutrition norms.

**Conclusions:** The greater the body weight, the lower the mobility within the spine. No associations were observed between the type, length and frequency of physical activity undertaken, as well as the amount of time spent in sitting positions and disorders of mobility within the spine. Despite the large amount of time in sitting positions, children often and willingly undertake physical activity. The respondents have a satisfactory knowledge of pro-health behaviors, however, they present an unsatisfactory state of knowledge in the field of awareness about correctness, norms and the way of proper nutrition.

Key words: physical activity, body weight, body posture, spine, adolescence

Słowa kluczowe: aktywność fizyczna, masa ciała, postawa ciała, kręgosłup, wiek dojrzewania

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#### INTRODUCTION

With the progress of technology, knowledge about the functioning of the human body, its structure and phenomena occurring in it, increases. However, broadly understood development is not only positive – nowadays people spend a lot of time in a sitting position, and various forms of recreation are displaced by digital media. The progress of technology is not selective and its impact can be seen not only in adults, but also in children.

Increasingly, postural defects in preschool and early school children are observed health problems [1, 2]. The

current education system is constructed in such a way that a child whose curvature of the spine is still forming is forced to take frequent sitting positions, and thus maintain and work in bending positions. Not only countless hours sitting in schools add up to the sum of the amount of time in sedentary positions. After school, the student spends the additional amount of time sitting while using a computer or watching TV [1].

Excessive body weight is also observed among children, which can be a factor that disturbs, among others, the proper development of body structure. There are many factors responsible for this trend – from the simple availability of low-nutritional products, through the strong advertising lobby of sellers, to neglect on the part of parents, which is also associated with an increasing pace of life [1, 3].

All these factors, added together with too heavy backpacks that children carry to school, the progress of technology giving the opportunity to work, study and play without the need to engage in physical activity, and therefore the long time spent in front of the TV and computer screens, do not present an optimistic picture of the health of the future society [3].

Interest in the subject of this work resulted from the desire to learn about the factors causing the occurrence of postural defects in children. Also the impact of reduced amount of physical activity and the tendency of population's excessive body weight on the morphological and functional parameters of the spine of children in the second critical stage of human posture development.

#### AIM

Assessment of the impact of nutritional status and physical activity on body posture, including selected morphological and functional parameters of the spines of children during adolescence.

Analysis of selected aspects of everyday life that may affect spinal defects.

Assessment of children's awareness of proper nutrition and the health-promoting role of physical activity.

#### MATERIAL AND METHODS

The study included 41 children aged 10 to 13 years, the average age of 12 years. The analyzed group consisted of 21 girls (51%) and 20 boys (49%). The study was conducted at Primary School No. 30 in Łódź. Due to the non-invasive nature of the study, it did not require the consent of the Bioethics Committee of the Medical University of Łódź.

The study used a self-authored survey that included 29 questions. It consisted of 3 parts: I – it contained record data (age, gender, body weight, body height), II – referred to knowledge and nutritional status, III – referred to the amount and type of physical activity undertaken.

A questionnaire of a modified method of scoring the assessment of body posture according to Kasperczyk was also

used. The assessment of body posture, in accordance with the guidelines of the questionnaire, was made visually.

Functional tests were also used: the chin-sternum test, which studied the range of motion of the forward bend within the cervical spine; Otto's test to assess mobility within the thoracic spine; Tomayer's test assessing the global mobility of the posterior band of the body.

Two measurement tests were also carried out. The first was a tape measurement to calculate the Waist Hip Ratio to determine the nutritional status of the subjects. Then, in order to determine the percentage of body fat in the children's body, the skin-fat fold was examined using skinfold calipers.

For the purposes of statistics, as well as to complete the picture of the nutritional status of the subjects, the values of the Body Mass Index were calculated.

Statistical analysis and elaboration of results was carried out using Microsoft Excel 2021, as well as based on Pearson's correlation coefficient  $(r_{x,y})$ , which determines the level of linear dependence between random variables.

#### RESULTS

The compilation of the collected results using the Pearson's correlation coefficient  $(r_{x,y})$  indicated the degree of dependence between the BMI and the result of the fold meter test to the results of the tests carried out, which is illustrated by Table1.

For the group of girls, a low degree of positive relationship between BMI and the average age of the subjects and the average Results of the Tomayer's test were obtained. A moderate negative relationship was noted between the BMI and the Otto's test for forward and backward bends. A low, negative degree of relationship occurred between the skinfold calipers test and the backward bend test in the Otto test and a moderate, positive degree for correlation with the Tomayer's test. Statistically significant (p<0,05) in girl's correlations are data: BMI with Otto's test for forward and backward bends, skinfold calipers and Tomayer's.

The values for boys of the Pearson correlation coefficient  $(r_{x,y})$  of the BMI index for the skinfold calipers test assumed the following values for the tests performed [Table 1]. The degree of correlation of BMI to the age of the subjects and to the forward bend in the Otto's test indicated a positive, moderate degree of dependence. In the comparison of the correlation of the results of the skinfold calipers measurements

**Table. 1.** Correlation between nutrition status and spine function and morphology in the test group

		· ·		57 5				
	Studies included		Otta	′s test	Chin-sternum		Questionnare of Kasperczyk	
Gender		Age of respondents	Bend forward	Bend backward	test	Tomayer's test		
Girls	Body Mass Index	0,248	-0,471	-0,434	0,195	0,286	0,06	
	Measurement with skinfold calipers	-0,021	0,141	-0,362	0,127	0,507	-0,085	
Boys	Body Mass Index	0,484	0,571	-0,014	0	-0,107	0,151	
	Measurement with skinfold calipers	0,239	0,313	0,484	0	0,186	0,533	

with the age of the subjects and the forward bend, in the Otto test a low, positive correlation with the backwards bend was observed. In Otto's test, there was a moderate, positive relationship to the questionnaire of the modified method of scoring body posture assessment according to Kasperczyk. For boys, statistically significant (p<0,05), were following data. There was also a relationship between the BMI index with the age of the subjects, the Otto's test for forward bending, but also between the results of the skinfold calipers measurements and: the age of the respondents, the Otto's test backwards, the modified protocol of body posture scoring according to Kasperczyk [Table 1].

Analysis of the sum of hours of sitting in sedentary positions per week and the weekly frequency of physical activity to the survey data and tests performed among girls and boys showed the following results of the correlation coefficient  $(r_{xy})$  – in girls, the result of the correlation of the sum of hours spent sitting in a week to the sum of hours per week spent actively outdoors was recorded as a moderate degree of dependence. After comparing the amount of physical activity undertaken weekly with the age of the subjects, a low, positive relationship was also observed. Statistically significant in girls (p<0,05) for these comparisons were sitting hours summed with hours spent doing physical activities outside. For the same values in boys, the correlation coefficient  $(r_{x,y})$  indicated a low, positive relationship between the amount of physical activity undertaken per week and the age of the subjects. Also, such a relationship was noted between the sum of hours spent sitting and bending backwards in the Otto's test. This test correlated negatively with the frequency of physical activity undertaken during the week. The significant degree of dependence was indicated only by the comparison of the number of activities undertaken to the sum of hours of outdoor activity. For boys, statistically significant (p<0.05) was a correlation between an amount of weekly physical activity and hours spent actively outside, as shown in Table 2.

The vast majority of respondents attended physical education classes – 40 (98%). The average assessment of physical activities (on a 5-point scale) indicated by the respondents was 4.1 points,

also when classifying "physical activity as a favorite form of spending time" the average value obtained was the same.

Of the children surveyed, 24 people (59%) took part in sports competitions, including 50% of girls and boys, 26 (63%) of them trained non-amateur sports – 50% of girls and boys [Figure 1].

The research shows that the average daily number of hours spent by the studied children in the fresh air was 2 hours 24 minutes. In addition to the educational institution, additional physical activity was undertaken by the majority, that is, 37 people (90%). Performing such activities declared: daily 14 people (34%), 3 times a week 2 (5%), 6 people (15%) 2 times a week, and 8 (20%) once a week, less often 4 respondents (10%), did not take up the activity of 4 children (10%), which is presented in Figure 2.

The average number of hours a day spent sitting was 3 hours 49 minutes. The respondents declared that on average it took them 1 hour 24 minutes to do their homework. In their free time, they spent an average of about 2 hours 24 minutes a day in front of the TV or computer. After adding up the duration of sedentary activities per week, an average of 6 hours 7 minutes a day was obtained, the whole is illustrated in Table 3.

28 people (68%) did not know what a BMI is. Surveys show that 10-13 year old children did not pay attention to the calorific value of the meals consumed, only 8 of the respondents (20%) showed interest in this topic [Figure 3].



Figure 1. Participation of respondents in sport competitions and physical activity

		4.00	The sum of hours	Questionnare	Chin stormum	Otta	- Tomovor's	
Gender	Studies included	of respondents	from home and school	of Kasperczyk	test	Bend forward	Bend forward	test
Girls	The sum of hours spent sitting during the week	0,165	0,639	0,199	0,176	-0,06	-0,15	-0,032
Cint	Weekly frequency of phisical activity	-0,308	-0,045	-0,043	0,088	-0,169	-0,184	-0,163
Boys	The sum of hours spent sitting during the week	-0,166	-0,022	0,041	0	0,067	0,321	0,056
	Weekly frequency of phisical activity	0,278	0,753	0,115	0	0,136	-0,401	-0,017

Table. 2. Correlation between physical activity, sedentary lifestyle and morphology/activity parameters of the spine in the test group

Quantity of hours	Average number of hours per week sitting at school desks	Number of hours a day for homework	Number of hours a day in front of digital screens	Weekly amount of homework time	Weekly amount of hours in front of digital screens	Weekly amount of hours spent sitting	Average number of hours a day spent on sedentary activities
Average	19'06"	1'24'	2′24	6'48″	16'54"	42'48"	6'06″
Standard deviation	1′54″	0'42″	1′06″	3′18″	7′42″	8′30″	1′12″
Coefficient of variation	10%	49%	46%	49%	46%	20%	20%

Table. 3. Weekly tally of hours spent in a sitting position by the test group



Figure 2. Frequency of a weekly physical activity in the test group



Figure 3. Awareness of BMI and calorie intake in the test group

The average arithmetic amount of fluids drunk per day (in glasses of about 150 ml) in the study group was declared at about 8 glasses. The most common foods appearing in the daily diet were: flour products, dairy products, meat, fruits and vegetables, sweets.

#### DISCUSSION

Due to the growing digitization, more and more activities can be done using the Internet, thus reducing the amount of physical activity undertaken. The pace of life and habits that the world of that time exerts on adults are not without impact on children, who are also forced to transform physical activities into more sedentary ones. The process of human growth has not changed and still has critical points – a higher risk of malformations – called critical moments for posture development An increase in the occurrence of risk factors and the converging puberty period in the second critical stage of posture development may lead to an increase in the appearance of postural defects in the spine and difficulties in their subsequent correction [1, 4].

This study involved 41 peripubertal children (10-13 years), 21 girls and 20 boys. The largest group of respondents were 12-year-olds (29%), in which the female sex predominated.

In the work of Waszyńska et al. [5]. The number of 12-yearolds also dominated the study group. This may indicate that this is the moment when the environment notices the effects of the pubertal jump, including the negative ones, associated with the formation of postural defects.

The analysis of own research, based on the modified protocol for posture assessment according to Kasperczyk, shows that 100% of the examined children developed a disorder of normal body posture.

In the study conducted by Maciałczyk-Paprocka [6], according to the Dega table, a high percentage (71.4%) of abnormalities in body posture was also found.

Research by Janiszewska et al. [7] also indicated the occurrence of postural abnormalities in the entire study group, and 93.2% classified as postural defects. This may illustrate the scale of the problem of this type of disorder and how important the study of children during critical periods of posture development is.

In this study, the frequency of normal body weight, overweight and obesity, and underweight (in reference to BMI) among the subjects showed that 60% of them were within the weight norm. About 17% of the children had excessive body weight, and 22% reached the weight range classified as underweight. Thus, 39% of the respondents had abnormalities in body weight.

Similar results were obtained by Maciałczyk-Paprocka [6], who showed that abnormal weight occurred in 49.1% of the children studied. Accordingly, 26.4% of the respondents had excessive body weight, while 22.7% of the respondents had too low weight.

It can be concluded that the scale of this issue is important and is not only a local problem, but takes on a more global character.

When dealing with eating disorders, it is important to introduce a balanced diet and adequate physical activity. These processes can be supported with the help of physiotherapy, including balneotherapy. A good solution for children may be spa treatment stays [8, 9].

Own research has indicated the selectivity of knowledge, and its general condition unsatisfactory, in terms of nutritional standards. A low level of engagement was also shown, as well as little control over the menu among the respondents, as well as a lack of control over the amount of calories consumed.

Similar conclusions were obtained in Kałużyński's work [10], in which the state of knowledge of the subjects was also not at a satisfactory level. This may indicate that the impact of education on topics related to health-promoting behaviors and prevention of eating disorders in children is still too small.

In this study, it was shown that increased body weight correlates with abnormalities in the mobility of the spine in children. A significant part of the respondents had limitations of flexion mobility, which may indicate hypomobility in this respect. The reason for this may be the deepening of lumbar lordosis as a result of being overweight.

This phenomenon is also described by Jankowska-Szymańska et al. [11], who have shown that increased body weight affects the deepening of lumbar lordosis.

This paper also points to the relationship between elevated BMI and spinal extension disorders in the Otto test.

Similar results regarding mobility disorders were obtained by Molina-Garcia et al. [12], examining children (6-13 years) who are overweight and obese. They saw a statistically significant, strong association between excessive body weight and poorer functional quality of movement. The research was carried out using the Functional Movement Screen test.

The same method was also carried out by García-Pinillos et al. [13]. They also obtained a negatively correlated BMI result with the Functional Movement Screen method (p<0,001). This may indicate that the nutritional status even with proper physical activity is a binding factor determining the morphologies and functions of the spine.

Own research shows that there was a correlation between the increase in the sum of measurements of the fold meter indications and the increase in the limitation of the mobility of the bend in the Tomayer test in girls. A positive relationship was also shown between the indications of the skinfold calipers measurements and the result of a modified posture scoring protocol according to Kasperczyk in boys – the larger the indications, the more and higher the abnormalities in body posture in children were evaluated. A positive correlation was also indicated by the combination of sums of measurements of skin-fat folds and the results of extension in the Otto's test. Own research indicated the possibility of a relationship between the increase in the average thickness of the skin-fat fold and the reduction of spinal mobility in the study group. This may mean that maintaining proper hygiene of healthy eating, and therefore the lack of excessive body fat, may lead to maintaining the correct indications of mobility within the spine. The dependencies described above have not been referenced in the articles of other authors.

In the analysis of the data, no statistically significant relationships were found in the combination of sedentary habits with mobility and structure within the spine. The positive correlation among girls was indicated only by the dependence of the number of hours sitting on the number of hours spent outdoors. On the other hand, a positive correlation was shown in boys by the frequency of physical activity with the sum of hours spent away from home.

Similar conclusions were reached by Jodkowska et al. [14], who also found no relationship between the duration of sedentary activities and physical activity. They observed similar (to those presented above) results regarding the average time spent in sitting positions for both girls and boys.

The above data indicate that despite the large amount of sitting during the day, children equally often take up physical activity, which may reduce the occurrence of disorders in posture. Thus, physical activity is necessary for the development and maintenance of proper body posture.

#### CONCLUSIONS

The greater the body weight, the lower the mobility within the spine.

No associations were observed between the type, length and frequency of physical activity undertaken, as well as the amount of time spent in sitting positions and disorders of mobility within the spine.

Despite the large amount of time in sitting positions, children often and willingly undertake physical activity.

The respondents have a satisfactory knowledge of prohealth behaviors, however, they present an unsatisfactory state of knowledge in the field of awareness about correctness, norms and the way of proper nutrition.

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# Individual Rate of Motor Activity as a Criterion for Assessment of Students' Physical Health

Indywidualny wskaźnik aktywności ruchowej jako kryterium oceny zdrowia fizycznego studentów

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#### SUMMARY

**Aim:** To develop a methodology for determining the individual rate of motor activity of students in the process of physical education on the basis of indicators of their physical well-being.

**Materials and Methods:** The research involved 82 first year students aged from 17 to 19 (38 – male students, 44 – female students). Research methods: analysis and generalization of literature, modelling, anthropometry and physiometry, pedagogical testing, experiment, methods of mathematical statistics.

**Results:** Low existing level of physical development and physical fitness of students both male and female was revealed due to their low motor activity and passive lifestyle. The relationship between the indicators of students' physical well-being and their motor activity were established, the closest connection of motor activity was revealed with the indicators of the Rufier index. Regression equations were developed, which are the content of the methodology for determining the individual rate of motor activity of students in the process of their physical education. **Conclusions:** The obtained results testify to the need for wide introduction of the methodology for determining the individual rate of motor activity of students on the basis of indicators of their physical well-being in the process of physical education. This will allow students to receive information about the appropriate level of physical well-being in accordance with their indicators of physical development, physical fitness and daily motor activity.

Key words: individual rate, motor activity, students, physical well-being, health

Słowa kluczowe: stawka indywidualna, aktywność ruchowa, studenci, samopoczucie fizyczne, zdrowie

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#### INTRODUCTION

Adequate motor activity is one of the main factors that determine the level of physical health of the population [1]. The strong physical health of young people is one of the most important criteria for the development potential of modern society and indicators of the formation of a personality culture. At the same time, the insufficient level of motor activity of student youth is a factor in the emergence and development of various diseases [2].

According to the World Health Organization [3], the weekly rate of motor activity of a person in the age from 17 to 64 should make at least 150-300 minutes of moderateintensity aerobic physical activity, or at least 75-150 minutes of high-intensity aerobic physical activity, or an equivalent combination of physical activity of moderate and high intensity.

According to the scientists [4-6], a person should take an average of 10 000 steps a day. However, the above rates of motor activity are statistically average and do not take into account the individual characteristics of those involved. Given that the rate of motor activity of modern youth is a value that fully meets the biological needs of movements, accounts the functional capabilities of the organism, promotes its physical development and health, so one of the most important scientific tasks of this problem is to develop a methodology for determining individual daily rates of motor activity of students of higher educational institutions (HEI) in the process of physical education, taking into account their physical well-being.

#### AIM

The aim is to develop a methodology for determining the individual rate of motor activity of students in the process of physical education on the basis of indicators of their physical well-being.

#### MATERIALS AND METHODS

We identified the following *tasks* to achieve the aim of the research: to investigate the current level of indicators of physical well-being (physical development, physical fitness and motor activity) of students of HEI; to study the relationship between the indicators of students' physical well-being and their motor activity; to develop a methodology for determining the individual rate of motor activity of students in the process of their physical education.

The research was conducted in 2019-2022 at the National Pedagogical Dragomanov University (Kyiv, Ukraine). The research involved 82 1<sup>st</sup> year students aged from 17 to 19 (38 – male students, 44 – female students).

Research methods: theoretical (analysis and generalization of literature, conceptual and comparative as well as structural and system analysis - to clarify modern approaches to determining motor activity of student youth; modelling - to develop the authors' methodology for determining individual rate of motor activity of students in the process of their physical education); empirical (anthropometry and physiometry - to determine the indicators of students' physical development; pedagogical testing - to determine the indicators of physical fitness of students; the Fremenham technique - to assess the level of motor activity of students); ascertaining pedagogical experiment - to assess the indicators of physical well-being of students and determine its relationship with the level of their motor activity; methods of mathematical statistics - to carry out qualitative and quantitative analysis and process research results.

Physical development of students was assessed by indicators of height, body mass, vital capacity of the lungs, heart rate at rest and after standard load and hand strength. The following indices were determined on the basis of these indicators: body mass index, vital index, strength index and the Rufier index. Physical fitness of students was assessed by the following tests: the Romberg test (balance), 30 m run (speed), standing long jump (speed and strength qualities), 4x9 m shuttle run (agility), pull-ups on the horizontal bar (strength, man), push-ups (strength, women), lifting the torso from the prone lying position (strength endurance), torso tilt (flexibility) and swimming for 12 min (endurance). The Framingham method was used to determine the motor activity of students. It allows you to quantify and qualitatively determine the motor activity of the student on the basis of the time tracking of daily activities of various kinds with the registration of the intensity of each type of physical effort. The value of these measurements is presented in the form

of a digital value of the index of physical activity according to time tracking, which records all activities that take more than 5 minutes. The day is described from the moment when the student woke up after a night's sleep to the time when he/she fell asleep.

This research was conducted in accordance with the requirements of the Code of Ethics of the National Pedagogical Dragomanov University. Informed consent was received from all students who took part in this research.

#### RESULTS

It was found that the indicators of physical development and physical fitness of students were in the range from low to average, which is associated with low motor activity and passive lifestyle. The following indicators of physical well-being for boys were established: heart rate –  $81.0\pm14.0$ beats/min, age - 18.0±1.0 years, body mass - 74.0±9.5 kg, body length –  $181.5\pm6.6$  cm; for girls: heart rate –  $89.2\pm4.4$ beats/min, age - 18.0±0.5 years, body mass - 61.1±8.6 kg, body length - 164.0±6.2 cm. Relevant students' indices were calculated. Thus, the average value of the body mass index for boys was  $22.8\pm2.5$  kg/m<sup>2</sup>, for girls –  $229\pm2.1$  kg/m<sup>2</sup>. The results obtained indicated the average level. According to the results of the research, the vital index for boys was low (47.2±14.4 ml/kg), and for girls – average (48.2±5.4 ml/kg). The indicators of the strength index for both male students  $(60.8\pm13.1\%)$  and female students  $(39.0\pm6.6\%)$  were within low levels. According to the results of the Rufier index, the level of functional reserve of the heart and adaptation of the body to physical loads for girls was 11.0±3.5 c.u., which was below the average level, for boys - 9.5±4.0 c.u., which was the average level.

The results of testing the level of physical fitness of students showed that the level of endurance for boys on the test of swimming for 12 min made 468.0±102.0 m, for girls - 338.5±58.7 m. The level of strength in the test of push-ups for boys was 10.0±6.9 times, for girls according to the push-ups test - 9.3±5.5 times. The level of strength endurance on the test of lifting the torso for 1 min for boys was 40.6±7.8 times and for girls – 36.1±8.3 times. The level of manifestation of speed and strength abilities according to the results of long jump for boys was 207.0±17.0 cm and for girls - 184.3±22.1 cm. The level of manifestation of speed in the time of overcoming the distance of 30 m was 5.2±0.1s for boys and 6.5±0.7 s for girls. The level of agility according to the results of the 4x9 m shuttle run was 10.20.8 s for boys and 11.1±0.9 s for girls. The level of flexibility in the test of torso tilt forward from a sitting position was 5.2±3.6 cm for boys and 15.2±3.8 cm for girls.

The results of the Framingham method for assessing daily physical activity according to 5 levels (basic, sedentary, small, average and high) showed that the level of boys' physical activity was  $8.0\pm1.9$  hours at the basic level, which included sleep, and rest in the lying position. Students spend  $4.0\pm1.4$ hours at a sedentary level of physical activity (moving in transport, rest in the sitting position and eating). Analysis of the time tracking of daily motor activity of students showed that most of them had a low level of physical activity (preparation for classes, personal hygiene, walking and training sessions), the duration of which made  $9.1\pm2.6$  hours for boys. The indicators of average and high levels of motor activity were the lowest. Thus, the average level of motor activity, which includes housework, walking and morning exercises made  $2.6\pm2.0$  hours for boys. The baseline level of motor activity was  $8.7\pm1.6$  hours for girls. The girls spent  $4.2\pm1.3$  hours at a sedentary level of motor activity. The duration of the low level made  $10.8\pm1.8$  hours, the average  $- 2.6\pm2.0$  hours.

In percentage terms, more than 80% of daily motor activity for boys made at the basic, sedentary and low levels (basic – 31.9%, sedentary – 15.7%, small – 36.5%); for girls – about 90% (basic – 33.4%, sedentary – 16.1%, small – 39.2%). The high level of motor activity included specially organized physical exercises and sports, moving and sports games. It made 5.6% for boys and 3.4% for girls in terms of daily motor activity.

The index of physical activity (IPA) according to the results of the Framingham method application made 25.4±1.5 points for boys and 26.8±2.9 points for girls. Given that the optimal IPA indicator was a value that corresponds to 42 points, which provides eight-hour duration at the basic level, eight-hour duration at the sedentary, two-hour duration in terms of the low-level physical activity and three-hour duration of the high-level activity; such an indicator was not recorded in any student as a result of the research, which confirms the low level of their motor activity.

We conducted the correlation analysis, which established the dependence of the indicators of physical development and physical fitness of students on the level of their motor activity in order to determine the presence and nature of the relationship between motor activity and indicators of physical well-being of students. Only the volume of high level, i.e. the time directly spent on exercise was considered as an indicator of motor activity.

During the correlation analysis the girls revealed a reliable ( $p \le 0.05$ ) direct relationship between motor activity and indicators of physical well-being: endurance (r=0.60), hand strength (r=0.64), strength endurance (r=0.65), speed and strength qualities (r=0.45) and balance (r=0.52). They also showed the inverse correlation coefficients between motor activity and the Rufier index (r=-0.79). Motor activity revealed significant ( $p \le 0.05$ ) correlation relationships with endurance (r=0.63), strength endurance (r=0.59), speed and strength qualities (r=0.52), speed (r=-0.66), the Rufier index (r=-0.50) and mass index (r=-0.50) for boys.

The research showed that the level of health depends on the indicators of physical well-being and motor activity. Accordingly, a person needs to determine the required rate of motor activity in order to maintain the state of health at the adequate level. The research substantiates the need to develop a methodology for determining individual motor activity of students in the process of their physical education. The basis of the proposed author's methodology is the process of creating mathematical models in the form of regression equations, where the indices of physical development and physical fitness are used as variables. The parameters included in the independent variables of the mathematical model allow to influence the level of physical well-being of students. In addition, taking into account the real level of physical well-being of students allows them to operate with indicators of their physical well-being and to determine the appropriate level of motor activity, based on their own data.

Independent variables include the most informative parameters that have the most significant relationship with the level of motor activity. Thus, the regression equation rightly includes variable indicators of physical development and physical fitness, which can be purposefully influenced by the performance of regular physical activity in the process of motor activity, as well as the daily level of individual motor activity directly related to exercise. Given the above, the dependent variable Y is chosen integral value, which depends on the indicators of physical development, motor fitness, functional capabilities, and the daily level of motor activity, namely the Ruffier index, as this indicator is the most informative one of physical well-being for girls and boys and has the closest correlation relationship with motor activity of all the studied parameters. This indicator is conditionally called the level of health.

Thus, to develop the methodology for determining the individual motor activity of students in the process of their physical education, we calculated multiple regression equations to determine the dependence of the integrated indicator of physical well-being on the most important parameters of physical development, physical fitness and motor activity of students. The mathematical model of the appropriate level of physical well-being for female students is as follows:  $Y = 19.38 - 0.02x_1 - 0.25x_2 + 0.035x_3 - 0.1x_4 + 4.0x_5 - 0.13x_6$ , where Y is the Ruffier index,  $x_1$  is endurance,  $x_2$  is strength,  $x_3$  is strength endurance,  $x_{4}$  is speed and strength qualities,  $x_{5}$  is balance and x<sub>c</sub> is motor activity. The mathematical model of the appropriate level of physical well-being for male students is as follows: Y=-19.8545-1.1795x<sub>1</sub>+0.00743x<sub>2</sub>- $0.0056x_{2}+0.0465x_{4}-0.9583x_{5}+5.5792x_{6}-0.1112x_{7}$ , where Y is the Ruffier index,  $x_1$  is body mass index,  $x_2$  is endurance,  $\mathbf{x}_{A}$  is strength endurance,  $\mathbf{x}_{A}$  is speed and strength qualities,  $x_5$  is speed,  $x_6$  is agility and  $x_7$  is motor activity.

We slightly modified the rated scale and the assessment of the Ruffier index for the convenience of using the mathematical model i.e. the integrated health indicator was combined into 3 levels: high, average, satisfactory. We can determine the appropriate level of health of an individual student by substituting informatively significant individual indicators of physical development, physical fitness, as well as real indicators of physical activity in the formula that corresponds to a particular age and sex (Table 1).

The appropriate rates of individual daily motor activity depending on the level of health of students were calculated upon determination of the appropriate level of health and

Levels	Girls/Boys
High	≤6
Average	7-9
Satisfactory	10-14

<b>Table 2.</b> Appropriate rates of daily motor activity of average intensity
of students, according to the level of health, min

Levels of health	Girls	Boys
Satisfactory	below 25	below 70
Average	26-50	71-105
High	≤51	≤106

the indicators of physical fitness, i.e. the time required for moderate-intensity exercise to maintain proper health was determined (Table 2), by formulas: for girls:  $x_6=(Y+19.38+0.02x_1+0.25x_2-0.035x_3+0.1x_4-4.0x_5)/-0.13$ ; for boys:  $x_7=(Y+19.8545+1.1795x_1-0.00743x_2+0.0056x_3-0.0465x_4+0.9583x_5-5.5792x_6)/-0.1112$ .

It is assumed that students actively involved in exercising can consciously improve their health since motor activity, which depends on motivational factors, is the most variable indicator. It is important to note that the level of motor activity is determined not so much by the time of exercise as by intensity, i.e. the greater the intensity of an exercise, the less time it takes to perform it, and vice versa.

The peculiarity of our methodology is to determine the individual rates of motor activity of different aerobic efficiency, taking into account the indicators of physical development and physical fitness of those involved. The rates of aerobic efficiency were determined according to the methodology for determining the rates in physical education and sports: if x<x-0.5 $\delta$ , it is a low level of aerobic efficiency; if x-0.5 $\delta$ ≤x≤x+0.5 $\delta$ , then this is an average level of aerobic efficiency; if x<x+0.5 $\delta$ , then this is a high level of aerobic efficiency.

The low level of aerobic efficiency include the following sports and exercises: bowling, judo, static yoga, stretching exercises and weight training exercises. The average level includes badminton, volleyball, football, basketball, ice skating, table tennis and slow dancing. The high level includes walking from 3.8 to 7.2 km/h, swimming, rollerblading, cycling and running from 8.8 to 16 km/h.

Therefore, having determined the student's level of health and the required rate of motor activity, the student can determine the level of aerobic efficiency and choose the appropriate type of exercise. This calculation makes it possible to set the pace of a particular type of physical activity to achieve the desired level of health.

#### DISCUSSION

The analysis of the scientific and methodological literature [7, 8] confirms the importance of pedagogical control in the physical education of HEI students not only in theoretical but also in practical terms. It is established that the issue of developing and implementing a system of control and evaluation of motor activity, which would meet modern requirements of the educational process and have an effective impact on improving the status of physical education and attracting young people to exercise is still acute nowadays [9, 10].

The work of many scientists [11, 12] states that modern student youth is characterized by a low level of responsibility for their own health, the prevalence of health risk factors (smoking, alcohol and drugs abuse, etc.). Urgent sociopedagogical as well as treatment-and-prophylactic measures are needed to preserve and strengthen the health of modern youth. In this regard, the process of physical education in the HEI should be aimed primarily at developing a healthy lifestyle, an active mode of behaviour in students, by increasing motor activity.

The analysis of the literature sources [2, 13, 14] showed that the low level of motor activity contradicts the biological laws of human development and leads to negative changes in the body, which are manifested in reduced functional activity of organs and systems; in violation of the processes of nervous and humoral regulation; in the appearance of trophic and degenerative changes of the musculoskeletal system, its neuromuscular and skeletal components; in violation of metabolic processes; in increasing the volume of adipose tissue. The importance of motor activity is especially growing in modern conditions of society, when due to the rapid development of scientific and technological progress, as well as mass computerization, there is hypodynamia in children, adolescents and students.

Physical education of students in the conditions of use of modern information technologies should be based on specially developed computer programs, realization of programscomplexes of physical exercises in various forms of training sessions. The use of modern information technology will allow to predict, control the dynamics of changes in physical well-being, choose individual loads, determine the individual level of motor activity necessary for standard functioning of the body, and timely assess somatic health in the process of physical education.

The analysis of the scientific literature on the researched problem [8, 15] revealed the availability of methodologies for determining the individual rate of motor activity of students, developed on the basis of modern information and computer technologies. However, there are not enough methodologies that take into account the indicators of physical well-being, i. e. indicators of physical development and physical fitness of those involved, which determined the choice of the research. It is worth noting that in today's world; most young people have fitness bracelets that can be used in any sport. Most of all the models look quite simple and are identical to each other, but there are many different fitness programs for each gadget. Fitness bracelet software is a specialized utility that allows you to synchronize various information from fitness bracelets to smartphones via a wireless connection. However, these programs are

multifunctional, with most of them related to determining the state of health, the level of physical development and physical fitness of those who go info sports. At the same time, insufficient programs have been developed to determine the individual level of motor activity of students taking into account their physical well-being (anthropometric indicators, physical fitness and morphofunctional indices). Therefore, we have developed the author's methodology for determining the individual rate of motor activity of students in the process of physical education on the basis of indicators of their physical well-being. Multiple regression equations, which constitute the content of the author's methodology, allow students to obtain information about the appropriate level of physical well-being in accordance with their indicators of physical development, motor fitness and daily motor activity. Based on this methodology, we have developed a computer program named "Activity for health", which reflects the process of determining individual motor activity, creating an individual program of training, analysis and adjustment of practical results. Our results complement and expand the findings of many scientists [16-18].

#### CONCLUSIONS

- 1. The analysis and generalization of the scientific and methodological literature revealed that the priority of improving the system of physical education is the formation of young people's caring attitude to their own health, sustainable needs and habits of motor activity not only during physical education training sessions, but also in everyday life. This is especially true today, during the pandemic, when students in many countries around the world are forced to study remotely and exercise independently during quarantine.
- 2. The current level of physical development and physical fitness of the HEI students has been studied. It was found that the studied indicators are in the range from low to average, which is associated with low motor activity and passive lifestyle.
- 3. As a result of the correlation analysis, the existence of a close relationship between the indicators of physical well-being and the level of their motor activity was established.
- 4. The methodology for determining the individual motor activity of students in the process of their physical education was developed based on multiple regression equations, which provide information about the appropriate level of physical well-being of students, according to the indicators of their physical development, physical fitness and motor activity. The Rufier index was found to be an integral indicator of students' physical well-being, as it was proved to be most closely related to motor activity.
- 5. The peculiarity of the developed methodology is the determination of the individual rate of motor activity of different aerobic efficiency, taking into account the indicators of physical development and physical fitness

of students. The student can independently choose the level of aerobic efficiency and the appropriate type of physical activity having determined the level of his/her physical well-being and the required rate of motor activity.

Prospects for further research are to investigate the influence of the methodology for determining the individual rate of motor activity of students on the quality of their life.

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# The Influence of Natural Tempering on the Physiological Age of People of Different Ages

Wpływ naturalnego hartowania na wiek fizjologiczny ludzi w różnym wieku

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#### SUMMARY

**Aim:** The aim is to scientifically substantiate the feasibility of using the health improving forces of nature to slow down the natural aging of people of different ages.

**Materials and Methods:** The research involved 5 groups of respondents: the 1st group – students who were involved in sports (28 boys, 34 girls), the 2nd group – students who were not engaged in sports (29 boys, 22 girls), the 3rd group – female adults (45-65-year-old; n = 16), who were not engaged in health improvement training, the 4th group – female adults (45-65-year-old; n = 13), who used biologically active additives, the 5th group – 45-65-year-old women (n = 27) and men (n = 18) who were engaged in health improvement training according to the system by P. K. Ivanov.

**Results:** It was found that the physiological age of the 1st group was higher than the stated age; of the 2nd group corresponded to the stated age; of the 3rd group was exceeded the stated age by 6.9 years; of the 4th group was exceeded by 5.8 years; of the 5th group was lower than the stated age by 4.8 years for men and by 10.1 years for women.

**Conclusions:** It is proved that tempering according to the system by P. K. Ivanov, which does not require any material costs, has a pronounced health effect on the body of people of different ages (especially mature and elderly).

Key words: physiological age, tempering, health improvement system, people of different ages

Słowa kluczowe: wiek fizjologiczny, hartowanie, system poprawy zdrowia, osoby w różnym wieku

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#### INTRODUCTION

The formation of people's health priorities, motives for a healthy lifestyle since childhood, during school and student years is an urgent problem today in terms of the future of the state. According to sociological data, in particular oblasts of Ukraine, being in a difficult economic, social and environmental situation, only up to 2-4 % of children can be considered completely healthy: they have no disabilities in physical development. Over the past 10 years, the incidence rate among the population of Ukraine has increased by 2.5 times. The respective number of people who consider themselves unhealthy has grown during this period from 30 to 90%. Even athletes who are characterized by a high level of physical development and fitness, also suffer from various cold-related diseases [1-3].

Modern medicine offers a large arsenal of pharmacological agents to prolong active human longevity. It is no coincidence that the concept of "anti-aging" or "healthy aging" is one of the priorities of the United Nations project entitled: "Research programs on aging in the XXI century". However, the use of these drugs for revitalization or anti-aging is limited due to the frequent development of allergic reactions and various complications that occur during their use [4, 5]. Moreover, nowadays humanity has to fight for life with the coronavirus (COVID-19), using a large arsenal of psychophysical rehabilitation agents in the fight against the viral pandemic [6-8]. Whether we like it or not, we need to "learn" how to live with the coronavirus for some period of our lives. Blind faith in medicine, in its main remedy i.e. pills, with which a person can easily become healthy, is the psychological basis of neglect of real natural remedies for health improvement. The scientists [9] emphasize the need to replace the traditional health care strategy, which involves the prevention and treatment of diseases, and to develop a fundamentally new strategy that is to stimulate the viability and body defences.

The natural health improvement of a human being is one of such stimulants. There are many systems of health improvement and tempering; the system by P.K. Ivanov is one of the most famous. This system is simple and accessible to everyone. It is based on love and trust in nature and people, wishes for health, help to those who need it, as well as swimming in open water or dousing with cold water, conscious refusal to eat and drink for a certain period of time, mental selfregulation, observance of moral norms, etc. [10, 11].

It is everyone's responsibility to maintain and enhance one's own health. But it is more often than not for a person with the wrong lifestyle, pernicious habits, sedentary lifestyle, overeating, etc. to have many different diseases before 30 years. The physiological age of such people is much higher than their stated one. Therefore, the subject of our research is to study the physiological age of people as an indicator of their health, quality and life expectancy.

#### AIM

The aim is to scientifically substantiate the feasibility of using the health improving forces of nature to slow down the natural aging of people of different ages.

#### MATERIALS AND METHODS

Our survey embraced 5 groups of people of different ages and occupations:

- the 1<sup>st</sup> group was represented by 18-19-year-old students who were involved in various sports (track-and-field athletics, swimming, boxing, wrestling) while studying at the Brovary Higher School of Physical Culture (28 boys, 34 girls);
- the 2<sup>nd</sup> group included students of the Faculty of Social Technologies of the University "Ukraine" (29 boys, 22 girls) who were not engaged in sports;
- the 3<sup>rd</sup> group consisted of adults (45-65-year-old women; n=16), who were not engaged in health improvement tempering;
- the 4<sup>th</sup> group comprised adults (45-65-year-old women; n=13), who were not engaged in health improvement tempering, but were supporters of nutrition with the use of food biologically active additives (BAA) produced by "Tianshi" corporation;
- the 5<sup>th</sup> group was represented by members of the Brovary city club of natural human health according to the system

by P.K. Ivanov entitled "Aquarius": 45-65-year-old women (n=27) and men (n=18).

The representatives of the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> groups were investigated once, the 5<sup>th</sup> group members were examined repeatedly for 30 years (from 1995 to 2020): the 1<sup>st</sup> survey took place in 1995, the 2<sup>nd</sup> – in 2005, the 3<sup>rd</sup> – in 2015 and the 4<sup>th</sup> – in 2020. The subjects of this group were divided into three subgroups depending on the length of their experience: the 1<sup>st</sup> subgroup included individuals with 5 years of experience, the 2<sup>nd</sup> – 15 years and the 3<sup>rd</sup> – 25 years or more.

It is important to note that P.K. Ivanov's health improvement system (system of healing of the person by forces of nature) is a complex influence on the human body of natural factors such as air, water and the earth for the purpose of activation of protective forces for struggle against diseases. This system is simple and accessible to everyone, there are almost no contraindications. The proponents of the health improvement system by P.K. Ivanov (group 5) led an active and healthy lifestyle (HLS). All of them follow the 12 rules of this system, move around the city only on foot or by bicycle, come upstairs exclusively on foot. All of them have homesteads or countryhouses where they are engaged in "occupational therapy". They do not take medication, because they stopped suffering from cold-related diseases and flu after they began practicing natural tempering. All members of this club have been vaccinated against COVID-19. The participants are not vaccinated against seasonal flu as there is no need for it.

The physiological age of the research participants was determined by the method of V.M. Serheiev [12]. This technique involved testing participants on 15 tests: body-weight indicator (c.u.); heart rate after coming upstairs to the 4<sup>th</sup> floor (beats/ min.); heart rate after 2 minutes of rest (beats/min.); ability to come upstairs (number of floors); heart rate after 20 squats for 30s (beats/min.); heart rate 1 minute after 20 squats (beats/min.); systolic blood pressure (mm Hg); diastolic blood pressure (mm Hg); strong hand dynamometry (kg); Genchi test (breath-holding after exhalation) (s); push-ups from the floor (hardpoint) (times); flexibility test (angled position) (cm); Bondarevskyi test for balance (standing position, for example, on the left foot, with your right heel put on the knee of the left foot, hands on the belt, eyes closed) (s); tapping test in the first square for 10 s (times); tapping test in the fourth square (%). The test results were correlated with tabular data according to the age of the participant [Table I]. The difference between the tabular value and the obtained one was determined (with the corresponding sign: "-" if the participant's indicator exceeds the tabular one, or "+" if the participant's indicator is less than the tabular one). After that, the sum of all differences for each test (taking into account the sign) was determined and divided by the number of tests (15). The value obtained made the physiological age of the participant [Table 1].

The health status of the research participants was monitored systematically by medical staff (twice a year). In addition, self-control was exercised.

The research methods: analysis and generalization of literature sources, study of medical records of participants,

	15	20	25	30	35	40	45	50	55	60	65	70	75	80
Body-weight indicator	105	104	103	102	101	100	98	96	94	93	92	91	90	88
Heart rate after coming upstairs to the 4 <sup>th</sup> floor	104	106	108	110	112	116	120	122	124	126	128	130	132	134
Heart rate after 2 minutes of rest	93	94	95	96	98	100	102	104	106	108	110	112	114	116
Ability to come upstairs	35	32	30	28	26	24	22	18	14	12	8	6	4	3
Heart rate after 20 squats for 30 s	106	108	110	112	114	116	118	120	122	124	126	128	130	132
Heart rate 1 min after squats	72	74	76	78	80	82	84	86	88	96	102	108	112	114
Systolic blood pressure	100	105	108	110	115	120	125	130	135	140	145	150	155	160
Diastolic blood pressure	60	65	68	70	73	75	78	80	83	85	88	90	93	95
Dynamometry	45	56	54	52	51	50	49	48	47	46	44	43	42	38
Genchi test	45	42	40	38	35	32	30	28	25	23	21	19	18	15
Push-ups from the hardpoint	32	30	28	25	22	20	18	16	14	12	10	8	6	-
Flexibility test	-12	-11	-8	-7	-5	-3	0	+2	+6	+8	+10	+12	+14	+15
Balance test	42	40	33	30	28	25	20	17	15	10	8	7	5	3
Tapping test in in the 1 <sup>st</sup> square	74	72	70	67	65	63	61	59	57	55	53	51	49	47
Tapping test in the 4 <sup>th</sup> square	3,5	4	4,5	5	5,5	6	7	8	9	10	12	13	14	15

Table 1. Normative indicators for determining the physiological age of persons of different ages according to the method by V.M. Sergeiev [12].

observation, testing, pedagogical experiment, statistical analysis. The authenticity of difference between the indicators of studied groups by means of Student's t-test was determined. The significance for all statistical tests was set at p<0.05.

The research was carried out according to the requirements of the Code of Ethics of Boris Grinchenko Kyiv University (protocol No.11 of 27 November 2019). Informed consent was received from all individuals who took part in this research and who could refuse participation at any time.

#### RESULTS

According to the research results of student youth [Table 2], it was found that the physiological age of male athletes with an average stated age of 18.9 years was 1.5 years younger and made 17.4 years. The female athletes' difference between the stated and physiological age made 0.4 years (the stated age was 18.5 years and physiological – 18.1 years). The physiological age of the students who were not engaged in sports (boys and girls) outstrips their stated age: for boys by 12.3 years; for girls by 8.7 years. This indicates premature physiological aging of student youth.

The comparative analysis of the stated and physiological age of students-athletes and students who were not engaged in sports shows a significant (p<0.001) aging of the body of students who were not engaged in sports, regardless of their gender peculiarities, while statistically insignificant (p>0.05) differences were registered in students-athletes (boys and girls) between the physiological and stated age, i.e. there was no "age wear" of the organism.

Table III reveals the results of longitudinal studies of the impact of tempering activities according to the system by P.K. Ivanov on the body of adults. It was found that the average values of the physiological age of HLS supporters, regardless of the length of their experience (5, 15, 25 and more years), differed from the stated age in the direction of its reduction. Namely: for women with 5 years of experience the difference was 8.9 years (48.2-39.3), for 15 years of experience - 16.3 years (58.8-42.5), for 25- and 30 years of experience - 8.4 years (60.0-51.6) and 6.8 years (65.0-58.2), respectively. On average, their physiological age was 10.1 (8.9+16.3+8.4+6.8/4) years lower than their stated age. The similar trend was observed among men: the physiological age was lower than the stated age by 5.4 years (45.6-40.2) with 5 years of experience in tempering and 4.1 years (56.3-52.2), respectively, with 15 years of experience. In all these cases, the physiological age lagged behind the stated age by an average of 4.8 years (5.4+4.1/2), i.e. there was no natural "wear" of the organism [Table 3].

The comparative analysis of the indicators of the stated and physiological age of 45-65-year-old women who were not supporters of the health improvement system by P.K. Ivanov and their female peers who were not engaged in health training, and those women who were supporters of health nutrition using biologically active additives, indicates the accelerated aging of the body particularly of the representatives of the 3<sup>rd</sup> and 4<sup>th</sup> groups [Table 4].

The latter was reflected in a probable (p<0.05) increase in their physiological age relative to the stated one. Thus, the physiological age of women of the  $3^{rd}$  group on the average

Gender	n	Stated age	Physiological age	Difference
		Students who were engaged in	sports	
Boys	28	18.90±1.47	17.40±1.35	1.5
t; p		0.75; >0.05		
Girls	34	18.50±1.34	18.10±1.28	0.4
t; p		0.22; >0.05		
	St	udents who were not engaged	in sports	
Boys	29	19.10±1.60	31.40±1.34	12.3
t; p		5.89; <0.001		
Girls	22	19.60±1.55	28.30±1.30	8.7
t; p		4.30; <0.001		

**Table 2.** Indicators of the stated and physiological age of the student-athletes (group 1) and the students who were not engaged in sports (group 2), Mean±SD, years

Note: Mean – arithmetical average; SD – standard deviation; p – the significance of the difference between the indicators of studied groups due to the Student's t-test, t – t-test value

**Table 3.** Indicators of the stated and physiological age of 45-65-year-old men and women, who were engaged in tempering according to the system by P.K. Ivanov (group 5), at different stages of the survey (1995, 2005, 2015, 2020), Mean±SD, years

Studied indicators	<b>Research stages</b>	EG	CG	p2
Well-being, points	Beginning	4.3±0.19	4.4±0.20	p>0.05
	End	6.4±0.17	5.9±0.18	p<0.05
	p1	p<0.001	p<0.001	
Activity, points	Beginning	4.7±0.21	4.8±0.23	p>0.05
	End	5.6±0.22	5.7±0.23	p>0.05
	p1	p<0.01	p<0.05	
Mood, points	Beginning	4.8±0.18	5.1±0.19	p>0.05
	End	7.2±0.19	6.4±0.20	p<0.05
	p1	p<0.001	p<0.001	

Mean – arithmetical average, SD – standard deviation, p1 – the significance of the difference between the studied indicators within groups at the beginning and the end of research, p2 – the significance of the difference between EG and CG

**Table 4.** Indicators of the stated and physiological age of 45-65-year-old women who were not engaged in health improvement tempering (group 3) and those who were not engaged in health improvement tempering, but used food biologically active additives (group 4), Mean±SD, years

Gender	n	Stated age	Physiological age	Difference		
Persons who were not engaged in health improvement tempering (group 3)						
Women	16	42.90±2.26	49.80±1.62	6.9		
t; p		2.48; <0.05				
Persons who were proponents of food biologically active additives (group 4)						
Women	13	39.00±1.86	44.80±1.77	5.8		
t; p		2.26; <0.05				

Note: Mean – arithmetical average; SD – standard deviation; p – the significance of the difference between the indicators of studied groups due to the Student's t-test, t – t-test value

was higher by 6.9 years (49.8-42.9), and the  $4^{\text{th}}$  group – by 5.8 years (44.8-39.0) than their stated age.

#### DISCUSSION

The use of tempering procedures in combination with health improving physical training sessions, as one of the components of a healthy lifestyle, is a powerful factor in improving health, increasing the body's reserve capacity, as well as reducing the physiological age of people of different ages, genders and occupations that a priori increases their life expectancy [13]. Tempering according to the health system by P.K. Ivanov is not only tempering of the body on the physical level, it is also hardening of the spirit, training of the will, achieving harmony in development through love of nature and people around you [12, 14]. The use of this system, which does not require any material costs, can be one of the alternative programs for the formation of a healthy lifestyle of young people, which aims to educate a healthy harmoniously developed and spiritually enhanced personality.

Before analysing the materials of our research, we would like to focus on one fact, which, in our opinion, is debatable. Thus, from the studies [15], we find that the differences between the stated and physiological age, which allow us to assess the intensity of aging of the individual, are most pronounced in long-living persons, while they are insignificant in young people. Therefore, according to the authors [15], "it makes sense to determine the physiological age only in 30-year-old or even 35-year-old persons." We partially agree with the covered fact. After all, there are a number of works that indicate significant differences between the stated and physiological age even at a young age. Thus, we clear out from the researches [16] that the difference between the stated and physiological age of students can be 4-5 years or more.

According to the materials of our research, the physiological age of 18-19-year-old students-athletes was 1.5 years lower than their stated age, while their peers-athletes' physiological age in the same sports, respectively, was higher than their stated age by 0.4 years, that is, we can assume that it, in general, corresponded to the calendar one. Therefore, we can assume that such athletes do not have "age-related wear" of the body. Different situation was observed in their peers (boys and girls) who were not engaged in sports. Thus, according to the results of the research, they revealed significant differences between their physiological and stated age in the direction of increasing the latter. All this indicates the aging of their still young body.

The slowdown in physiological aging among the surveyed adults (groups 3, 4 and 5) was observed in the followers (men and women) of natural tempering according to the system by P.K. Ivanov. Thus, men's physiological age was lower than their chronological age by an average of 4.8 years, respectively, women's by 10.1 years. The adults of the same age category, who were not engaged in health tempering, revealed age "wear" of the body. Their physiological age was 6.9 years higher than their stated one. Accelerated (on average by 5.8 years) age-related aging of the body was also observed in adults who were supporters of HLS in the nomination of "health nutrition" with the use of biologically active additives. To the above it should be added that those individuals who adhered to the principles of HLS, had a naturally greater energy potential for health, and therefore did not get sick, maintained efficiency, vigour for many years.

Thus, the following effects of tempering procedures were revealed according to the results of the research, as well as in our previous studies: 1. Systematic dousing with cold water according to the system by P.K. Ivanov significantly increased the body's defences of people of different ages and, as a result, they did not suffer from acute respiratory and viral infections; 2. Such persons also completely refused to take flu pills; 3. They got rid of pernicious habits (smoking, alcohol); 4. The use of cold water therapeutic procedures had a positive effect on the vegetal tonicity of the body, which contributed to the harmonization of their psycho-emotional state; 5. The result of many years of tempering of people of different ages, genders and occupations according to the system by P.K. Ivanov is a restructuring of their consciousness in relation to themselves, their partners (for example, the elimination of possible aggressive behaviour towards rivals in sports), other people, and so on. The results of our many years of research complement and expand the findings of many scientists [17-19].

#### CONCLUSIONS

- 1. The physiological age of students who were not engaged in sports is higher than their stated age (in boys by 12.3 years, in girls by 8.7 years), which indicates the "age wear" of their body. The physiological age of students who were engaged in sports is generally consistent with the stated one. The physiological age of 45-65- year-old men, who were systematically engaged in the health system by P.K. Ivanov, is lower on average by 4.8 years than the stated one, of women by 10.1 years. Persons of the same age who were not engaged in health tempering have age "wear" of the body. Their physiological age is 6.9 years higher than their stated age. Accelerated (on average by 5.8 years) age-related aging of the body was also observed in women who used of biologically active additives, but were not engaged in tempering procedures according to the mentioned system.
- 2. P.K. Ivanov's system of natural tempering of the person does not demand any material expenses, has the expressed improving effect on the body of people of different ages, gender and professional employment, and therefore, in our opinion, it can be referred to the existing methods of a healthy way of life and anti-aging.

Prospects for further research: to investigate the impact of P.K. Ivanov's system on the span of life and health indicators of people of different ages.

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### Balneotherapy in Stimulating Resistance to Infections – the Little-used Health Resort's Potential During the COVID-19 Pandemic

Balneoterapia w stymulowaniu odporności na zakażenia – potencjał uzdrowiskowy mało wykorzystany w okresie pandemii

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#### SUMMARY

To function properly, the human immune system must be adequately stimulated. Immune activity is stimulated as a result of the use of vaccines as well as the exposure of the body to infections. This type of stimulation only increases the specific humoral immunity, characterized by relatively short duration, and targeted at a well-defined antigen. In the case of the COVID-19 virus, immune memory cells persist for up to one year. In parallel with specific stimulation, it is necessary to develop non-specific immunity. It is the body's first line of defense against infection, affects many microorganisms, and supports specific immunity. We can develop and strengthen this immunity using non-pharmacological methods, including balneotherapy, physical activity, and an appropriate diet. There is now much scientific evidence showing the effectiveness of balneotherapy in improving innate immunity. In in vitro and in vivo studies with high scientific credibility, the following effects of balneotherapy on the immune system were demonstrated: stimulation of the proliferation of T lymphocytes (especially CD4), normalization of the phagocytic activity of granulocytes and macrophages, lowering the concentration of proinflammatory cytokines and stimulating the secretion of anti-inflammatory cytokines, CRP, prostaglandins (PGE2), as well as antioxidant and neurohormonal activity. Among treatments with balneoimmunostimulatory effects, one should mention sulfide baths, peloid compresses, brine baths, radon treatments, and hot baths. These treatments are mainly used as part of health resort treatment represents excellent health potential. Unfortunately, it is very modestly used in activities aimed at improving the immunity of Polish society. This treatment would be best combined in patients after vaccination and in a certain period before vaccination, which would significantly increase the effectiveness of prophylactic vaccinations.

Key words: immune system, immunity, COVID-19, balneological and radon treatments

Słowa kluczowe: układ immunologiczny, odporność, COVID-19, zabiegi balneologiczne, radonowe

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#### INTRODUCTION

People live in an environment with many dangers and harmful effects. Bacteria, fungi, viruses, and other microorganisms constantly around people generally do not cause disease, thanks to a well-developed defense and immune system. People with a highly educated and efficient immune system rarely suffer from bacterial, viral, or fungal infections. Just as we should take care of the cardiovascular system, control blood pressure, blood glucose, and lipids levels, it is also necessary to control the immune system. If it is not stimulated, its functions disappear or are significantly weaker. The immune system becomes active during microbial infections, after inoculation, and during tempering and the appropriate application of other therapeutic stimuli. The immune system performs the following most important functions: recognizes a foreign antigen, starts the production of executive cells, produces antibodies, destroys pathogens, and produces immune memory cells [1].

The immune system consists of a central and a peripheral part. Its central part consists of the bone marrow and thymus. The peripheral part consists of the lymphatic system, lymph nodes, spleen, circulating lymphocytes, and leukocytes. The main part of the peripheral system is lymphocytes, which comprise the circulating population of T lymphocytes (derived from the thymus gland) and B lymphocytes (derived from the bone marrow). In addition, T lymphocytes are composed of subpopulations (CD4, CD8, and T-reg lymphocytes) dedicated to performing specific activities.

CD4 lymphocytes play a central immune role. They act directly on the antigen and through cytokines. CD8 lymphocytes have a cytotoxic (Tc) effect (they kill microorganisms) as well as suppressive (Ts) activity (they inhibit the immune response). Treg lymphocytes regulate the immune response and reduce inflammation. Another interesting group is innate-like lymphocytes (ILL), which are involved in non-specific immunity and kill microorganisms. These include NKT, B1, and NK lymphocytes, called "natural killers". In addition to lymphocytes, leukocytes are the second group of cells involved in the immune response, such as monocytes and neutrophils. They are involved in the process of phagocytosis. Moreover, dendritic cells are the next group of immunologically active cells found in all tissues and come from the bone marrow. They have phagocytic abilities and transport pathogens to the lymph nodes [1].

Immune cells, especially macrophages and NK cells, produce proinflammatory cytokines when the pathogen enters the body. They mediate the inflammatory process and stimulate the production of antibodies. They take an active part in immunological processes. Cytokines are a broad family of regulatory proteins produced primarily by macrophages, monocytes, and lymphocytes. They have a proinflammatory effect, but some have an anti-inflammatory effect. Also, they can promote or sometimes prevent the development of atherosclerosis. Tumor necrosis factor-alpha (TNF alpha) is the main cytokine. It is involved in the regulatory process of the immune system, mitosis, inflammation, and angiogenesis. Another important cytokine is interleukin 6 (IL-6), which stimulates inflammatory processes, especially acute inflammation. Other cytokines involved in the immune response processes are interleukins: IL-1, IL 8, IL-12, IL-22. The anti-inflammatory cytokines include: IL-2, IL-4, IL10, IL-11, IL-13.

#### **REVIEW AND DISCUSSION**

#### SPECIFIC AND NON-SPECIFIC IMMUNITY

Functionally, the entire immune system consists of specific and non-specific immunity, also known as innate or general immunity. In addition, we distinguish the humoral immunity related mainly to specific immunity and the predominant participation of B lymphocytes, and cell immunity related to non-specific immunity and T lymphocytes [1].

Specific immunity targets only a given antigen. Its activation leads to the formation of antibodies produced by B lymphocytes, assisted by the complement system. This system plays an important role in preparing an antigen for its complete destruction in the process of phagocytosis. B lymphocytes, cytokines, the complement system, and antibodies play the most important role in the immune response. The specific immune response develops slowly, usually within six days of infection with the microorganism in question, and is time-limited. It is formed after vaccinations and after infection in convalescents.

Non-specific (innate) immunity is the most important weapon in the fight against infections. Properly functioning non-specific immunity means that, despite constant exposure to pathogenic microorganisms, symptomatic infections occur exceptionally, and even during a pandemic, only a part of the population becomes ill. Non-specific immunity is the first line of defense and is activated immediately after the pathogen enters our system. It focuses on various pathogens and factors harmful to the human body. It is attended by ILL lymphocytes, monocytes, granulocytes, the complement system, dendritic cells, and cytokines. Non-specific immunity is mainly cellular, with the predominant participation of T lymphocytes, including Tc and NK. This immunity can be improved and strengthened by balneotherapeutic methods or body tempering as well as increased physical activity.

Both types of immunity work together and, which is very important, an efficient immune system supports specific immunity. In practice, this means that general immunity after vaccination will be better in people with good non-specific immunity. Moreover, the contribution of both types of immunity is slightly different for different kinds of infections. In extracellular infections (usually bacterial infections), the humoral immune response is stimulated, while in intracellular (usually viral) infections, the non-specific, general response is dominant (2).

The remainder of the article will be devoted to the problems of non-specific immunity and the importance of balneotherapy in the treatment and prevention of the immune system.

#### INFLUENCE OF BALNEOTHERAPY ON THE INCREASE OF NON-SPECIFIC IMMUNITY

Balneological treatments such as mineral baths and peloid compresses have a beneficial immune effect by stimulating the immune and neuroendocrine systems. They mainly improve non-specific cellular immunity. The immunological impact is demonstrated by treatments applied serially on large body surfaces and with a gradual intensity of action. As a result of the stimulus effect of balneotherapy with graded intensity, the immune system reacts, and after taking a series of treatments, patients develop a state of immune adaptation. Thus, using this method, it is possible to improve non-specific immunity and, through the process of immune adaptation, protect the body against infections [3]. Recently, especially during the COVID-19 pandemic, interest in the immune system has increased, including the use of balneotherapy for its stimulation. The largest number of recent studies on the effects of balneotherapy on the immune system are preclinical (in vitro) studies. In vitro and in vivo (clinical) studies are of particular interest to us. They were developed following the principles of EBM. They are clinical-control studies, meta-analyses, and blinded randomized studies, so they are scientifically reliable studies. In the literature, we can find laboratory, cell culture, virological, animal, and human studies [2]. These studies not only show the improvement in the body's immunity through balneotherapy, but also there are attempts to explain the mechanisms of this action. However, the effects and mechanisms of balneological treatments on the immune system are still not fully understood. This article analyzes selected in vitro and patient research studies.

Previous studies have shown that balneological treatments have a positive effect on the system of lymphocytes, leukocytes,

and cytokines, and therefore mainly on the peripheral centers of the immune system. The following effects of balneological treatments have been found:

- Stimulation of the proliferation of T lymphocytes, especially CD4.
- Normalization of the proportion between lymphocytes with different cytotoxic and anti-inflammatory effects.
- Increase in the number of granulocytes and stimulation of their phagocytic activity.
- Lowering the concentration of proinflammatory cytokines and stimulating the secretion of anti-inflammatory cytokines, CRP, and prostaglandins (PGE2).
- Antioxidant and neurohormonal activity.

The effect of balneological procedures aimed at stimulating the proliferation of T lymphocytes was demonstrated by Piao et al. (2021) [4]. The authors used hot radon baths in healthy people, which caused a significant increase in the proliferation of T lymphocytes (especially CD4) and B lymphocytes. They also showed the impact of balneological treatments on proportion regulation between different functional groups of lymphocytes, including Th1, Th2, Th17, and Treg CD4 [4]. Rinald et al. (2006) investigated the effect of sulfide baths on the immune system and showed the increased proliferation of lymphocytes and neutrophils and their activity in patients with osteoarthritis [5]. Miller et al. (2012) demonstrated an increase in serum T lymphocytes and their activity in mice bathed in mineral water [6]. Finally, Cucu et al. (2017) conducted a study in patients receiving treatments with a low dose of radon for three weeks. They disclosed an increase in only Treg cells, but not Th17 cells, which number did not change [7].

Galves et al. (2018) showed an increase in the activity of neutrophils in patients treated with mineral baths and peloids. This translated into an increase in their phagocytic capacity. Moreover, a decrease in the concentration of proinflammatory cytokines and an increase in the production of anti-inflammatory IGF-1 was demonstrated in that study population [8].

Cytokines play an important role in immunological, especially inflammatory processes. It was shown that in psoriasis patients, the secretion of IL-6, IL-8, and TNF alpha is significantly reduced after bathing in mineral water [9]. Similar effects were obtained by other authors who showed a significant reduction in the concentration of inflammatory cytokines in patients treated with balneological procedures [10-15]. Prandelli et al. (2013) used mineral water rich in NaHS to culture keratinocytes from psoriasis patients. They found that after using the mineral water, the severity of inflammation that accompanied psoriasis was significantly reduced. The authors explained these effects by the observed reduction in the concentration of inflammatory cytokines IL-8, IL-17, and IL-22 [16]. Fiorovanti et al., in a chapter included in the Great Book of Balneology of Physical and Health Resort Medicine, cite their own research on the effects of sulfide waters on the immune system. The authors showed that balneological treatments inhibited the formation of inflammatory cytokines, mainly Il-2, produced primarily by CD4 lymphocytes. The authors speculated that immune memory T cells could be stimulated by sulfide waters [17]. In addition to mineral waters, peloid therapy is an extremely valuable

anti-inflammatory cytokine - interferon [18]. Bellometti et al. compared peloid treatments (12 compresses) at 40 degrees for 20 minutes and bathing in ordinary water at 37-38 degrees for 10-12 minutes in patients with osteoporosis. The authors found a significant increase in IGF-1 (insulin growth factor) and a decrease in serum TNF-alpha in the study group, compared to the control group [19]. Other in vitro studies showed that peloid humic acids inhibited the production of proinflammatory cytokines - TNF alpha, IL-1, IL-6. Moreover, the action of humic acids was confirmed in the studies of the antioxidant system in the liver mitochondria. These acids stimulate the antioxidant defense system by capturing free oxygen radicals and strengthening the body's antioxidant mechanisms [20]. Ortega et al. (2017) conducted a clinical trial in patients with osteoarthritis after a 10-day peloid therapy cycle. In addition to favorable clinical results, the authors observed a significant reduction of the proinflammatory cytokines TNF alpha, IL-8 Il-6, Il-10, TGF beta, and the concentration of the endocrine marker of stress (cortisol was significantly increased) [21]. Changes in cortisol levels suggest that mineral baths may modulate the pituitary-adrenal axis activity, inducing an increase in ACTH concentration [22]. Hypothetically, it can be concluded that an increase in blood cortisol levels after balneotherapy may support the stimulation of neutrophil activity [21]. Galvez et al. (2018) and other authors investigated the number of Treg regulatory lymphocytes and the anti-inflammatory effect of peloid therapy in elderly patients with degenerative changes in the joints. The study was performed on 36 patients, and total peloid compresses with a temperature of 40-42 degrees were applied for 10 days. A favorable clinical effect was obtained, as well as a decrease in serum levels of IL-8 and TGF-beta, which correlated with clinical improvement. In addition, a decrease in the percentage of CD4 T lymphocytes was observed, while the regulatory CD8 T cells increased, and the activity of neutrophils increased. Moreover, the authors showed that CRP, which increases in inflammation, was significantly reduced after balneological procedures [8].

balneological method, including the action of humic acids

contained in organic peloids (biolytes). These acids stimulate

the activity of T lymphocytes and stimulate an important

In addition, the effects of systemic hyperthermia on cytokines and lymphocyte proliferation were investigated. Tarner et al. (2009) investigated the influence of systemic hyperthermia in patients with ankylosing spondylitis (AS) and its influence on the concentration of proinflammatory cytokines. The authors performed 9 sessions of systemic hyperthermia in 12 patients with AS and 12 healthy subjects, who constituted the control group. In patients under the influence of hyperthermia, the concentrations of all cytokines significantly decreased (by 40-50%), mainly TNF-alpha, IL-1, IL-1beta, and IL-6, which was not observed in the control group [23]. Other authors obtained similar results [24]. In addition, the influence of hot mineral baths on hormone secretion and the number of lymphocytes in the peripheral blood was investigated, obtaining a significant increase in both the total number of lymphocytes and the CD4 + fraction, which might indicate increased proliferative activity of T and B lymphocytes [25].

The effect of radon treatments on the cellular immune response was also investigated. A slight but long-lasting increase in monocytes was demonstrated in patients taking radon baths [26]. Ardic et al. (2007) showed in randomized case-control studies in patients with fibromyalgia the beneficial effect of mineral baths on the concentration of cytokines. Baths were used for 3 weeks, after which a significant reduction in inflammation and pain mediators - PGE2, IL-1, and LTB4, was achieved (12). Yamaoko et al. (2004) demonstrated a significant effect of radonotherapy (baths and inhalations) on lymphocytes in case-control studies. The authors showed a significant increase in the amount of CD4+ and a decrease in the amount of CD8+ after 5-10 radon treatments. This was not observed in the control group [27]. Indirectly, the immune system is also influenced by hormonal changes, especially changes in the secretion of pituitary-adrenal hormones. It was shown that changes in their concentration occur under the influence of balneological procedures. Hot mineral baths stimulate the growth of ACTH, cortisol, prolactin, and growth hormone, which is related to the anti-inflammatory effect through endocrine stimulation of corticosteroids [28]. In recent years, hydrogen sulfide (H<sub>2</sub>S) has enjoyed a great interest in treatment and research. Research on the effects of H<sub>2</sub>S on immune and inflammatory processes has been the subject of interest of numerous authors, including Munteanu et al. and Vitale et al. [29, 30]. H<sub>2</sub>S is involved in many physiological and pathological functions of the human body, and endogenous H<sub>2</sub>S production is biologically regulated. Hydrogen sulfide shows cytoprotective, antioxidant, immunological, and anti-inflammatory effects. It has a positive impact on granulocytes and macrophages involved in phagocytosis. This gas is the most important component of sulfide waters; therefore, these waters may play a special role in immunological processes that stimulate resistance to bacteria and viruses. Miller et al. (2012) showed in animal studies that exogenous H<sub>2</sub>S activated T cells, reduced their apoptosis, and increased the expression of genes encoding IL-2, CD-69, and CD-25 [6]. Similarly, Yang et al. (2016) highlighted the stimulating effect of H<sub>2</sub>S on the proliferation and activation of T lymphocytes and the release of proinflammatory cytokines by immune cells [31]. Other authors showed in vitro studies using a bacterial culture that H<sub>2</sub>S prolonged the survival of granulocytes, which might have an anti-inflammatory effect [5]. In vitro studies on human monocytes showed that the sulfur releasing molecule, sodium sulfide, NaHS, effectively increases the release of the anti-inflammatory cytokine IL-10 [16]. Sulfide waters exert a robust inhibitory effect on proinflammatory cytokines, especially IL-2 and interferon-gamma. Since CD4 lymphocytes mainly produce these cytokines, it can be assumed that sulfide waters may influence immune memory T lymphocytes. Other authors found that sulfide waters reduce the ability of memory cells to proliferate and produce cytokines, thus modulating the immune system [32]. Many other authors have recently dealt with the problem of hydrogen sulfide from the point of view of human physiology and its use in the treatment of many diseases [5, 6, 10, 28, 29, 30, 33, 34].

Apart from the aforementioned classic balneological treatments, also other health resort treatments, such as hot

baths, including a sauna [11, 22, 24, 25] and cryotherapy [35], can be used for immunological stimulation. In our own research using flow cytometry, we showed that in rheumatoid arthritis patients, there was an increase in the total number of peripheral lymphocytes and CD4 lymphocytes after using cryotherapy and systemic treatments [35].

Physiotherapeutic treatments are less important than balneological treatments in stimulating the immune system and anti-inflammatory effects. But recently, research has been conducted on using laser therapy for pneumonia during COVID-19 viral infection. The stimulation laser used in patients with pneumonia because of COVID-19 viral infection showed anti-inflammatory effects, decreased proinflammatory cytokines, and increased CD4 and CD8 lymphocytes. Thus, laser therapy treatments can reduce the cytokine storm and stimulate the healing of lung tissue in patients with pneumonia. The authors obtained good clinical, biochemical, and immunological results [36].

#### CONCLUSIONS

Extensive in vitro, laboratory, and animal studies, as well as clinical studies in patients, have shown that balneological treatments have immunostimulatory and anti-inflammatory effects. Serial use of balneological procedures with the gradual intensity of therapeutic stimuli causes the effect of immune adaptation. According to clinical observations, sulfide baths, radon and brine treatments, hot baths, and peloid treatments play a particularly important role. The mechanism of the immunostimulant effect of balneotherapy is little known. However, it is known that the action of balneological treatments strengthens non-specific cellular immunity and supports specific immunity. Previous studies indicate that, under the influence of balneotherapy, the improvement of nonspecific immunity occurs as a result of stimulation of proliferation of T-lymphocytes, but also B lymphocytes, regulation of the proportions between the functional groups of the lymphatic system, an increase in the number of granulocytes and their phagocytic activity, a decrease in the concentration of proinflammatory cytokines and an increase in anti-inflammatory, reduction of proinflammatory factors (CRP and prostaglandins) as well as antioxidant and neuroendocrine activity.

Due to the beneficial effects of balneotherapy on the immune system, there is an increasing interest in these treatments worldwide. The COVID-19 pandemic is probably important here, as well as a broader look at the functions of the immune system. Balneological treatments and health resort treatments can be used more commonly in the treatment of chronic complications after COVID-19 infection (long COVID syndrome) and the prevention of infection by strengthening non-specific immunity as well as the immune effects of specific vaccines.

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## Physiotherapy Procedure in the Treatment of Right Lateral Ankle Joint After Fracture

# Postępowanie fizjoterapeutyczne w leczeniu kostki bocznej prawej po złamaniu

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#### SUMMARY

The paper describes the case of a patient with a lateral ankle fracture, who came to the hospital emergency department. After a series of diagnostic tests, the patient was fitted with a plaster splint and was discharged home. During the follow-up visit, the cast was removed (numerous bruises, circulation problem, mobility problem, swelling), the patient started rehabilitation due to the persistent complications described above and in order to restore the condition of the treated limb. After 2 months of intensive rehabilitation, including a number of methods, therapies and physical treatments, limb mobility was restored, swelling and pain were reduced, which enabled the patient to live independently and return to work.

Key words: rehabilitation, fracture of the right lateral ankle, magnetostimulation, magnetoledtherapy, ultrasounds, TENS

Słowa kluczowe: rehabilitacja, złamanie kostki bocznej prawej, magnetostymulacja, magnetoledoterapia, ultradźwięki, TENS

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#### INTRODUCTION

Traumatic injuries of the ankle joint, which are quite common in patients, are mostly caused by dislocation accompanied by damage to the joint capsule and ligaments. Lateral ankle fractures occur through an indirect mechanism of injury. It very often occurs as a result of putting the foot incorrectly on uneven ground. We rarely see fractures caused by direct trauma, which is understood as an impact to the ankle area. There are several types of ankle fractures. It may be an isolated fracture, or part of a more complex fracture in the ankle area. A fracture accompanied by another fracture, incl. fracture of the posterior edge of the tibia or medial malleolus, is called a bimalleolar or trimalleolar fracture [1, 2].

Depending on the extent of the injury, the place of its occurrence and the mechanism of damage, it is necessary to implement appropriate treatment and proper rehabilitation, which may take up to several months. There are also situations where rehabilitation is carried out over a longer period of time. Each injured person asks themselves a question: "Will it be possible to return to full mobility from before the accident?". It all depends on the extent of the injury, patient's determination in the rehabilitation process and a bit of luck [3]. According to Oryna Z et al., comprehensive solutions are necessary to

improve the effectiveness of the implemented activities in the field of rehabilitation procedures, because in many cases physiotherapeutic treatment does not bring the expected therapeutic effects. This applies in particular to patients with musculoskeletal injuries [4].

There are often cases where a fracture of the lateral malleolus is accompanied by a dehiscence of the tibiofibular syndesmosis. This is a significant damage to the joints between the tibia and the fibula, where both bones move relative to each other, which extensively impairs not only the structure, but also functions of the ankle joint. The choice of the treatment method is markedly influenced by the assessment of the orthopedic surgeon in terms of syndesmosis damage [5].

Symptoms of a lateral malleolus fracture are: pain, swelling and local bruising in the ankle area, often accompanied by reduced mobility. In most patients, the pain associated with the injury is so severe that it prevents movement. If the fracture is swollen, the foot and ankle will become numb. Symptoms of a lateral ankle fracture are often confused with an ankle sprain. In the vast majority of cases, it is recommended to perform an X-ray that will allow to distinguish the nature of the injury. The Danis-Weber division is used as a criterion for a lateral ankle fracture, according to which there are 3 types of lesions depending on the location of the fracture: Type A, B and C.

- A. Fracture below the tibiofibular syndesmosis,
- B. Fracture at the level of tibiofibular syndesmosis,
- C. Fracture above the tibiofibular syndesmosis.

If an injury is suspected by a patient, the limb should be placed high, it is recommended to relieve the load, apply cooling dressings (according to the RICE method), and immediately report to the hospital for further diagnostics. Painkillers can be used temporarily [5, 6].

#### TREATMENT METHODS FOR A LATERAL ANKLE JOINT FRACTURE

There are two options for a treatment of lateral ankle fractures. It is a conservative (non-surgical) and surgical treatment. If a fracture is not displaced and not accompanied by other injuries, it is advisable to immobilize the limb by placing it in an orthosis or a plaster cast. This model of treatment is also recommended when the patient cannot undergo surgery, e.g. due to comorbid diseases. The healing process of a lateral ankle fracture may even last for 8 weeks. Rehabilitation and return to full mobility may take from 2 to 6 months [7, 8].

A set of splints, screws and wire can be used to fix the fragments, if as a result of a trauma, an extensive fracture displacement, a damage to the tibiofibular syndesmosis or other fractures have occurred. Regardless of a method of treatment used, rehabilitation is necessary after a removal of plaster, an immobilization, or a surgery [2, 6, 9].

#### AIM

The aim of the study is to present the physiotherapeutic treatment of a 42-year-old female patient after a fracture of the right lateral ankle joint.

#### **CASE REPORT**

A 42-year-old patient was admitted to the Emergency Room with severe pain and swelling of the right ankle joint as a result of an injury to this joint on the way to work. An interview, physical examination and radiological diagnostics were conducted. Diagnosis: trauma and fracture of the lateral ankle ICD-10, S82.6. Additional examinations were performed in the form of X-rays: right crus with the knee joint AP + side, right ankle joint AP + side + mortise view, ankle joint AP + side. Immobilization in a long leg splint was recommended (Figure 1).

First consultation took place on the 10<sup>th</sup> Feb 2021 and showed that the positioning of the fragments was correct, the blood supply and innervation were properly preserved. An additional X-ray of the right ankle joint AP + side was performed. Second consultation took place on the 17<sup>th</sup> Feb 2021. It was an examination in a plaster splint that showed: fracture of the lateral ankle without significant displacement, symmetrical ankle joint space and DTFS not widened. Third consultation was held on the 3<sup>rd</sup> March 2021 and showed the correct positioning of the fragments, preserved blood supply and innervation. The plaster splint was removed. An X-ray examination was performed in the anterior-posterior AP + side view. Rehabilitation was recommended (Figures 2, 3).



Figure 1. Right lower limb immobilized with a plaster cast



Figure 2. Right lower limb after removal of the plaster cast. Visible significant warming of the joint and swelling. Extensive limitation of the scope of mobility



Figure 3. Right lower limb after removal of the plaster cast

#### THE APPLIED METHODS OF PHYSIOTHERAPY SUPPORTING THE TREATMENT AFTER THE REMOVAL OF THE PLASTER CAST

After removing the plaster cast, the patient complained of severe pain (6 on the VAS scale). Swelling of the joint, bruising of the limb and significant limitation of mobility were visible. It was also impossible to put stress on the limb. Manual therapy was used with the active participation of the patient - each session for 45 minutes. The therapy was used for 2 months, 6 days a week, except Sundays. Additionally, active and passive exercises, deep tissue massage, muscle relaxation therapy, flossing and lymphatic drainage were applied. After 2 weeks of rehabilitation, a control photo was taken (Figure 4).

The therapy also included physical treatments: magnetostimulation and magnetoledtherapy with the parameters of the M1P2 device, the intensity of the magnetic field 5-12. Each physical session lasted 20 minutes [10-13]. In addition, TENS currents were used to reduce the perceived pain. Phonophoresis treatments along with the drug Diclofenac 23.2 mg/1g were also applied for 10 minutes. The treatments were performed in two series over a period of 2 weeks [14, 15], (Figures 5, 6).

After 2 months of comprehensive physiotherapy, the patient reported complete pain relief (0 on the VAS scale). The range of mobility of the ankle joint has also increased. Swelling and bruising were gone. The patient moves on her own without the help of elbow crutches. Stability is preserved, normal physiological gait.



Figure 4. The photo was taken after 2 weeks of rehabilitation



**Figure 5.** Photograph taken after the end of treatment (2 months from the beginning of physiotherapy)



Figure 6. Photo taken after the end of therapy (2 months from the beginning of physiotherapy - side view)

#### CONCLUSIONS

The use of selected methods of physiotherapy in the treated patient influenced a significant regression of the existing ailments, restored independent existence, and made it possible to return to professional activities.

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Info

#### LICENCE

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### The Effect of Dry Needling, Shock Wave Therapy and Manual Therapy on the Achilles Tendon Enthesopathy. A Case Study

Wpływ suchej igłoterapii, terapii falą uderzeniową i terapii manualnej na entezopatię ścięgna Achillesa. Opis przypadku

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#### SUMMARY

Aim: The aim of the study was to evaluate the effectiveness of the therapy applied on the health condition of a patient with an Achilles tendon injury.

**Case study:** A case study of a 23-year-old runner with an Achilles tendon injury that was diagnosed by an orthopedist. After two plateletrich plasma injections within 6 weeks, the patient was referred for rehabilitation. An ultrasound scan of the Achilles tendon was performed before and after the therapy was applied. Also, three months after the treatment was completed, orthopedic examination was performed - VAS scale, algometry and ultrasound scanning.

**Conclusions:** The use of the extracorporeal shock wave therapy, dry needling and manual therapy in treating an Achilles tendon injury proved to be highly effective. The orthopedic examination and ultrasound scanning performed 3 months after the treatment was completed showed that the patient's pains and difficulty walking had been removed.

Key words: enthesopathies, Achilles tendon enthesopathy, shock wave, manual therapy

Słowa kluczowe: entezopatie, entezopatia ścięgna Achillesa, fala uderzeniowa, terapia manualna

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#### INTRODUCTION

In modern-world professional and amateur sports, different kinds of injuries seem to be common, regardless of an individual's age or gender. It is worth mentioning, however, that different injuries are discipline-specific, a good example of which is an Achilles tendon injury. The Achilles tendon (also known as the calcaneal tendon) is formed form the triceps surae muscle, which consists of the gastrocnemius and soleus muscles. The muscles unite half way down the calf to become a single flat tendon, which is where the Achilles tendon begins. Several centimeters above the heel bone, the Achilles tendon gets thicker and narrower and winds about 90 degrees. The anatomy of the tendon makes it possible to extend the tendon and release energy during movement. The tendon inserts into the heel bone [1].

There are two bursae that the Achilles tendon have - the deep bursa and the calcaneal bursa. They are often pointed out to be a source of pains. Unlike the other tendons, the Achilles tendon does not have a tendon sheath. It is surrounded by a highly vascularized tissue – paratenon, which plays an important role in healing of the tendon injuries [2, 3]. Being

made up of strong collagen fibers, the tendon can withstand large forces and it is extensible [4].

Enthesopathy is a common Achilles tendon condition. Entheses are bony attachment sites of ligaments, tendons, fascia and joint capsule. All pathologies that affect entheses are defined as enthesopathies. One of the most common conditions are inflammations. They are reported to be caused by different diseases (metabolic diseases, endocrine disorders and others) as well as injuries [5].

When it comes Achilles tendon enthesopathies, rehabilitation consisting of different techniques is said to play a big role in the treatment process. Practice shows that it is the most effective to use a few varied, properly chosen ways of affecting the tissues. Combining dedicated treatments with manual therapy seems to be perfect. Manual therapy is a treatment method using many hands-on techniques in work with patients, the aim which is to manage the disorders within the soft tissue. Properly applied manual therapy results mainly in relieving pain, correcting the posture, increasing flexibility, etc. [6].

Another treatment method that is gaining popularity is needling. There are two main types of needling, i.e., acupuncture

and dry needling. The latter one consists of inserting a fine needle at different angles at MFTrP, the aim of which is to initiate muscle response [7]. This method is applied on underlying muscular trigger points while acupuncture is often used to treat overall disorders. Dry needling is described in the literature as an effective treatment method, but there are also many complications that are likely to occur when this treatment method is applied.

As far as the healing of Achilles tendon injuries is concerned, a shock wave therapy proves to be effective, too. The treatment, which is based on jump change in pressure, is becoming more and more popular. The waves are generated outside of the body and then their energy is transmitted into the body [8]. The waves go into the patient's body 1-60 mm deep, depending on the machine used and the tissue shock wave absorption [9]. Depending on the machine used, shock waves can be either radial or focused [10]. Achilles tendon injuries are often suffered by both professional and amateur runners.

#### DESCRIPTION OF A CASE

A 23-year old sportsperson (male) diagnosed by an orthopaedic specialist on the basis of ultrasound scanning. The patient reported the typical "crackling" sound in the tendon and a thickening about 2.5 cm above the heel bone. On palpation, the tendon was painful and tender. The condition was diagnosed as an Achilles tendon enthesopathy, which was caused by the right leg injury [Figure 1]. The pain level measured with VAS was 7 and the pain level measured with algometry was 2.9 kg/cm<sup>2</sup>.

Platelet-rich plasma injections were first used (the patient had two plasma injections within 6 weeks). The applied treatment, however, did not bring the expected results and did not improve the patient's health. Due to the low effectiveness of the procedure, the patient was referred for rehabilitation.

To continue the healing process, it was decided to simultaneously apply manual therapy techniques (mainly mobilization and traction were used on the soleus and gastrocnemius muscles), shock wave therapy and dry needling. It was assumed that the treatments would allow the patient to regain optimal functioning and that it would eliminate the pains he felt.

There were 5 treatment sessions at intervals of 7-10 days.



Figure 1. Ultrasound image of the right Achilles tendon enthesopathy



Figure 2. Ultrasound image of the healthy right Achilles tendon after rehabilitation

Dry nneedling – needles were inserted along the tendon; the length of the treatment was 10-15 minutes.

Shock wave therapy – frequency 5-10 Hz, pressure (power) 2.3 – 2.8 bar, number of shocks 2000-2500

Manual therapy – mobilization of and traction on the Achilles tendon, stretching of the triceps surae muscle for 15-20 minutes, making the muscles and the tendon more flexible. The Achilles tendon was stretched, mobilized and the dorsiflexion of the foot was performed [Figure 2].

Ultrasound scanning of the tendon was performed both before and after the therapy. Four treatment sessions resulted in considerable improvement, both in the patient's ability to move and the level of pain, which was minimal. The patient himself reported improvement, too. Also, an orthopaedic examination (including ultrasound scanning) showed there were no pains and that the range of motion of the right leg was normal, which proved a high degree of effectiveness of the overall therapy. Once the physiotherapy was over, the pain level measured with algometry was 4.7 kg/cm<sup>2</sup> and the pain level measured with VAS was 2. After 3 months, the patient felt no pain at all – VAS 1, algometry 4.9 kg/m<sup>2</sup>) and he regained full functioning and could continue his running training sessions.

#### DISCUSSION

Over the last years, there has been a significant increase in the number of people interested in taking up physical activity and doing sports, which is, on the one hand, beneficial, but results in a growing number of different types of motor organs injuries. One of the most common and serious soft tissue injuries is damage to the Achilles tendon, currently considered a civilization disease. In the world of sports, the Achilles tendon is one of the body structures most frequently injured, just as the ankle is [11].

Therapists point out that, in fact, there is no single treatment method that could be considered the most effective one – both in the case of acute and chronic Achilles tendon damage. It is stressed that the choice of an appropriate therapy must be based on the assessment of a particular case – the type of injury, diagnosis and the patient's health, etc. [12]. Besides
physical therapy and kinesiotherapy, massages are a frequently used form of intervention in therapeutic management of various Achilles tendon injuries [13]. Numerous studies also emphasize the effectiveness of cryotherapy, laser therapy, ultrasounds, micro currents or shock waves (the method used together with manual therapy and needling in the described case study) [14,15]. Kinesio taping is also commonly applied to treat Achilles tendon enthesopathy [16].

The current case study has confirmed the effectiveness of applying manual therapy, shock wave therapy and dry needling in treating enthesopathy. The results obtained for the patient who had failed the platelet-rich plasma therapy were highly satisfactory. Within three months after the end of the therapy, the pains disappeared completely and the normal range of movements was restored. What is more, the first effects could be observed after four of the five treatment sessions. Other researchers have also observed a generally beneficial effect of the application of shock waves on various types of enthesopathy (including elbow and ankle enthesopathy) [17, 18].

### CONCLUSIONS

- 1. Physiotherapy treatments, including manual therapy, shock wave therapy and dry needling have proved to be a highly effective way of relieving pains caused by the ankle injuries (the Achilles tendon enthesopathy).
- 2. The treatments have also been a very effective way of improving and maintaining the range of movements after an injury diagnosed as an Achilles tendon enthesopathy.
- 3. The therapy effects could still be observed three months after it was completed, which proves high effectiveness of the physiotherapy treatments applied.

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A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of article

### Kurs Balneologiczny doskonalący dla lekarzy w czerwcu 2022 r.



W dniach 30.05- 10.06. 2022 r. odbył się kolejny kurs dokształcający z balneologii, medycyny fizykalnej i uzdrowiskowej. Kurs odbył się w sanatorium St. George w Ciechocinku pod kierownictwem naukowym Prof. dr hab. med. Ireny Ponikowskiej. Obejmował 74 godziny wykładowe oraz 3 godziny ćwiczeń. Celem ćwiczeń było zapoznanie się z praktycznym stosowaniem zabiegów balneofizykalnych w warunkach uzdrowiskowych. Uczestnicy kursu przyjmowali również sami zabiegi balneologiczne, fizykoterapeutyczne oraz ćwiczenia hydrokinezyterapeutyczne w basenie. Większość osób po raz pierwszy miała szanse bliższego zapoznanie się z zabiegami balneofizykalnymi od strony praktycznej.

Celem całego 2-tygodniowego szkolenia było zapoznanie lekarzy mających różne specjalizacje klinicznie z podstawowymi problemami balneologicznymi i uzdrowiskowymi. Znaczna część uczestników nie pracowała jeszcze w uzdrowisku, ale deklarowała chęć w najbliższej przyszłości podjęcia pracy w polskich uzdrowiskach, inni aktualnie pracują w uzdrowisku ale chcieli pogłębić swoją wiedzę. W kursie wzięło udział 34 lekarzy z całej Polski reprezentujących prawie wszystkie specjalizacje lekarskie kliniczne. Warto zaznaczyć że w zajęciach uczestniczyło 2 profesorów oraz 8 lekarzy ze stopniem doktora nauk medycznych. Wstępne zainteresowanie kursem było bardzo duże, ale w końcowej fazie znaczna część lekarzy z różnych powodów rezygnowała z odbycia kursu

Kurs obejmował zagadnienia podstawowe z zakresu geologii uzdrowiskowej, klimatologii, balneochemii, wskazań i przeciwwskazań do leczenia uzdrowiskowego oraz wybrane dziedziny kliniczne w aspekcie uzdrowiskowym, jak: ortopedia, reumatologia, nadciśnienie tętnicze, kardiologia, ginekologia, diabetologia, psychogerontologia i inne tematy kliniczne. Ponadto zapoznano uczestników z najważniejszymi metodami stosowanymi w lecznictwie uzdrowiskowym, jak: balneohydroterapia, peloidoterapia balneogazoterapia, hydroterapia, kinezyterapia, ciepło- i zimnolecznictwo, ultrasonoterapia, magnetoterapia, laseroterapia, elektroterapia. Do prowadzenia wykładów zaproszono wybitnych specjalistów, którzy od wielu lat z nami współpracują. Wykładowcami byli pracownicy naukowi reprezentujący różne dziedziny kliniczne oraz mający równocześnie specjalizację z balneologii i medycyny fizykalnej. Taki dobór wykładowców gwarantuje wysoki poziom dydaktyczny szkolenia. Wszystkie zajęcia odbywały się kontaktowo, co sobie uczestnicy niezwykle cenili.

Na zakończenie kursu uczestnicy zobowiązani byli do zdania testu obejmującego 42 pytania jednorazowego wyboru z tematyki poruszanej na kursie. Wszyscy uczestnicy test zdali z wynikiem dobrym i bardzo dobrym, a 1 osoba z wynikiem celującym, odpowiadając prawidłowo na wszystkie pytania.

Z satysfakcją podkreślam, że wszyscy uczestnicy wykazywali duże zainteresowanie, pilnie korzystali z zajęć dydaktycznych, po wykładach odbywała się ożywiona dyskusja. Zgodnie z opinią lekarzy kurs był na wysokim poziomie, miał charakter interdyscyplinarny. Wielu uczestników było zdziwionych tak szeroką i głęboką wiedzą w zakresie lecznictwa uzdrowiskowego. Część lekarzy uczestniczących w kursie deklarowała chęć podjęcia specjalizacji z balneologii i medycyny fizykalnej, chociaż wcześniej tego nie planowali.

W czasie trwania kursu panowała koleżeńska, pełna życzliwości atmosfera. Przed wyjazdem do domów wszyscy wymienili się adresami celem kontynuacji znajomości i współpracy. Zwyczajem jest uwiecznienie udziału uczestników kursu na zdjęciu "familijnym", które załączam.

Dziękuję wszystkim uczestnikom za zaangażowanie i wytworzenie koleżeńskiej atmosfery. Mam nadzieje ze zdobyta wiedza będzie przydatna w dalszej karierze zawodowej.

> Kierownik naukowy kursu Prof. dr hab. Irena Ponikowska

## **Reha INNOVATIONS. Mocny debiut!**

Innowacje, wiedza i relacje – te trzy słowa najlepiej oddają charakter premierowej edycji Reha INNOVATIONS "Fizjoterapia. Nowoczesna diagnostyka. Odnowa biologiczna", która 13-14 maja odbyła się w EXPO Kraków. Pierwsze na południu kraju wydarzenie dla fizjoterapeutów, kadry zarządzającej ośrodkami medycznymi i pacjentów było połączniem wystawy targowej, warsztatów eksperckich, wykładów otwartych i networkingu. Dywersyfikacja działań podjętych przez Targi w Krakowie sprawiła, że impreza przez wielu okrzyknięta została najciekawszym i najbardziej obiecującym wydarzeniem w branży.

### **TECHNOLOGIA W SŁUŻBIE CZŁOWIEKOWI**

Ambicją organizatorów Reha INNOVATIONS było stworzenie dogodnej przestrzeni do prezentacji produktów oraz nowych rozwiązań w zakresie profilaktyki, diagnozowania i leczenia w fizjoterapii, medycynie fizykalnej, inżynierii biomedycznej, medycynie sportowej, osteopatii oraz lecznictwie uzdrowiskowym. Plan ten udało się zrealizować, ponieważ na targach ofertę zaprezentowało 60 wystawców z topowych marek, którzy przez dwa dni szczegółowo odpowiadali na pytania zwiedzających i umożliwiali testowanie urządzeń. Słowem kluczem minionej imprezy była innowacja.

Doświadczenie (customer experience) klientów jest niezwykle ważne, dlatego wystawcy zadbali o to, aby zwiedzający mogli osobiście sprawdzić możliwości, jakie daje prezentowany sprzęt. Targi od lat są zwierciadłem branży. To tutaj można podpatrzeć nadchodzące trendy. Prezentowane rozwiązania bardzo szybko znajdują odbiorców i trafiają do gabinetów, dlatego targi są doskonałym miejscem na... premiery. Potencjał ten wykorzystała firma Koordynacja, która na Reha INNOVATIONS po raz pierwszy w Polsce zaprezentowała AntiGRAVITY Platform - AGP– platformę do ćwiczeń mięśni antygrawitacyjnych z wykorzystaniem sprzężenia zwrotnego.

### SIŁA SPOTKAŃ

Targi Reha INNOVATIONS były dowodem na to, że pomimo licznych zmian wokół jedno pozostaje niezmienne potrzeba bezpośredniego kontaktu z drugim człowiekiem. Targi pozwalają poczuć tętno branży. Wystawcy bliższej poznają potrzeby odwiedzających, a odwiedzający mogą szczegółowo zapoznać się z oferowanym rozwiązaniem. Wiele sprzętów trzeba po prostu zobaczyć, dotknąć, przetestować. Jesteśmy tutaj po długiej przerwie spowodowanej pandemią i bardzo się cieszymy, że możemy wyjść do ludzi, pokazać nasze innowacje, pokazać nasz sprzęt i zaprezentować nowości. Jest to fantastyczna okazja, żeby spotkać się wreszcie twarzą w twarz, a nie przez internet..



### **REKORD GUINNESSA**

Wisienką na torcie był ustanowiony przez Valerjana Romanovskiego nowy rekord Guinnesa w najdłuższym kontakcie ciała ze śniegiem. Polak z Wileńszczyzny przebywał w śniegu 1 godzinę, 45 minut i 9 sekund i tym samym pobił rekord ustanowiony w 2013 roku przez Oleksiya Gutsulyaka z Ukrainy wynoszący 60 minut i 8 sekund. Mężczyzna ubrany jedynie w kąpielówki położył się na pokrywie śnieżnej liczącej około 50 cm, a następnie został zasypany ponad 70-centymetrową warstwą śniegu. W trakcie bicia rekordu specjaliści na bieżąco monitorowali i analizowali parametry życiowe mistrza i dzielili się obserwacjami z widzami.

Valerjan Romanovski osiągnął doskonały wynik, a po wyjściu spod śniegu był w bardzo dobrej formie.

Valerjan Romanovski stale przesuwa granice – testując organizm w najtrudniejszych warunkach. Pobił rekord najdłuższego kontaktu ciała z lodem, przez kilka dób podróżował rowerem po mroźnej Jakucji w temperaturze –50°C, spędził 100 godzin w komorze termoklimatycznej w temperaturze odczuwalnej –60°C, spożywając jedzenie w postaci lodu i jak sam mówi – największą satysfakcję daje mu wydobywanie z organizmu możliwości czy zasobów wcześniej uśpionych.

### **OGROMNY ZAPAŁ**

Debiut zawsze wiąże się z ryzykiem, jednak w przypadku Reha INNOVATIONS ryzyko to warto było podjąć. Wystawcy nie kryli zadowolenia z organizacji targów na południu kraju, co dla wielu stało się szansą na otwarcie na nowy rynek. Poziom przygotowania imprezy został doceniony przez wystawców, którzy w EXPO Kraków czuli się komfortowo. Z całą pewnością słowa uznania są najlepszą motywacją do rozwoju imprezy przez organizatorów.

(em)

# XI MIĘDZYNARODOWE DNI FIZJOTERAPII 26-28 MAJA 2022 R. WROCŁAW "OD JUNIORA DO SENIORA– FIZJOTERAPIA ŁĄCZY POKOLENIA"

Konferencja Międzynarodowych Dni Fizjoterapii już na stałe wpisała się w kalendarz naukowych spotkań środowiska fizjoterapeutów, lekarzy, kosmetologów, terapeutów zajęciowych, naukowców z różnych stron świata.

Głównym tematem XI Międzynarodowych Dni Fizjoterapii było zwrócenie uwagi na istotną rolę nowoczesnej i kompleksowej fizjoterapii na każdym etapie życia człowieka- od juniora do seniora. Wszystkie ośrodki naukowe, z których pochodzili prelegenci oraz autorzy plakatów XI Międzynarodowych Dni Fizjoterapii, to placówki prowadzące badania naukowe w obszarach: nauk medycznych i nauk o zdrowiu, nauk humanistycznych oraz nauk społecznych. To przedstawiciele wielu dziedzin i dyscyplin naukowych, w tym nauk o kulturze fizycznej, jak również nauk medycznych i nauk o zdrowiu.

Prezentowano prace oryginalne i eksperymentalne, które w zdecydowanej większości finansowane były przez macierzyste dla autorów jednostki naukowe i naukowodydaktyczne, jak również instytucje finansujące badania naukowe, m.in. Narodowe Centrum Nauki oraz zagraniczne instytucje badawczo-rozwojowe. Przeprowadzone w trakcie XI Międzynarodowych Dni Fizjoterapii rozważania, inspirowane wynikami badań podstawowych i klinicznych oraz analizy rodzajów praktycznego działania terapeutycznego, podkreślały ogromną wagę naukowego podejścia do nowoczesnej i kompleksowej rehabilitacji uwzględniającej kolejne etapy naszego życia.

Uroczyste otwarcie konferencji wzbogacone zostało wykładami inauguracyjnymi, które wygłosili: prof. dr hab. Anna Skrzek pt. 25-lecie Wydziału Fizjoterapii Akademii Wychowania Fizycznego we Wrocławiu w obiektywie) oraz prof. Jason Crandall z Western Kentucky University

Wśród prelegentów pojawiło się liczne grono wybitnych fizjoterapeutów, lekarzy i naukowców z Polski, Czech, Hiszpanii, Szwecji, Włoch i Stanów Zjednoczonych.

Sesje naukowe dotyczyły następujących tematów m.in.: Aktywność fizyczna i styl życia na różnych etapach życia - od Juniora do Seniora, Zastosowanie nowoczesnych technologii w rehabilitacji i terapii, Kompleksowa rehabilitacja a jakość i styl życia w chorobach wewnętrznych i chorobach układu nerwowego, Znaczenie terapii zajęciowej w kompleksowej rehabilitacji na różnych etapach życia.

Odbyły się liczne warsztaty skierowane do juniorów i seniorów oraz warsztaty tematyczne dla studentów. Imprezami towarzyszącymi konferencji były: wernisaż prac uczestników warsztatów arteterapii "Pasja nie ma wieku" oraz Dziecięca sesja plakatowa z udziałem dzieci z Polski i Ukrainy.



Patronem medialnym Konferencji było: Wydawnictwo Aluna wydawca czasopisma Acta Balneologica oraz MDPI International Journal of Environmental Research and Public Health.

Konferencja Międzynarodowych Dni Fizjoterapii już na stałe wpisała się w kalendarz naukowych spotkań środowiska fizjoterapeutów, lekarzy, kosmetologów, terapeutów zajęciowych, naukowców z różnych stron świata. Prezentowano prace oryginalne i eksperymentalne. Przeprowadzone w trakcie XI Międzynarodowych Dni Fizjoterapii rozważania, inspirowane wynikami badań podstawowych i klinicznych oraz analizy rodzajów praktycznego działania terapeutycznego, podkreślały ogromną wagę naukowego podejścia do nowoczesnej i kompleksowej rehabilitacji uwzględniającej kolejne etapy naszego życia.

(ał)

