Patronage of Committee of Rehabilitation, Physical Education and Social Integration of the Polish Academy of Sciences

Acta Balneologica

ISSN 2082 - 1867

Published since 1905

JOURNAL OF THE POLISH BALNEOLOGY AND PHYSICAL MEDICINE ASSOCIATION

2025 MARCH-APRIL VOL. LXVII ISSUE 2 (186)

● HEALTH-RESORT MEDICINE ● PHYSICAL MEDICINE ● BIOCLIMATOLOGY

INDEXED IN EMERGING SOURCES CITATION INDEX THOMSON REUTERS

ISSN 2082-1867

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Aluna Publishing

Acta Balneologica

PUBLISHER:
ALUNA Publishing
29 Z.M. Przesmyckiego St.
05-510 Konstancin Jeziorna, Poland
www.actabalneologica.pl

PROJECT COORDINATOR:
MEDDOM PRESS
tel. 604-208-453
barbadom@wp.pl

GRAPHIC DESIGN:
PHU Piotr Dobrzyński,
www.poligrafia.nets.pl

The journal is indexed in Web of Science – ESCI (IF 0.3), Index Copernicus, EBSCO, Ministry of Science and Higher Education and the Polish Medical Bibliography

CONTENTS

ORIGINAL ARTICLE

Evaluating the effectiveness of a robotic rehabilitation algorithm in functional testing in patients with cerebral palsy

Anna Krzyżańska[1,2], Wojciech Popłonyk[1], Marek Jóźwiak[1]

[1]PEDIATRIC ORTHOPEDIC AND TRAUMATOLOGY DEPARTMENT, WIKTOR DEGA ORTHOPEDIC AND REHABILITATION UNIVERSITY HOSPITAL, POZNAN UNIVERSITY OF MEDICAL SCIENCES, POZNAN, POLAND
[2]DOCTORAL SCHOOL POZNAN UNIVERSITY OF MEDICAL SCIENCES, POZNAN, POLAND

ABSTRACT

Aim: The purpose of this study is to evaluate the functional improvement achieved after a six-week rehabilitation program using an exoskeleton and technology.

Materials and Methods: Eighteen individuals with cerebral palsy were evaluated. The group was divided according to the Gross Motor Function Classification System: I- 3, II- 9, III- 6. Patients' ages were 12- 41 years (mean 17.9). Patients were subjected to a homogeneous technology-assisted rehabilitation program. They began with a warm-up on a stationary bicycle. This was followed by strength training using elastic resistance on the JUPITER and TELKO, body weight transfer training on the AFLA and GAMMA platform, gait re-education in an exoskeleton with functional electrostimulation, and training on the Zebris treadmill. Assessment was performed using functional tests: 6 Minute Walking Test, UP&GO.

Calculations were performed using Statistica 13 software from TIBCO and PQStat software from PQStat Software. $\alpha=0.05$ was used as the level of significance. A result was considered statistically significant when $p<\alpha$. Normality of the distribution of the variables was tested using the Shapiro-Wilk test. Sphericity was examined using the Mauchley test.

Results: The results showed a statistically significant improvement in functional tests: a decrease in the UP&GO test execution time and an increase in the distance in the 6MWT test.

Conclusions: Technology-assisted rehabilitation has proven effective in improving patients' motor functions, as well as stability and postural control during gait. These results are particularly important because these tests are considered indicators of falls risk and level of mobility.

KEYWORDS: walking, locomotion, exoskeleton, technology

Acta Balneol. 2025;67(2):85-89. doi: 10.36740/ABAL202502101

INTRODUCTION

Cerebral palsy (CP), due to its frequency of occurrence in the population, is a very well-studied disease entity. It is estimated that there are about 18 million people with cerebral palsy worldwide. About 40 percent of cases are due to premature birth. The picture of patients varies widely, but a common feature is impaired movement, especially gait. To evaluate the condition of patients, we use various diagnostic methods and tests focused on functions in the upper and lower extremities. Particularly helpful is the Gross Motor Classification System (GMFCS), which allows us to predict the functional capabilities that a child will achieve in the future and allows us to adjust diagnostic methods, rehabilitation and surgical treatment. The cooperation with the patient is long-term, requiring detailed diagnostics before and after the applied treatment. In the absence of improvement or in the case of deterioration, we receive clear information about the need to change the treatment procedure.

Today, rehabilitation in many centers is based on supplementing conventional therapy with technology and robotics. This helps keep patients focused and engaged at a very high level. Upright, stationary and mobile robots facilitate static verticalization, dynamic verticalization and gait re-education. Stations using feedback mobilize patients to achieve better and better results and beat their previous records, performing active exercises with resistance or training on stabilomeric and dynamographic platforms [1-4].

AIM

The aim of the study was to evaluate the clinical effectiveness of using a six-week protocol in colmpex rehabilitation for individuals with cerebral palsy.

MATERIALS AND METHODS

The research began with approval from the local bioethics committee.

Patients referred from orthopedic outpatient clinics based on the information provided on inclusion and exclusion criteria and from the database of patients rehabilitated at X- Rehab Poznań at the Wiktor Degi Orthopedic and Rehabilitation Clinical Hospital in Poznań were eligible for the study.

During the study, each patient underwent 28 treatment days and two study days. The entire protocol of the study is shown (Fig. 1). During the study days, assessment was carried out using the Gross Motor Function Measure (GMFM), the UP & GO test, (TUG) and the 6-minute walking test (6MWT).

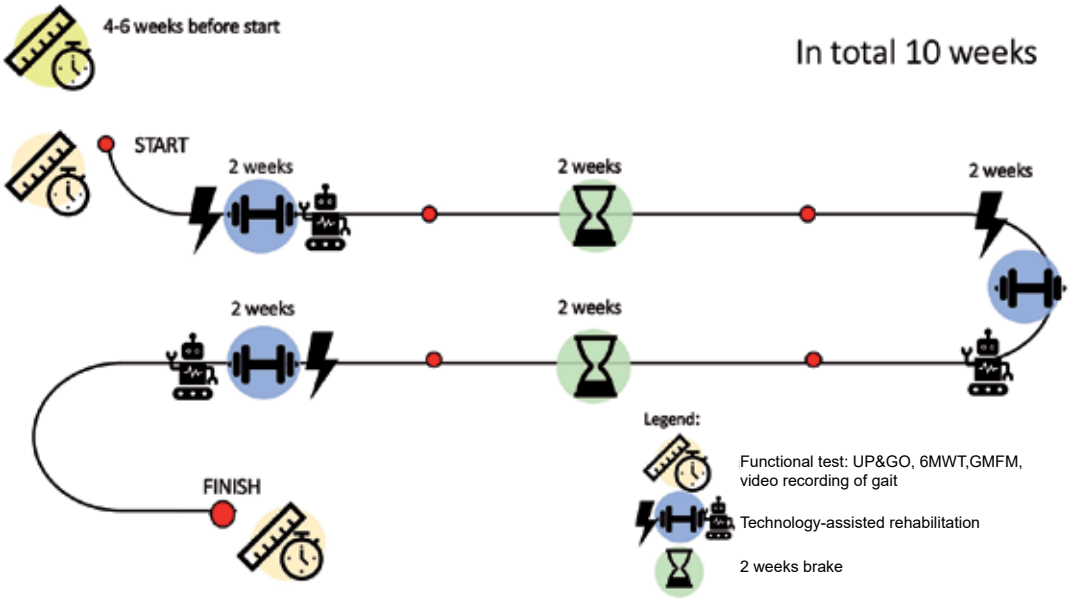

Fig. 1. Rehabilitation protocol.

Homogeneous protocol was implemented as part of the rehabilitation program. The first component of the protocol is stationary cycling. Next, patients performed muscle strengthening exercises on equipment with elastic resistance: JUPITER and TELKO. The JUPITER was used for exercises to strengthen the extensor muscles of the knee joint. TELKO, through a triceps movement, strengthens all muscle groups, especially the knee joint extensors and hip extensor muscles. Another element was load distribution training using the GAMMA and ALFA platform. Training on the GAMMA platform is designed to prepare the patient to smoothly transfer weight from one limb to the other. Training on the ALFA platform as the next level of difficulty prepares the patient to smoothly transfer weight from one limb to the other, additionally from forefoot to rearfoot and vice versa.

Training in the EKSO NR exoskeleton. Workouts started with a few minutes, gradually increasing the time during subsequent workouts. The exoskeleton was individually adjusted to the patient's height, but also to the functional level and degree of spasticity.

During the course of the therapy, the exoskeleton was additionally fitted with a functional electrostimulator, which provides the possibility of working on 8 channels, 4 for each limb. A prerequisite for the use of the exoskeleton is the ability to walk smoothly in the exoskeleton. Patients using the exoskeleton for the first time as part of the study were given several days of adaptation, then the functional electrostimulator was incorporated into the therapy [5, 6].

Depending on the nature of the muscle tension disorder, the electrostimulator allows muscle strengthening or muscle relaxation training. We have options for settings for endurance training, strengthening training, training to reduce spasticity, training to reduce overall tension. The manufacturer of the functional electrostimulator provides settings for post-stroke and spinal cord injury patients. For patients with cerebral palsy, a post-stroke protocol was used (Table 1).

The next stage was training on the Zebris H/P Cosmos treadmill - the incline of the treadmill belt ultimately 10 degrees upwards. In very fit patients, an additional load was applied to the lower limbs (cuff weights) and a weighted vest. Individual exercise stations and duration are shown in Figure 2.

FUNCTIONAL EVALUATION

TUG and 6MWT were used for functional assessment. The tests were performed 4-6 weeks before the start of rehabilitation, then on the first day of rehabilitation and on the last day of rehabilitation. All patients performed the tests

Table 1. Functional electrostimulation parameters

	Impulse time	Frequency	Ramp/modulation
The first training session	150	30	3
Initial introduction	50	20	0
Endurance training	200	25	3
Strength training	250	40	3
Reducing spasticity	200	25	3
Reducing tension	300	45	3

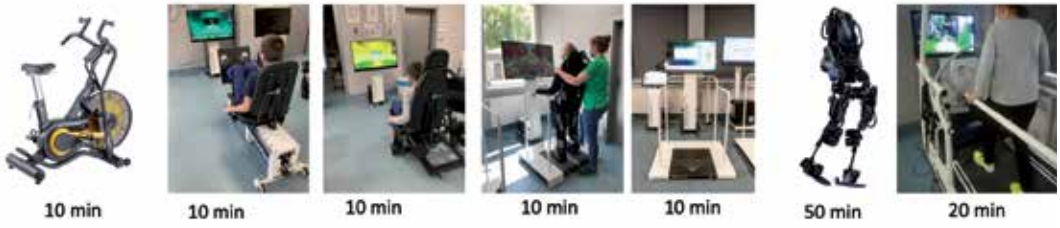

Fig. 2. Sequence of therapy.

in the same place and in the same way. The GMFM test was performed only at the beginning of therapy and at the end.

Group characteristics:

- 18 individuals with cerebral palsy.
- Age 12-41 years (mean 18,9).
- 11 females, 7 males.
- GMFCS looks as follows I- 3 individuals, II- 9 individuals, III- 6 individuals.

Inclusion criteria:

- Diagnosed cerebral palsy.
- GMFCS I-III.
- Ability to walk independently or to walk with assistance (ability to walk at least 4-5 meters independently, with a balcony, on crutches or with one arm held by a companion.
- No contraindications to gait training on the part of musculoskeletal or other systems,
- Height from 150- 195 cm.
- Written consent of the adult, parents or guardians of the child to participate in the study.

Exclusion criteria:

- Less than 6 months after botulinum toxin administration, and lower extremity surgery performed within the last year.
- Dislocation or subluxation of the hip joints.
- Contractures in the knee joints of more than 20 degrees.
- Significant foot deformities.
- Lack of cooperation from the patient.
- Advanced osteoporosis that prevents safe standing or may cause fractures during gait training or standing.
- Active drug-resistant epilepsy,
- Open skin lesions around the trunk and/or lower extremities.
- Cardiac contraindications to gait training.

One of the most important elements regarding the criteria is the height of the patient, which enabled the use of the exoskeleton. All patients had to be at least 150 cm tall, with appropriate lengths of the thigh and shin segments, but the movements taking place while walking in the exoskeleton were in the correct axes at the knee and hip joints. Patients' height ranged from 150 cm to 185 cm.

RESULTS

TUG

The results show significant functional improvement in patients after the intervention. The UP&GO test time was reduced in the study performed on the first day of rehabilitation and the last day. The study performed within the "observation window" without intervention shows no change. The average time obtained in study one was 13 seconds, in study two it was 12, and in study three it was 10 seconds (Fig. 3).

6MWT

The results show functional improvement in the patients. The gradual increase in the distance of the test performed within the "observation window" without intervention shows little change, in addition, we again observe an increase in the distance after the intervention was applied. The average distance obtained in test one was 335 meters, in test two it was 348, and in test three it was 377 meters (Fig. 4).

Calculations were performed using Statistica 13 by TIBCO and PQStat software by PQStat Software. $\alpha=0.05$ was used as the level of significance. A result was considered statistically significant when $p<\alpha$. Normality of the distribution of the variables was tested using the Shapiro-Wilk test. Sphericity was examined using the Mauchley test. In the case of conformity to the normal distribution and preserved sphericity, the test of analysis of variance for paired samples was calculated with the Tukey test of multiple comparisons; in the absence of preserved sphericity, the Greenhous-Geisser correction was applied. In the absence of fit to a normal distribution, the Friedman test with the Dunn-Bonferroni test of multiple comparisons was applied.

Patients showed statistically significant improvement in functional tests: a decrease in UP&GO test time and an increase in distance in the 6MWT test.

DISCUSSION

Research confirms that TUG has excellent reliability both performed in a single session and in repeated tests after the therapy has been administered in individuals with CP between the ages of 3 and 12, provided the child understands the instructions. The TUG test combines the assessment of repositioning with walking skills and provides information on functional ability that is relevant to most individuals; therefore, it therefore, it can be used as a reliable indicator to assess functional mobility in children with CP [7-10].

The Six-Minute Gait Test is also an excellent test, which is a submaximal, valid and reliable test used to assess endurance and aerobic capacity in children with CP.

The results show significant functional improvements in patients after the intervention. A reduction in the time to perform the UP&GO test and an increase in the

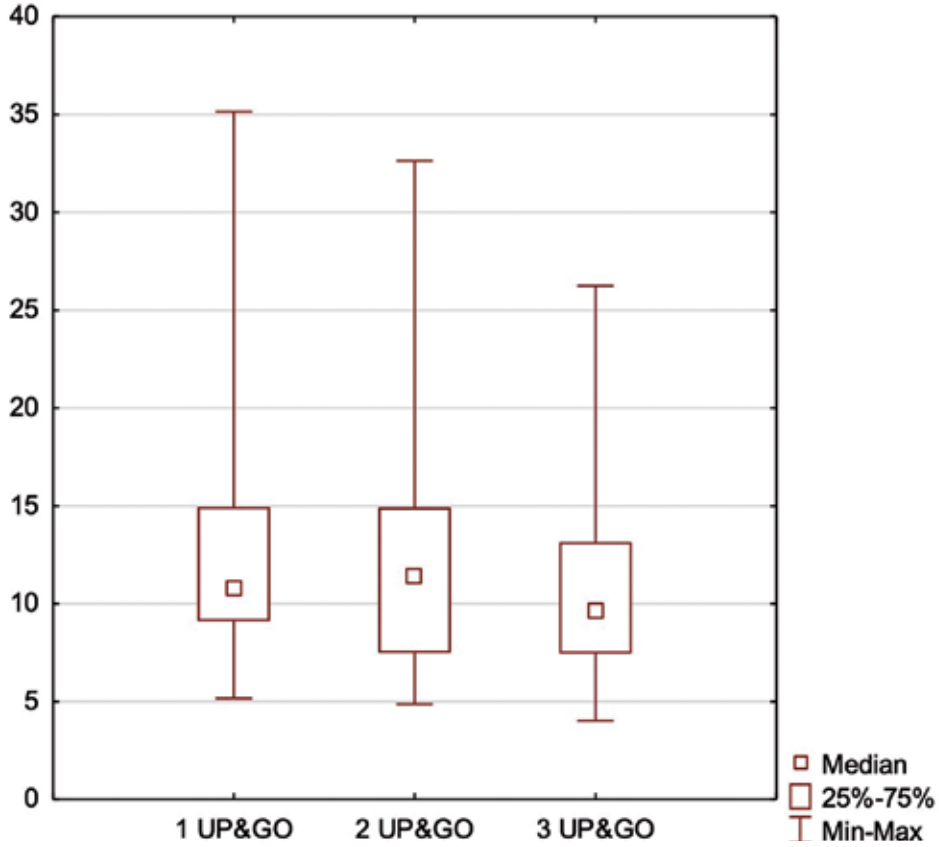

Fig. 3. UP&GO test results.

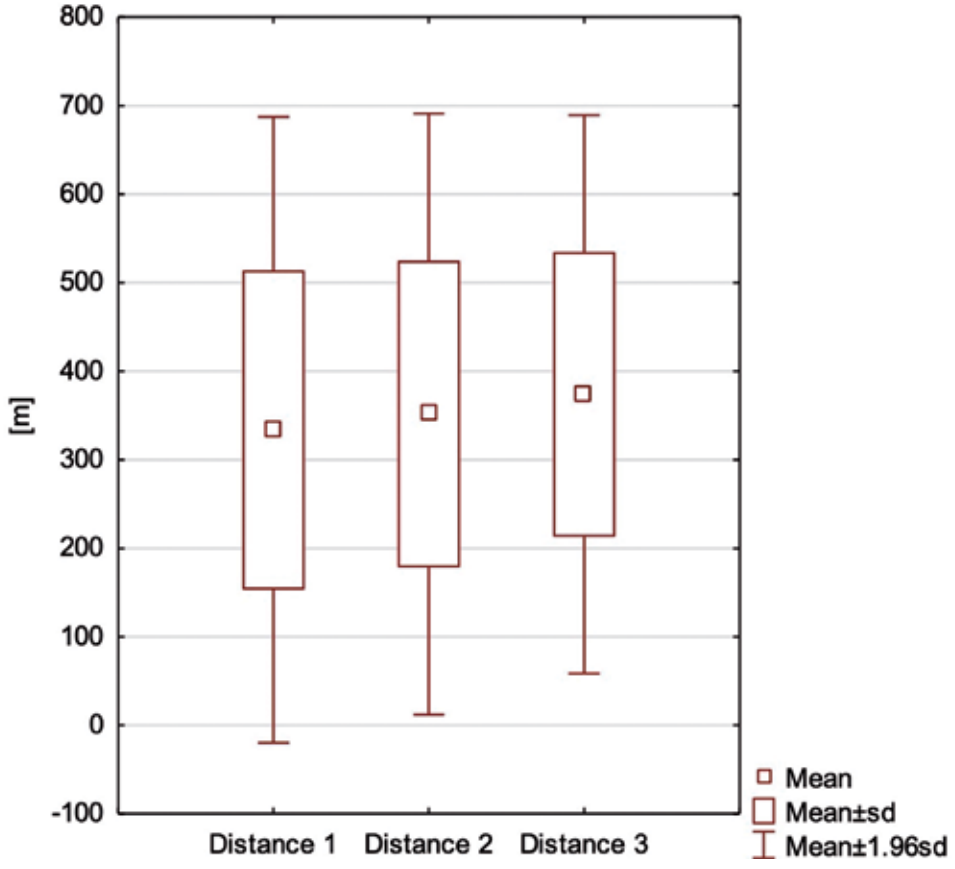

Fig. 4. 6MWT test results.

distance in the 6MWT test indicate an improvement in mobility and physical fitness, reflecting better functioning in daily activities. These results are particularly important, as these tests are considered indicators of falls risk and mobility level. This is the initial phase of the study. The target group is to have 60 subjects with 20 in each GMFCS group [11-15].

The proposed diagnostic and rehabilitation protocol can be used in rehabilitation wards and sanatoriums. Increasing accessibility would enable a more thorough study of the impact of technology-assisted rehabilitation on individuals with cerebral palsy.

CONCLUSIONS

Technology-assisted rehabilitation proved effective in improving patients' motor function, as well as stability and postural control during gait. The improvement was mainly related to movement dynamics.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Anna Krzyżańska
Department of Pediatric Orthopedics and Traumatology,
Poznan University of Medical Sciences, Poznan, Poland
e-mail: krzyzanska123@gmail.com

ORCID AND CONTRIBUTIONSHIP

Anna Krzyżańska: 0000-0003-0486-508X (A) (B) (C) (D)
Wojciech Popłonyk: 0009-0002-2195-7154 (B)
Marek Jóźwiak: 0000-0002-7496-8722 (F)

(A) – Work concept and design, (B) – Data collection and analysis, (C) – Responsibility for statistical analysis, (D) – Writing the article, (E) – Critical review, (F) – Final approval of the article

RECEIVED: 05.01.2025
ACCEPTED: 24.03.2025

ORIGINAL ARTICLE

Gonarthrosis as a clinical and social problem: analysis of physical therapy after knee arthroplasty

Włodzisław Kuliński[1], Mateusz Kaczmarczyk[2]

[1]DEPARTMENT OF REHABILITATION, MILITARY INSTITUTE OF MEDICINE-NATIONAL RESEARCH INSTITUTE, WARSAW, POLAND
[2]COLLEGIUM MEDICUM, JAN KOCHANOWSKI UNIVERSITY, KIELCE, POLAND

ABSTRACT

Aim: To analyse and evaluate physical therapy in patients after knee arthroplasty.

Materials and Methods: The study involved 40 patients after knee arthroplasty who underwent physical therapy and rehabilitation for a period of three weeks.

Results: After treatment, patients showed resolution of pain, a radically improved walking ability, an increased range of mobility in the knee joint, and a better quality of life.

Conclusions: 1. Arthroplasty is a procedure that has a positive effect on the condition of patients. 2. The procedure helped improve mobility, increase quality of life, and eliminate pain. 3. Prevention is based on engaging in regular physical activity, maintaining a normal body weight, and undergoing physical therapy and rehabilitation.

KEYWORDS: knee osteoarthritis, arthroplasty, physical therapy

Acta Balneol. 2025;67(2):90-95. doi: 10.36740/ABAL202502102

INTRODUCTION

Knee osteoarthritis (gonarthrosis) is a progressive disease characterised by the gradual damage and loss of joint cartilage. It constitutes the main cause of disability in aging societies.

Knee osteoarthritis currently affects 250 million people worldwide. In the European population, it can be found in approximately 15% of women and 10% of men over the age of 60 years [1-8].

This condition is a multifactorial process that leads to the destabilisation of the development and degeneration of cartilage and the subchondral layer of bone, thus affecting all joint tissues. Knee osteoarthritis (OA) is the most common cause of musculoskeletal symptoms, with an onset at the age of 40 to 60 years. OA is found in 80% of people over the age of 75 years. In Poland, OA affects an estimated 4 million people. In the US, OA is found in approximately 15% of the population, which is approximately 20 million people, and almost 500,000 total joint arthroplasty procedures are performed per year. In Western Europe, OA affects approximately 13% of the population. The incidence of this condition is similar in men and in women, but its more severe forms occur in women [6-16].

In its early stage, OA is mainly associated with pain during movement. The pain increases over time, and patients experience stiffness as well as pain at rest and at night. OA-specific radiographic changes in the knee joints are found in 19-28% of people examined at the age of over 45 years and in approximately 37% of people examined at the age of over 60 years [1-8].

OA is the most common cause of pain and functional impairment in people over 60 years of age. It is one of the main diseases of civilisation, along with diabetes and ischaemic heart disease.

OA is a serious social, economic, and health problem. The annual cost of treatment in industrialised countries is estimated to constitute 1–2.5% of the gross domestic product. OA symptoms are responsible for a lower quality of life. OA patients are initially able to compensate for the disability; however, in later stages the condition leads to functional impairment and pain. For many people, this means they can no longer perform certain everyday activities, which makes them feel excessively dependent on others and affects their mental state, emotional functioning, and social life. Moreover, OA patients often lose the ability to work, which worsens their financial situation.

Pain caused by the affected knee joint is usually present at the joint itself and in the upper part of the shin. Patients usually find it more difficult to walk down stairs than to climb stairs. Varus knee alignment is more common than valgus deformities. Knee joint contours become deformed over time, and in cases with advanced changes, where knee movement is limited, patients may show quadriceps femoris atrophy, joint contractures, and symptoms of enthesopathy.

There are two basic forms of this condition: primary and secondary. The primary form results from degenerative

Fig. 1. Bilateral knee osteoarthritis.

changes occurring as the patient ages while the secondary form is caused by congenital joint defects or systemic, inflammatory, and genetic disease. The following forms can be described based on the location of changes in the knee joint:

- medial, most common, accompanied by varus knee deformities,
- lateral, less common, accompanied by valgus knee deformities,
- patellofemoral (so-called patellofemoral conflict) [1-5].

When conservative treatment fails and the pain and joint function impairment cause a marked reduction in the quality of life, patients undergo surgical treatment in the form of total knee arthroplasty.

Kinesiotherapy starts as soon as the next day after surgery. On the first post-operative day, patients perform isometric exercises of the quadriceps femoris. Depending on the surgical approach, isometric exercises are also used. It is important to ensure a proper position of the limb: it should be in abduction and rotation should be prevented, which helps avoid prosthesis displacement. Breathing exercises are an important part of kinesiotherapy on the first post-operative day.

The exercises described above are continued between the second and sixth post-operative day. In addition, patients are verticalised with a walking frame and start the process of gait re-education: in case of arthroplasty, this requires partial weight-bearing three-point gait. Active exercises of the ankle and knee joints, active non-weight-bearing exercises for the range of motion of the hip, and closed chain exercises should be added.

These exercises should be continued between week 2 and week 12, together with active exercises of the hip, knee, and ankle joints. Increasing the intensity of the exercises is also important. Over time, patients gradually stop using orthopaedic aids and walk using a single crutch. Once the surgical wound has healed, exercises in a pool can be introduced along with medium- and short-distance walks. After week 12, exercises are performed with full weight-bearing on the limb. Moreover, patients perform exercises for the full range of joint motion in the lower limb. The programme also includes physical therapy procedures [17-20].

Physical therapy should continue until patients show normal values in gait and clinical examinations. The rehabilitation programme should be tailored to each patient; the above timeline is not rigid and depends on the outcomes achieved in each patient.

AIM

The aim of this study was to analyse and evaluate a physical therapy programme performed in patients after knee arthroplasty.

MATERIALS AND METHODS

The study and follow-up involved 40 patients after knee arthroplasty treated at the Inpatient Rehabilitation Centre at Sandomierska 241B in Kielce. Patients were evaluated before and after surgery, and the results were statistically analysed.

RESULTS

The study included a total of 40 patients after knee arthroplasty. Figure 2 shows the age of study patients.

The vast majority of study patients (almost 80%) were aged 51-60 years. 11% of study patients were under 50 years old, and the other patients were over the age of 61 years. Figure 3 shows types of work performed by study patients.

Most study patients declared that they did manual work (61%) and a little over 30% worked in a sitting position. The others did not work. Study patients were asked to describe their osteoarthritis symptoms (Fig. 4).

Pain due to knee osteoarthritis was reported by most study patients. All patients pointed out that the pharmacological and non-pharmacological treatment they had used did not resolve their symptoms (Fig. 5).

All study patients underwent physical therapy, and 96% reported that their physical therapy had very positive results. In the patients , the following physical rehabilitation procedures were used: ultrasound, cryotherapy, active exercises in non-weightbearing mode, on a rotor for the lower limb, and isometric exercises. Study patients were asked about their weight; the answers are shown in Figure 6.

Based on the body weight values, almost 70% of study patients were classified as overweight or obese. Normal body weight was reported by approximately 30% of study patients.

Study patients were asked if their range of knee joint motion increased after the knee arthroplasty procedure; the answers are shown in Figure 7.

The answers provided by the patients show that the range of knee motion increased after the procedure in the entire study group.

Study patients were asked if they noticed an increase in the walking distance; the answers are shown in Figure 8.

All study patients reported that the distance they were able to walk after the procedure was longer and that the pain had resolved or had been radically reduced (Fig. 9).

The results were statistically analysed. Tests for dependent samples were performed in order to assess differences between the first and the second measurement. Student's t test was used when the assumption of a normal distribution was met, and the Wilcoxon test was used when there

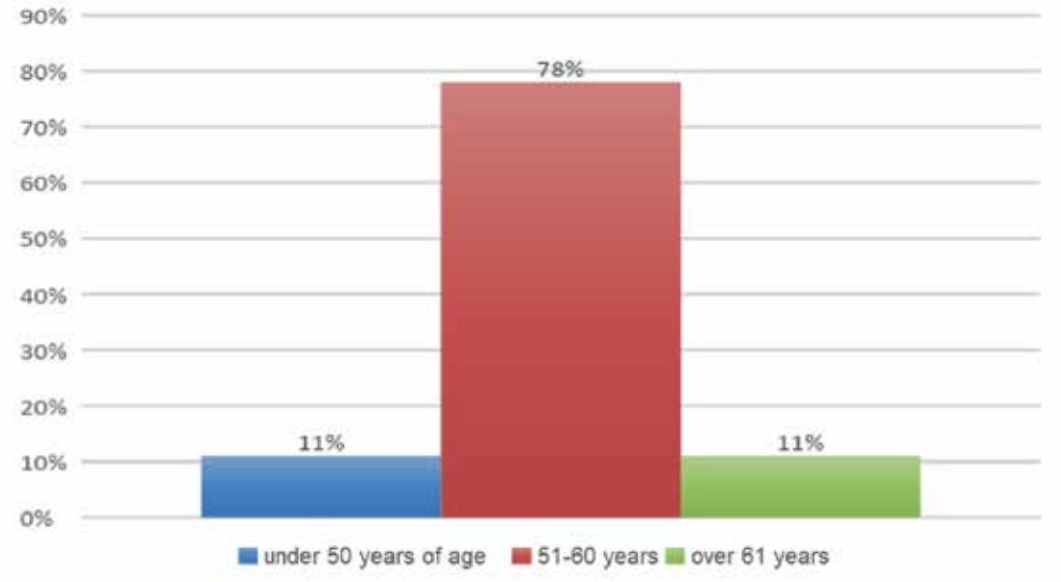

Fig. 2. Age of study patients.

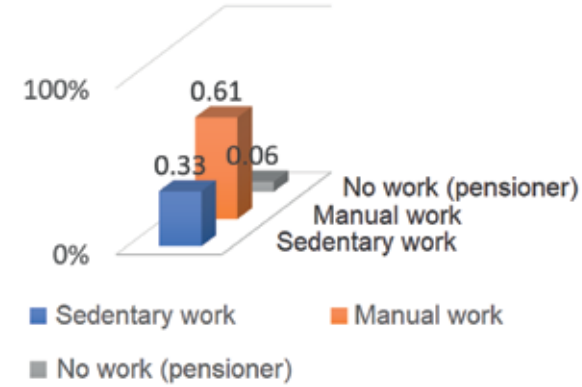

Fig. 3. Type of work performed by study patients.

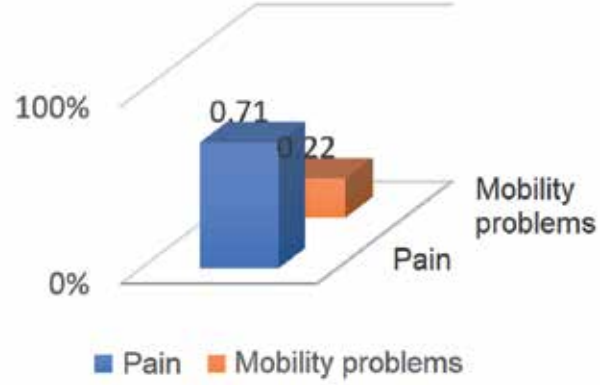

Fig. 4. Osteoarthritis symptoms.

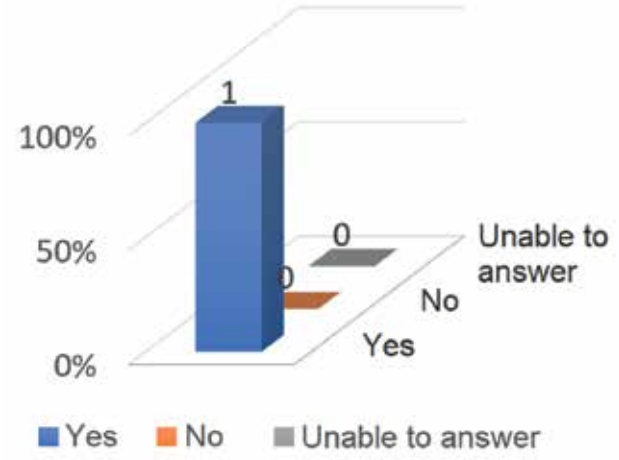

Fig. 5. Physical therapy after arthroplasty procedure.

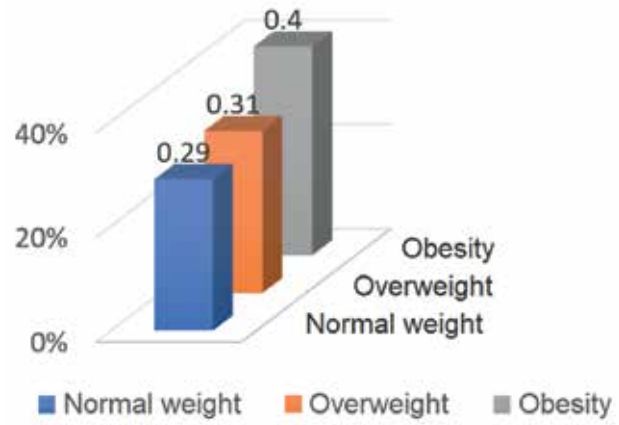

Fig. 6. Weight of study patients.

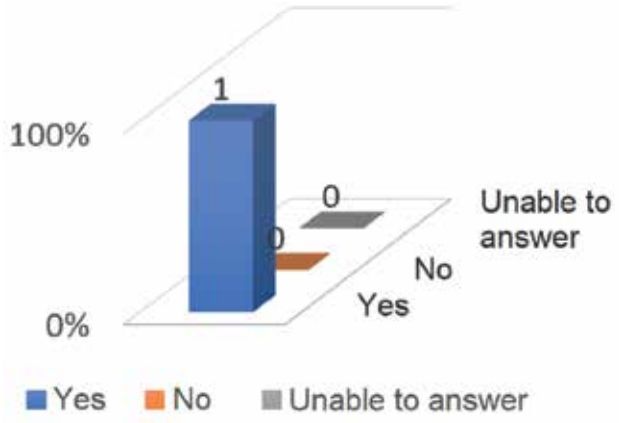

Fig. 7. Increased range of motion after procedure.

were significant deviations. The significance level was set at α=0.05. The data were analysed using the Statistica 13 software.

THE RANGE OF MOBILITY IN THE JOINT WAS EVALUATED

The analysis indicated the presence of significant differences in the range of knee motion before and after treatment

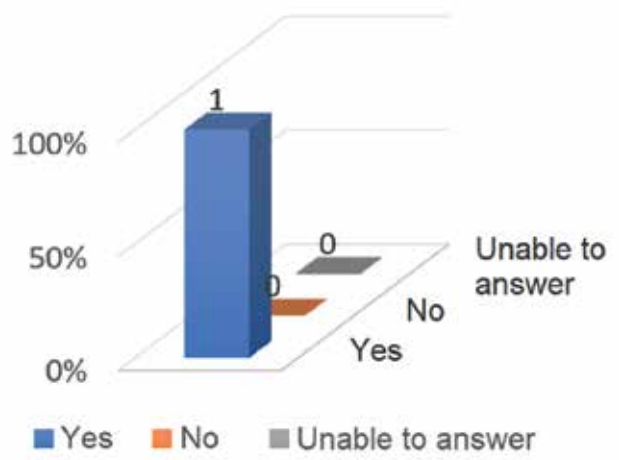

Fig. 8. Increase in walking distance after procedure.

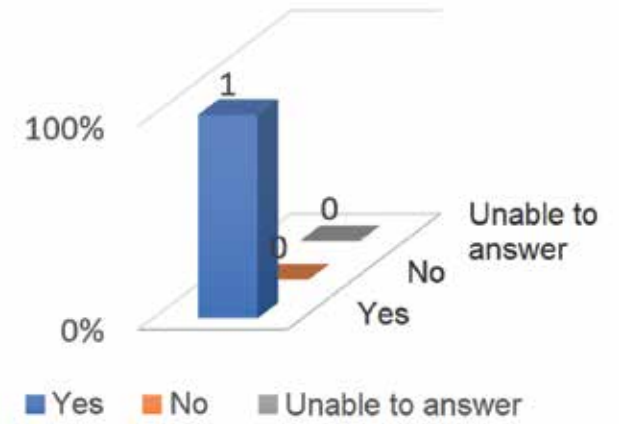

Fig. 9. Pain reduction.

(t(39)=-9.57; p<0.001). The mean range of mobility after treatment was significantly higher (M=100.63; SD=4.52) as compared to the value obtained before treatment (M=88.40; SD=6.92) (Table 1).

The level of pain was evaluated in study patients. The analysis indicated the presence of statistically significant differences in the severity of pain before and after treatment (Z=5.51; p<0.001). The mean level of pain before treatment was significantly higher (M=7.75; Me=8; SD=1.19) than the level measured after treatment (M=2.18; Me=2; SD=1.13) (Table 2).

GAIT

The analysis indicated the presence of statistically significant differences in gait (t(39)=-14.44; p<0.001). The mean result after treatment was significantly higher (M=303.13; SD=35.05) than the result obtained before treatment (M=223.48; SD=35.00) (Table 3).

DISCUSSION

Knee arthroplasty is an increasingly common surgical procedure performed in patients with knee osteoarthritis. This condition leads to gradual joint destruction, increasing pain, and mobility limitations, eventually resulting in a

Table 1. Range of knee mobility before and after treatment

Variable	Descriptive statistics					T-test for dependent samples
	Mean	Median	Minimum	Maximum	SD	t
Range of knee motion before	88.40	88.00	70.00	100.00	6.92	
Range of knee motion after	100.63	99.00	90.00	110.00	4.52	-9.57

SD: standard deviation

Table 2. Pain before and after treatment

Variable	Descriptive statistics					Wilcoxon signed-rank test
	Mean	Median	Minimum	Maximum	SD	t
Pain before	7.75	8.00	5.00	10.00	1.19	0.00
Pain after	2.18	2.00	1.00	5.00	1.13	

SD: standard deviation

Table 3. Gait assessed before and after treatment

Variables	Descriptive statistics					T-test for dependent samples
	Mean	Median	Minimum	Maximum	SD	t
Gait before	223.48	221.50	152.00	294.00	35.00	
Gait after	303.13	303.00	222.00	367.00	35.05	-14.44

considerable decrease in the quality of life. It usually affects elderly individuals.

The present study was conducted in patients after knee arthroplasty treated at the Inpatient Rehabilitation Centre in Kielce. The patients stayed at the centre for 3 weeks, during which period they underwent targeted physical therapy and rehabilitation. In addition, study patients received psychological assistance during their stay at the centre.

An analysis of the results obtained in this study shows that most patients were female and did manual work.

OA prevention requires regular physical activity, a balanced diet that helps maintain a normal body weight, avoiding excessive joint overload, and maintaining a normal body posture.

Patients should also prevent pain by using conservative treatment; rehabilitation is required so that pharmacotherapy can be kept to a minimum. Exercise should be regular to ensure a high quality of life. After arthroplasty, patients must continue to maintain normal muscle strength both in their lower limbs and in their entire body.

This study showed an increased quality of life after knee arthroplasty in all patients. The mean pain score in a VAS measured before the procedure was 7.75; after the procedure, the value decreased to a mean of 2.175. The range of motion in the knee joint increased from a mean of 88.4° before the procedure to 100.6° after the procedure.

Arthroplasty improved gait in a considerable proportion of study patients, who are now able to walk a much longer distance than before surgery. Patients are no longer hindered by pain at work, even though a considerable proportion of the study group were unable to work without experiencing pain before the procedure. The quality of life and pain scores are markedly improved as compared with the values obtained before the surgery. Knee arthroplasty is a method of choice, is effective, and improves functioning; however, conservative treatment with physical therapy and rehabilitation should be used more often as it can markedly delay the need for surgery and improve the quality of life.

CONCLUSIONS

1. Arthroplasty is a procedure that has a positive effect on the condition of patients.
2. The procedure helped improve mobility, increase quality of life, and eliminate pain.
3. Prevention is based on engaging in regular physical activity and maintaining a normal body weight.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Włodzisław Kuliński
Department of Rehabilitation, Military Institute of Medicine
National Research Institute, Warsaw, Poland
e-mail: wkulinski52@hotmail.com

ORCID AND CONTRIBUTIONSHIP

Włodzisław Kuliński: 0000-0002-6419-4030 A C D E F
Mateusz Kaczmarczyk: B C D

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 20.12.2024
ACCEPTED: 04.03.2025

ORIGINAL ARTICLE

Peculiarities of time perception function development in students under the influence of physical activity of different orientation

Mykhailo F. Khoroshukha[1], Grygoriy P. Griban[2], Nadiia A. Orlyk[3], Iryna S. Oliinyk[4], Vadym O. Muzhychok[5], Serhii P. Drachuk[5], Hennadii V. Krotov[6]

[1]BORYS GRINCHENKO KYIV METROPOLITAN UNIVERSITY, KYIV, UKRAINE
[2]ZHYTOMYR IVAN FRANKO STATE UNIVERSITY, ZHYTOMYR, UKRAINE
[3]K. D. USHINSKY SOUTH UKRAINIAN NATIONAL PEDAGOGICAL UNIVERSITY, ODESA, UKRAINE
[4]BOGDAN KHMELNITSKY MELITOPOL STATE PEDAGOGICAL UNIVERSITY, ZAPORIZHZHYA, UKRAINE
[5]KHERSON STATE AGRARIAN AND ECONOMIC UNIVERSITY, KHERSON, UKRAINE
[6]NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF UKRAINE, KYIV, UKRAINE

ABSTRACT

Aim: The aim is to investigate the influence of physical activity of different orientations on the development of the time perception function in students.

Materials and Methods: The research, which was conducted in 2023-2024, involved 195 students aged 17-20 (males), who were divided into two experimental (A and B) and one control (C) groups: group A (n = 65) included students who were engaged in high-speed and strength sports during their studies, group B (n = 61) – students who were involved in endurance sports, and group C (n = 69) – students who were not engaged in sports. The development peculiarities of time perception function were evaluated using V. L. Maryshuk's method.

Results: It has been established that there are insignificant ($p > 0.05$) changes in the average values of the time perception function under the influence of endurance physical activity. In contrast, under the influence of high-speed and strength loads there is a statistically significant ($p < 0.05$-0.001) improvement in the time perception function in students. Compared to students who did not do sports, the function of time perception in students engaged in high-speed and strength sports is significantly ($p < 0.05$).

Conclusions: The results obtained can be used to select and orient young people in certain sports and implement medical and biological control of the educational and training process.

KEYWORDS: physical activity, time perception function, students

Acta Balneol. 2025;67(2):96-101. doi: 10.36740/ABAL202502103

INTRODUCTION

Chronobiological peculiarities of time and space perception as complex elements of human cognition are one of the leading factors limiting the success of sports activity in most sports [1, 2]. According to scientists [3, 4], the function of time perception is a universal indicator of the efficiency and success of competitive activity: the more accurate the perception of time, the more successful the activity. Concerning the function of time perception in athletes of different sports, few studies have answered, for example, the possibility of a specific impact of training loads of different orientations on the dynamics of the formation and development of the mentioned function. The study of the influence of training of varying nature and orientation on the function of time perception, in our opinion, will expand not only the theoretical arsenal of knowledge about the patterns of temporal regulation of the functions of the body of athletes and the mechanisms of adaptation to sports training, but also can be a practical platform for solving several issues related to the sports selection and orientation of young people in particular sports and the implementation of medical and biological control of the training process [5-7].

In our previous work, we presented the research study's results on the peculiarities of changes in the function of time perception in young athletes aged 13-16 years of specialized sports institutions, depending on the orientation of their training process [8]. The general conclusion of this work is the establishment of the specificity of the influence of trainings of different orientations (on strength, speed, and endurance) on the mental function of young athletes at the stage of specialized basic training. However, the issue of studying the influence of different sports on the formation and development of the time perception function at a later stage of long-term training – at the stage of sports excellence (17 years and older) remains unknown. That is why the latter prompted us to conduct a similar research on the influence of training loads of different orientations on time perception function development in students of 17-20 years old of specialized sports educational institutions.

AIM

The aim is to investigate the influence of physical activity of different orientations on the development of the time perception function in students.

MATERIALS AND METHODS

The research, which was conducted in 2023-2024, involved 195 students aged 17-20 (males), who were divided into two experimental (A and B) and one control (C) groups: group A (n=65) included students who were engaged in high-speed and strength sports (boxing, wrestling, athletics (sprinting, hurdling, jumping, shot put and discus throwing)), group B (n=61) included students who were engaged in endurance sports (skiing, cycling, swimming for 200, 400 and 1500 meters), and group C (n=69) included students who were not engaged in sports. Students of groups A and B studied at the Brovary Higher School of Physical Culture (Kyiv oblast, Ukraine), and students of group C – at the Borys Grinchenko Kyiv Metropolitan University (Kyiv, Ukraine).

RESEARCH METHODS

Theoretical analysis and generalization of scientific and methodological literature, pedagogical observation, testing, statistical analysis.

The peculiarities of time perception function development were evaluated according to the method of Maryshuk V.L. [9]. Its essence lies in the following: the experimenter by striking a pencil on the surface of the table gives a countdown of the beginning, and at the next strike – the end of a specific (in seconds) time interval; the subject, in turn, should reproduce the time interval set by the experimenter also by striking a pencil on the surface of the table, with the help of which the beginning and end of the time interval were determined. The range of time intervals was from 6 to 12 seconds. Each individual was asked to complete the above test task in 10 attempts. The following indicators were determined: the sum of errors made by the subject and the accuracy of time perception (accuracy of time interval estimation). The following formula determined the last indicator (accuracy of time interval estimation):

$A = 100 – (S2 \cdot 100 / S1)$,

where A is the accuracy of time interval estimation, %;

S1 – the sum of time intervals determined by the experimenter. For all subjects, this indicator was the same and amounted to 89 seconds, and the components of this sum (time intervals) were set in the following sequence: 8→11→6→10→7→12→6→9→9→11 seconds;

S2 – the sum of the subject's errors, seconds.

PROCEDURE

Evaluation of the research results was carried out according to the data of the comparative analysis of the first and second (in a year) stages of the students' examination according to the following scheme: separately for each sport, for groups of students by sports, comparative analysis A, B, C. Tests were carried out in the morning (from 9 to 12 o'clock, not earlier than 2 hours after eating). One or two days before the examination, the students were asked to reduce physical activity by 50% in volume and intensity, not to use tonic and sedative pharmacological drugs, and on the day of testing – strong tea or coffee. All students were healthy during the examination period.

STATISTICAL ANALYSIS

Mathematical statistics were used to process the data obtained. The reliability of the difference between the indicators was determined using the Student's t-test. The reliability of the difference was set at $p<0.05$. All results were presented as M±m, where M – arithmetic mean; m – error of arithmetic mean. This research followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was obtained from all participants who took part in this research.

RESULTS

The research results of the indicators of the time perception function in students who were engaged in high-speed and strength sports (group A) are given in Table 1.

The analysis of results showed that according to the data of the repeated (in a year) examination, the indicator of time perception accuracy significantly improved in all sportsmen (boxers, wrestlers, track and field athletes) of group A ($p<0.01$). In parallel with the improvement of this indicator, the number of made errors decreased statistically significantly ($p<0.001$).

According to the data of Table 2, the diametrically opposite character of changes in the indicators of the time perception function is registered among cyclists, skiers, and swimmers – representatives of endurance sports (group B). It was found that all students of this group had no statistically significant difference in changes of indicators of time perception accuracy and sum of made errors ($p>0.05$).

Similar dynamics of changes of the studied indicators are observed in students who do not participate in sports (group C). That is, there are insignificant differences in average values of indicators of the sum of errors and time perception accuracy according to the data of the first (I) and second (II) stages of the research ($p>0.05$), (Table3).

Taking into account the similar character of changes of the indicators of the time perception function in students who mainly develop certain motor qualities (high-speed and strength qualities or endurance), we analyzed changes of the time perception function separately in students of groups A and B (Table 4). It was found that the representatives of sports of high-speed and strength character (group A) noted statistically significant improvement of time perception accuracy and a significant decrease in the sum of the made errors ($p<0.001$). In contrast, students of endurance sports (groupB) registered insignificant differences in values of the studied indicators ($p>0.05$).

Below is the comparative analysis of the changes in the studied indicators in students of groups A, B, and C (Table 5). It was found that the sum of errors is significantly lower in students of group A compared to groups B and C, both according to the data of the first stage of the research

Table 1. Indicators of the time perception function in students engaged in high-speed and strength sports (group A) according to the data of the first (I) and second (II) stages of the research

Indicators	I	II	t	p
Boxers				
Number of students	(n=22)	(n=0)		
Sum of errors, s	4.9±0.53	2.1±0.42	4.14	<0.001
Time perception accuracy, %	95.2±0.55	97.7±0.43	3.58	<0.01
Wrestlers				
Number of students	(n=21)	(n=21)		
Sum of errors, s	5.0±0.55	2.2±0.39	4.15	<0.001
Time perception accuracy, %	94.9±.58	97.4±0.45	3.41	<0.01
Track and field athletes				
Number of students	(n=22)	(n=21)		
Sum of errors, s	5.2±0.61	2.0±0.42	4.32	<0.001
Time perception accuracy,%	94.2±0.69	97.6±0.58	3.77	<0.01

Legend: t – value of Student's t-test; p – level of statistical significance of differences.

Table 2. Indicators of the time perception function in students engaged in endurance sports (group B) according to the data of the first (I) and second (II) stages of the research

Indicators	I	II	t	p
Cyclists				
Number of students	(n=22)	(n=20)		
Sum of errors, s	6.9±0.63	6.7±0.68	0.22	>0.05
Time perception accuracy,%	91.4±0.70	91.5±0.77	0.10	>0.05
Skiers				
Number of students	(n=17)	(n=17)		
Sum of errors, s	7.2±0.72	7.1±0.63	0.10	>0.05
Time perception accuracy,%	92.0±0.78	92.1±0.71	0.09	>0.05
Swimmers				
Number of students	(n=22)	(n=21)		
Sum of errors, s	6.5±0.61	6.3±0.53	0.25	>0.05
Time perception accuracy,%	91.5±0.69	91.7±0.62	0.22	>0.05

Legend: t – value of Student's t-test; p – level of statistical significance of differences.

Table 3. Indicators of the time perception function in students who did not play sports (group C) according to the data of the first (I) and second (II) stages of the research

Indicators	I	II	t	p
Number of students	(n=69)	(n=66)		
Sum of errors, s	7.1±0.55	7.0±0.63	0.12	>0.05
Time perception accuracy,%	92.0±0.64	92.1±0.71	0.10	>0.05

Legend: t – value of Student's t-test; p – level of statistical significance of differences.

Table 4. Indicators of the time perception function in students of groups A and B according to the data of the first (I) and second (II) stages of the research

Indicators	I	II	t	p
Group A				
Number of students	(n=65)	(n=62)		
Sum of errors, s	5.0±0.56	2.1±0.35	4.39	<0.001
Time perception accuracy,%	94.8±0.62	97.6±0.44	3.68	<0.001
Group B				
Number of students	(n=61)	(n=58)		
Sum of errors, s	6.9±0.40	6.0±0.56	1.31	>0.05
Time perception accuracy,%	92.8±0.69	93.0±0.63	0.21	>0.05

Legend: t – value of Student's t-test; p – level of statistical significance of differences.

Table 5. Comparative analysis of the sum of errors in students of groups A, B and C according to the data of the first (I) and second (II) stages of the research

Stages	Group A [1]	Group B [2]	Group C [3]	t; [p1–p2]	t; [p1–p3]	t; [p2–p3]
I	5.0±0.56	6.9±0.40	7.1±0.55	2.76; <0.01	2.68; <0.01	1.47;>0.05
II	2.1±0.35	6.0±0.56	7.0±0.63	5.91; <0.001	6.80; <0.001	1.19;>0.05

Legend: t – value of Student's t-test; p – level of statistical significance of differences.

Table 6. Comparative analysis of the time perception accuracy in students of groups A, B, and C according to the data of the first (I) and second (II) stages of the research

Stages	Group A [1]	Group B [2]	Group C [3]	t; [p1–p2]	t; [p1–p3]	t; [p2–p3]
I	94.8±0.62	92.8±0.69	92.0±0.64	2.16; <0.05	3.14; <0.01	0.85;>0.05
II	97.6±0.44	93.0±0.63	92.1±0.71	5.99; <0.001	6.59; <0.001	0.95;>0.05

Legend: t – value of Student's t-test; p – level of statistical significance of differences.

(p<0.01) and the second stage (p<0.001). No statistically significant differences were found between the indicators of students of groupsB and C (p>0.05).

Accordingly, Table 6 presents the comparative analysis of the accuracy of time perception in three groups of students. It was found that the time perception accuracy is significantly higher in students engaged in high-speed and strength sports than in students involved in endurance sports and those who were not engaged in sports (p<0.05-0.001) both according to the data of the first and second stages of the research. At the same time, there were no significant differences like changes of this indicator between students of groups B and C (p>0.05).

DISCUSSION

There is a large arsenal of studies on the impact of various sports on the perception of time as a mental process of reflection in an individual's mind of holistic images, objects or phenomena under their direct influence on the sensory organs [10-12]. This type of research is relevant because the time perception function plays an essential role in human adaptation to the effects of various environmental factors, one of which is physical activity [13, 14]. However, the results of studies by different authors on the actualized problem of the influence of sports activity on the peculiarities of the development of time perception are polar. Thus, according to Edwards A.M. et al. [2], the slightest error in the value of an individual unit of time concerning an astronomical minute is observed in athletes of cyclic sports, whose activities are not limited by space or time, respectively, the error is more significant in representatives of situational sports, and the largest – in acyclic sports. At the same time Behm D.G. and Carter T.B. [3] note that the closest to the actual countdown is the individual perception of time intervals in martial arts athletes (boxing, wrestling). The authors explain the results of their research by the fact that the duration of a sports match (for example, a round in boxing) is not determined by the timer (the latter is under the control of the referee), but rather by the athlete's feelings – their "internal clock". Studying the genetic features of

time perception in athletes, scientists [1, 4] established the hereditary determination of the reproduction of periods of different durations. The research of Khoroshukha M.F. et al. [8, 9] may also be interesting, in which the authors testify to the possibility of using serological markers of blood groups in genetic prediction of the development of the quality of time perception in young athletes.

Summarizing the data of the research, we conclude that even though the main mental functions (perception, attention, memory, thinking) are characterized by a pronounced genetic heredity and are poorly corrected through physical education, we believe that the focus of physical activity specializes the peculiarities of the time perception function development. Thus, if students under the influence of endurance training (skiing, cycling, swimming) record insignificant changes in the time perception accuracy and the sum of errors, then under the influence of training that mainly develops high-speed and strength qualities (boxing, wrestling, athletics), a significant ($p<0.01$-0.001) improvement in indicators is observed. In students who do not go in for sports, there were no significant differences like changes in the studied indicators ($p>0.05$). The same changes in indicators of the time perception function were also revealed in athletes of two groups (by the direction of physical loads): group A, high-speed and strength sports, and group B, endurance sports. In particular, it was found that the improvement of the time perception function was observed only in students of group A, while in group B the nature of changes in indicators was unreliable. The fact that students with the same type of physical activity did not find significant differences in the indicators of the time perception function ($p > 0.05$) is evidence of the specific effect of physical activity on the body functions of people of different ages, sexes and occupations [15-23].

CONCLUSIONS

It was found that the orientation of physical activity specializes the peculiarities of the development of the time perception function in students aged 17-20 years of specialized sports educational institutions. The comparative analysis of changes in the indicators of the time perception function in three groups of students shows that under the influence of physical activity aimed at the development of high-speed and strength qualities, significantly better values of the time perception function are recorded compared to students who mainly develop endurance, as well as to students who do not play sports. Students who are not engaged in endurance sports have the same pattern of changes in the time perception function as students who are not engaged in sports. The results can be used to select and orient young people in particular sports and implement medical and biological control of the educational and training process.

PROSPECTS FOR FURTHER RESEARCH

It is planned to investigate the influence of physical activity of different orientation on the development of the time perception function in female students specializing in various sports.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Grygoriy P. Griban
Zhytomyr Ivan Franko State University, Zhytomyr, Ukraine
e-mail: gribang@ukr.net

ORCID AND CONTRIBUTIONSHIP
Mykhailo F. Khoroshukha: 0000-0001-5024-5792 F
Grygoriy P. Griban: 0000-0002-9049-1485 B D
Nadiia A. Orlyk: 0000-0003-0144-6576 A B
Iryna S. Oliinyk: 0000-0003-1888-1187 E
Vadym O. Muzhychok: 0000-0001-9429-6890 C D
Serhii P. Drachuk:0000-0001-5783-8830 F
Hennadii V. Krotov: 0000-0002-2158-1698 B

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 03.01.2025
ACCEPTED: 02.04.2025

ORIGINAL ARTICLE

Recreational activity of health resort guests as a factor increasing the attractiveness of a stay

Karina Przybyło-Kisielewska[1], Zygmunt Kruczek[2] , Anna Szczygielska-Babiuch[3]

[1]FACULTY OF SCIENCE AND TECHNOLOGY, INSTITUTE OF GEOGRAPHY AND ENVIRONMENTAL SCIENCES, UNIVERSITY JAN KOCHANOWSKI IN KIELCE, KIELCE, POLAND
[2]BRONISŁAW CZECH ACADEMY OF PHYSICAL CULTURE IN KRAKOW, KRAKOW, POLAND
[3]KRAKOW UNIVERSITY OF HEALTH PROMOTION, KRAKOW, POLAND

ABSTRACT

Aim: Identification of the reasons for visiting a health resort and the forms of recreational activity of its guests, as well as assessment of the impact of recreational services on increasing the attractiveness of stays in health resorts.

Materials and Methods: The study was conducted using the diagnostic survey method and survey technique among 377 patients visiting the Busko-Zdrój health resort, who were subjected to statistical analysis.

Results: The respondents surveyed indicated mainly therapeutic purposes as the reason for coming to Busko Zdrój. The most common form of recreational activity among the surveyed group of health resorts guests is walking (75%), almost half of the respondents also indicated swimming pool activities (41%) and Nordic Walking (40%). A highly significant ($p<0.0001$) negative correlation was found between the number of recreational activities and the age of the respondents, as well as significant correlations of gender, professional and financial status and health condition with recreational activities.

Conclusions: The recreational offer in Polish health resorts is becoming a supplement to health tourism services, which should include, among others: health resort tourism, wellness tourism and leisure tourism. Using recreational services increases the attractiveness of a stay in a health resort, especially in the group of commercial patients.

KEYWORDS: health resorts, recreational and tourist activities, Świętokrzyskie, Busko-Zdroj

Acta Balneol. 2025;67(2):102-107. doi: 10.36740/ABAL202502104

INTRODUCTION

Health tourism can be defined as a conscious and voluntary departure from the place of residence for a certain period of time during free time in order to regenerate the body through active physical and mental rest [1, 2]. Tabacchi extends the definition of health tourism to include aspects of health not only of the traveler but also of their family or closest environment [3]. The element that distinguishes health tourism from other forms of tourism is the purpose of the trip, such as: improving health, using medical and aesthetic medicine treatments or using the recreational infrastructure available in facilities and going to a place that specializes in providing broadly understood health services [4].

Health tourism is currently one of the most important types of travel, with a significant share in the global tourism market [5, 6]. In 2024, the wellness tourism market alone was estimated at $651 billion [7]. The factors driving the development of this type of service are primarily demographic changes, and especially the increase in the number of seniors.

Travel to health resorts, in addition to the natural therapeutic purpose, is enriched with an additional tourist offer (including recreational), which is sometimes the dominant form. The recreational offer has not been considered so far as a factor improving the quality of treatment, which is probably related to the limited experience of domestic patients with this type of offer in health resort facilities. It should be remembered that for years the therapeutic model dominated in Polish health resorts [8]. However, the development of other forms of health tourism, related to such goals as: improving appearance, counteracting aging through psychophysical activity, relaxation and rest, in fact took place in Poland only at the end of the 20th century and the beginning of the 21st century.

The importance of recreational services and the infrastructure appropriate for these services is emphasized by Hadzik and Tomik [9]. The growing interest in recreational activity among health resorts guests is indicated by the studies of Mirek in Krynica Zdrój [10] and Rapacz and Jeremen in Świeradów Zdrój [11]. According to the authors, this forces local government authorities to expand the offer with recreational services and make appropriate investments in thermal resorts infrastructure [12].

In attracting guests, high quality must be maintained in all components of the service, as well as in the entire package and the place where it is provided [13]. Improving and maintaining the quality of the health resorts offer is

related to the increasing share of commercial clients among those visiting thermal resorts. They provide sanatoriums with increasing profits, but unlike people using referrals from the state health care system, commercial guests have greater financial resources, but less time to spend on relaxation. They also have slightly different expectations regarding their stay. They expect state-of-the-art treatment facilities, high-quality specialists and a guarantee of an atmosphere conducive to their treatment and relaxation.

Studies of foreign health resorts emphasize that guests feel the need to engage in recreational activities during their stay in health resorts [14]. In Slovenian health resorts, recreational and sports services have been provided for many years and enjoy a high reputation [15]. The motives of relaxation, recreation and the possibility of participating in many recreational and sports activities are often dominant, as confirmed by studies conducted in Taiwan [16].

The Busko-Zdrój health resort was established based on the mineral waters found here, which are the basic asset used for the development of this region. Sulphur water with high medicinal values has made it one of the most valued balneological health resorts in the world. Natural sulphur-hydrogen sulphur waters can only be used at the source, because during transport and storage heavy metal sulphides are precipitated [17]. Medicinal sulphur waters must contain at least 1.0 mg/dm3 of sulphur determined iodometrically. In drinking therapy, to achieve full therapeutic effect, the total sulphur content should be 100.0 mg/dm3, excluding hydrogen sulphide. Medicinal waters mainly contain sulphides (compounds of sulphur with metals), which in the process of slow oxidation pass through sulphur to the sulphate form. Sulphur-hydrogen sulphide waters contain less total sulphur than sulphate waters, but they contain sulphur at lower oxidation levels, especially divalent sulphur, which is the most biologically active. The sulphide ion has a strong tendency to form complex compounds and very easily turns into disulphides and polysulphides [18]. «Buskowianka» table water is produced from iodine-bromine brine. The medicinal values of mineral waters enhance the climate values. The presence of tourist values and attractions in the immediate vicinity of the health resorts is important for creating offers of recreational and sports activities. Among them, the historical monuments of Wiślica and Pińczów, geotourist attractions related to gypsum karst, and the picturesque Nida valley are of outstanding, supra-regional importance. In nearby Pacanów, there is an attraction of international importance, the European Fairy Tale Centre. Within a distance of 100 km from the health resort there are one-day trip attractions for health resorts guests such as Krakow, Wieliczka, Kielce and Sandomierz.

AIM

The aim of the study is to identify the motives for visiting a health resort and the forms of recreational and sports activities of health resorts guests, as well as to assess the impact of recreational services on increasing the attractiveness of staying in health resorts.

MATERIALS AND METHODS

The study on the use of recreational, sports and tourist services and offers was conducted using the diagnostic survey method. It was conducted using the survey technique. The selection of respondents was purposeful, 2 sanatorium facilities were selected in which NFZ, ZUS, PEFRON contracts are implemented and 2 facilities in which 100% commercial treatment is implemented. In total, 4 facilities were included in the study, in which a total of 377 questionnaires were obtained (194 from respondents from facilities implementing commercial stays, 183 from respondents implementing stays in a sanatorium and thermal hospital with signed NFZ, ZUS, PEFRON I contracts). The study was conducted among guests/health resorts patients during their vacation or sanatorium stay.

Statistical analyses of the survey studies were carried out using the PQStat statistical package version 1.8.4.152. and the MsExel 2021 package. The number of recreational and sports activities depending on age was analyzed by estimating the Spearman rank correlation coefficient. The number of recreational and sports activities depending on gender was analyzed using the Mann-Whitney U test. The number of recreational and sports activities depending on professional status was analyzed using the Mann-Whitney U test. The number of recreational and sports activities depending on material status was estimated using the Kruskal-Wallis test and the post-hoc Dunn test with Bonferroni correction and the Jonckheere-Terpstra trend test. The number of recreational and sports activities depending on the self-assessed health status was analyzed using the Kruskal-Wallis test and post-hoc Dunn's test with Bonferroni correction and the Jonckheere-Terpstra trend test. The influence of age on selected motivations was analyzed by estimating logistic regression models.

The research obtained 377 questionnaires that were subjected to statistical analysis. The respondents provided information on their age, gender, place of residence, professional status, method of obtaining information about the thermal resorts, and number of visits to Busko Zdrój (Table 1).

The average age in the study group was 63±12 years. No less than half of the respondents were 66 years old. In turn, the full age range ranged from 30 to 92 years. This distribution is consistent with the age structure of the clientele of Polish health resorts. Women dominate among the respondents, constituting 2/3 of the respondents. The structure in terms of professional status shows that the largest group is made up of retirees – 57% and professionally active people – 40%. On the other hand, the fewest were people taking care of the household – 0.27%. 13% of the respondents assessed their financial status as very good, and 38% of the respondents assessed it as good. 48% assessed it as average, and only 0.5% of the respondents described their financial status as bad. 7% of the respondents assessed their health as very good, and 40% of the respondents assessed it as good. 49% of the respondents indicated an average assessment, and 3% indicated a bad assessment. 5% of respondents assessed their physical condition as very good, and 34% of respondents assessed it as good.

Average assessment was given by 51% of respondents, and bad and very bad were indicated by 7% and 0.5%, respectively. The largest number of respondents lived in the Małopolskie voivodeship – 22%, followed by the Mazowieckie voivodeship – 21% and Świętokrzyskie voivodeship – 20%, the most frequently indicated cities from which respondents came were: Kielce – 12%, Kraków – 10% and Warsaw – 9%. Full data are presented in Table 1.

The study of preferences regarding the chosen place of accommodation (for many people it was another stay in the Busko Zdrój health resort) shows that in the studied group, patients most often chose a hotel (46%), a health resort sanatorium (30%) and a health resort hospital (17%). Few people decided on private accommodation, guesthouses or apartments.

Table 1. Characteristics of the studied population

	N=377	%
Sex		
Female		67
Male		33
Age		
Under 30 y.o	10	2,6
From 31 to 50 y.o	185	54,9
From 51 to 65 y.o	112	33,2
Above 65 y.o	70	8,3
Professional status		
Professionally active	152	40,3
Unemployed	1	0,3
Retired	215	57,0
Housewife	1	0,3
Pensioner	8	2,1
Financial status		
Bad	4	1,2
Average	168	49,8
Good	120	35,6
Very good	45	13,3
Health status		
Bad	11	3,3
Average	168	49,8
Good	128	37,9
Very good	70	8,3
Physical condition		
Very bad	4	1,2
Bad	24	7,1
Average	164	51,0
Good	120	35,6
Very good	25	7,4

RESULTS

The surveyed respondents indicated therapeutic purposes (84%) as the reason for their visit to Busko-Zdrój (Table 2), and a quarter of the respondents indicated other purposes, such as improving beauty or using wellness services (27%) and using (visiting) the salt graduation tower (22%).

The results obtained indicate that the most common form of recreational and sports activity among the studied group of thermal resorts guests is walking (75%). Almost half of the respondents also indicated swimming pool activities (41%) and Nordic Walking (40%). The least frequently studied people indicated such activities as: yoga (9.8%), kayaking (0.3%), tennis (1.6%). Only 0.5% reported no activities.

The study found a highly significant ($p<0.0001$) negative correlation at a low level between the number of recreational and sports activities and the age of the respondents. Generally, the number of activities performed decreases with age (Table 3).

There was also a highly significant ($p<0.01$) difference in the distribution of results for the number of recreational

Table 2. Motives for coming to Busko-Zdrój in the surveyed group of respondents

Answers	N	%
Therapeutic purpose	317	84,08%
Learning about local culture and traditions	31	8,22%
Spiritual renewal	8	2,12%
Improving beauty	104	27,59%
Learning about the values of nature	27	7,16%
Entertainment	49	13%
Business matters	6	1,59%
Participation in training/conference	31	8,22%

Source: own research

Table 3. Number of recreational and sports activities depending on gender

Descriptive Statistics		Sex	
		Female	Male
Arithmetic mean		3,5929	2,6129
Standard deviation		2,0808	1,3048
Median		3	2
Minimum		1	0
Maxsimum		11	7
Lower quartile		2	2
Upper quartile		5	3
U Manna-Whitneya Test	Z	4,0980	
	p	<0,0001	

Source: own research

Descriptive Statistics		Health condition			
		bad (1)	average (2)	good (3)	very good (4)
Arithmetic mean		2,1538	2,6324	4	4,0714
Standard deviation		1,281	1,4314	2,0559	2,4332
Median		2	2	4	3
Minimum		1	0	1	1
Maxsimum		5	7	11	9
Lower quartile		1	2	2	2
Upper quartile		3	3	5	5,5
Kruskala-Wallis'a Test	H	51,8724			
	p	<0,0001			
POST-HOC (Dunn Bonferroni)	(1)		1	0,0017	0,022
	(2)	1		<0,0001	0,0084
	(3)	0,0017	<0,0001		1
	(4)	0,022	0,0084	1	
Homogeneous groups		a	a	b	b
Jonckheere-Terpstra trend test	Z	6,9666			
	p	<0,0001			

and sports activities depending on gender. In general, women choose more activities than men.

A highly significant ($p<0.01$) difference in the distribution of results for the number of recreational and sports activities depending on professional status was also demonstrated. In general, professionally active people choose more activities than the group of professionally inactive people. The number of recreational and sports activities is also highly significant ($p<0.01$) dependent on the financial status, and the differences have the character of a highly significant trend ($p<0.01$), i.e. the better the assessed financial status, the more activities are chosen.

The number of recreational and sports activities is highly significantly ($p<0.01$) dependent on the self-assessment of health status and the differences have the character of a highly significant trend ($p<0.01$), i.e. the better the health status is assessed, the more activities are chosen.

The results obtained indicate that the time spent on recreational and sports activities during the stay in Busko-Zdrój ranged from 2 to 4 hours. In turn, 35% of the respondents spent it in the range of 1 to 2 hours. Only 6.1% of thermal resorts guests spent more than 4 hours on this type of activity. The tourist activity of the respondents is exceptionally low, because 56.5% admitted that they had not visited any places in the vicinity of Busko-Zdrój, despite the available tourist offer (Table 4).

DISCUSSION

The development of health tourism can only be successful if it adapts to the needs of the market and the challenges of increasing competition at both national and international levels. The motivations and needs of consumers must be known, and service providers must anticipate everything as much as possible in order to maintain and increase guest traffic in the face of increasing competition [19].

Studies conducted in Polish health resorts draw attention to the differences in the behavior of traditional clients with referrals and commercial clients. The latter expect state-of-the-art treatment facilities, high-quality specialists and a guarantee of an atmosphere conducive to their treatment and relaxation [20]. Similar opinions can be found in studies conducted in Upper Silesian health resorts [21] and in foreign literature [22-24].

The offer of recreational and sports services in Polish health resorts was assessed based on the analysis of research results described in the literature and field research conducted in the Busko Zdrój health resort. In this health resort, the offer of these services is exceptionally rich. The operation of the #Tężnia recreational complex, cultural and entertainment activities and an extensive tourist offer deserve a mention. In this respect, Busko-Zdrój stands out from other health resort communes in Poland.

In Polish literature, we can find studies indicating a low assessment of the recreational and sports offer, e.g. in Ustroń [25]. Other studies have shown that in Lower Silesian health resorts such as Cieplice-Zdrój, Świeradów-Zdrój, Szczawno-Zdrój, and Jedlina-Zdrój, both the availability and attractiveness of sports and recreation facilities were among the lowest rated elements of the health resort product [11]. This is confirmed by Lewandowska's [24]

studies in West Pomeranian health resorts, or by Hadzik in Wysowa [25].

In general, the offer of recreational and sports services in Poland is still weakly identified with the health resort product. The situation is different in foreign, primarily Western thermal resorts, where in reality and in the social perception, the implementation of health goals was and is widely understood, i.e. not only in relation to treatment, but often in a comprehensive (holistic) view of the concept of health. This is confirmed by examples from abroad. In Slovenian health resorts and in Montenegro or Romania, as research shows, the offer of recreational and sports services is rich and enjoys a high reputation [15, 24, 25]. Often, this offer influences the decision to visit the health resorts again.

In the literature on the subject, there is a lack of research on the influence of factors such as gender, age, health condition, financial status and professional status on recreational and sports activity of health resorts guests. The results of our study therefore fill the research gap in this area. A significant negative correlation was confirmed between the number of recreational and sports activities and the age of the respondents. This means that with age, the number of recreational and sports activities performed among guests visiting the Busko Zdrój health resorts decreases. A significant, high-level difference in the distribution of recreational and sports activity results was also found depending on gender. This means that women choose more activities than men during their stay at the health resorts.

CONCLUSIONS

Studies have shown that there is a strong correlation between the health status of thermal resorts guests and the use of recreational and sports services. The number of recreational and sports activities depends on the self-assessment of health status, and the differences are of a highly significant trend, i.e. the better the health status is assessed, the more activities are chosen.

The research allows us to identify a significant difference in the distribution of results of recreational and sports activities of guests depending on their professional status. This allows us to conclude that professionally active people choose more activities than professionally inactive respondents. Recreational and sports activities also depend on financial status, and these differences have the character of a highly significant trend. This means that the better the assessed financial status, the more activities are chosen.

In the final conclusion, we can state that the recreational and sports offer in Polish health resorts is slowly becoming a supplement to health tourism, which should include: sanatorium-rehabilitation tourism, wellness tourism and leisure tourism. Wellness tourism, which includes elements such as: movement, fitness, cosmetics, beauty, nutrition, diet, ecology, nature, mind training, relaxation, meditation, stress management, is becoming the fastest growing form of the global tourism industry. Using recreational services increases the attractiveness of a stay in a health resort, especially in the group of commercial patients.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Karina Dominika Przybyło-Kisielewska
Faculty of Science and Technology, Institute of Geography and Environmental Sciences,
University Jan Kochanowski, Kielce, Poland
e-mail: k.kisielewska@etnografia.pl

ORCID AND CONTRIBUTIONSHIP

Karina Przybyło-Kisielewska: 0009-0007-2729-4941 A B D
Zygmunt Kruczek: 0000-0003-3015-2139 E F
Anna Szczygielska-Babiuch: 0000-0002-5383-7440 C

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 05.11.2024
ACCEPTED: 04.02.2025

ORIGINAL ARTICLE

Restoration of cadets' mental and somatic health during their training under stress

Oleksandr S. Kolesnichenko[1], Iryna V. Zhdanova[2], Valentyna O. Tyurina[2], Valerii V. Sereda[3], Ivan M. Okhrimenko[1], Yevhen V. Karpenko[4], Anna O. Slashchylina[5]

[1]NATIONAL ACADEMY OF INTERNAL AFFAIRS, KYIV, UKRAINE
[2]KHARKIV NATIONAL UNIVERSITY OF INTERNAL AFFAIRS, KHARKIV, UKRAINE
[3]INSTITUTION OF HIGHER EDUCATION «LVIV UNIVERSITY OF BUSINESS AND LAW», LVIV, UKRAINE
[4]LVIV STATE UNIVERSITY OF INTERNAL AFFAIRS, LVIV, UKRAINE
[5]MAIN DEPARTMENT OF THE NATIONAL POLICE IN THE CITY OF KYIV, KYIV, UKRAINE

ABSTRACT

Aim: The aim is to investigate the dynamics of stress levels, main symptoms of stress, and the level of cadets' somatic health during their training in stressful conditions under the influence of various types of motor activity.

Materials and Methods: The research, which was conducted in the academic year 2023-2024, involved 203 cadets of the 1st-4th training years (men), who were divided into five groups depending on the type of motor activity (sports games, strength sports, martial arts, athletics, integrated traditional methods). Scientific methods: analysis and generalization of scientific information sources; V. Yu. Shcherbatykh's method for assessing the level of stress; H. L. Apanasenko's method for evaluating the level of somatic health, statistical methods.

Results: It has been found that cadets who systematically and consciously practiced the selected sports during their training had a significantly lower level of stress than cadets who practiced the traditional complex method of motor activity. It has also been found that the frequency of psychosomatic symptoms of stress in cadets who additionally practiced in sports clubs was lower than in cadets who practiced according to the traditional method, but the somatic health level was significantly higher.

Conclusions: The results obtained indicates the effectiveness of any motor activity in reducing the negative impact of stress on the body of cadets during their training in stressful conditions of war. The results should be considered when organizing various forms of physical education in higher educational institutions where cadets are trained.

KEYWORDS: stress, war, mental health, somatic health, motor activity, cadets

Acta Balneol. 2025;67(2):108-113. doi: 10.36740/ABAL202502105

INTRODUCTION

Today, in times of war, one of the greatest threats to both mental and somatic health is stress, which occurs in conditions of risk, time pressure, the need to make crucial decisions quickly and independently, and to respond instantly to threats and surprises. Stress is the tension of defense forces, mobilization of internal resources, energy supply of opportunities for solving new problems, and the critical value of stress, after which it becomes destructive, differs for each person [1, 2]. Stress undermines the immune system and makes people vulnerable to infections. An incomplete list of pathologies caused by stress includes depression, anxiety, heart attack, stroke, weakening of the immune system and, as a result, vulnerability to various infections, ranging from colds and herpes to serious diseases of organs and body systems [3]. Stress causes skin reactions (rashes, itching, dermatitis, etc.), gastrointestinal disorders, neurological diseases, and other psychosomatic disorders [4].

Scientists [5-8] note that stress manifests itself at the mental and physiological levels with various symptoms, the most common of which include: increased blood pressure and heart rate; increased adrenaline levels in the blood; hormonal changes and disorders of sleep, attention, memory, fatigue; limb tremors, apathy; disorders (spasms) of the digestive tract; increased sweating; loss of sense of humor; constant feeling of malnutrition, or vice versa, loss of appetite and loss of taste for food; inaccuracy, errors in work, decreased working capability; a sense of constant internal tension; irritability, dissatisfaction, anxiety; depression, pessimism; low self-esteem, and others.

Among the means of coping with stress, scientists [9] identify: communication with family and friends, doing your favorite thing (hobby), various games (including sports), development of creative potential, mental self-regulation (self-analysis, relaxation), yoga, meditation, self-massage, motor activity (exercise). Scientists [10, 11] are convinced

that programs to combat stress and restore mental and somatic health must be based on muscle function (tension and relaxation), which is greatly facilitated by physical loads (motor activity). From the point of view of biochemical mechanisms, the improvement of mood during motor activity is caused by the effect on the hypothalamus-pituitary-adrenal axis, which reduces the physiological response to stressors [12, 13]. Also, according to researchers [14], exercise releases "happiness hormones" such as serotonin and endorphins, which increase life satisfaction, motivation, self-esteem, self-confidence, improve sleep quality, and reduce the risk of anxiety and depressive disorders. Scientists [15, 16] have shown that cortisol and adrenaline remain suppressed for 24-48 hours after exercise. At the same time, after training, the level of these hormones in the blood is lower than before training. In addition, according to Holovanova I.A. et al. [17], motor activity can be a kind of meditation that helps a person to distract from obsessive thoughts; repeating movements during exercise allows you to focus on the body, not on problems, which helps to maintain calmness and clarity of mind. However, studying the effectiveness of different types of motor activity in restoring cadets' mental and somatic health indicators at HEI with SLE during their training under stress is an urgent area of research.

AIM

The aim is to investigate the dynamics of stress levels, main symptoms of stress, and the level of cadets' somatic health during their training in stressful conditions under the influence of various types of motor activity.

MATERIALS AND METHODS

PARTICIPANTS

The research involved 203 cadets of the National Academy of Internal Affairs (NAIA, Kyiv, Ukraine) of the 1st-4th training years (men), who were studying in Law Enforcement specialty. Cadets were divided into five groups depending on the type of motor activity during the hours of their sporting and mass participation events (SMPE). Group 1 (n=33) – cadets who were engaged in game-oriented sports (football, volleyball, basketball); group 2 (n=25) – cadets who attended strength-oriented sports clubs (arm wrestling, powerlifting, kettlebell lifting); group 3 (n=29) – cadets who attended martial arts (boxing, combat sambo, mixed martial arts); group 4 (n=27) – cadets who attended field-events (running at different distances, cross-country, functional all-around); group 5 (n=89) – cadets who did not participate in any of the NAIA sports clubs, and during SMPE hours were trained under the guidance of unit commanders according to existing options (accelerated movement, strength exercises on gymnastic apparatus). Group 5 consisted of equal numbers of cadets from each training year (1st-4th) with one study group per year in equal proportion. The number of hours spent on motor activity was the same in all groups. The research was conducted during the academic year 2023-2024: the beginning – September 2023, the end – June 2024.

SCIENTIFIC METHODS

Analysis and generalization of scientific information sources; Shcherbatykh's V.Yu. method for assessing the level of stress and the frequency of its psychosomatic symptoms manifestation; Apanasenko's H.L. method for evaluating the level of somatic health, statistical methods. Analysis and generalization of scientific information sources was used to conduct an analytical review of scientific sources on the outlined range of issues (30 sources (2009-2025) from such databases as MedLine, Scopus, Web of Science were analyzed). Shcherbatykh's V.Yu. method allows assessing the degree of psychosomatic symptoms of stress in cadets and the overall stress level. The questionnaire contains four sets of 12 symptoms each. For the presence of one of the intellectual and behavioral symptoms, respondents scored 1 point; emotional symptoms – 1.5 points, and physiological symptoms – 2 points. If the score was 0-5 points, there was no stress; 6-12 points – moderate stress; 13-24 points – significant stress; 25-40 points – severe stress; 41 points and more – excessive stress [18]. Apanasenko's H.L. method involves the calculation of body weight, strength, vital, Robinson, Martine-Kushelevsky indices and, on their basis, as a sum of five indices, determination of cadets' somatic health level (SHL) (in points) [19]. If the sum of points is 0-3 points, the SHL is assessed as low, 4-6 points – below average, 7-11 points – average, 12-15 points – above average, 16-18 points – high.

STATISTICAL ANALYSIS

The methods of mathematical statistics were used to process the data obtained. The compliance of the sample data distribution with the Gauss' law was assessed using the Shapiro-Wilk W test. The reliability of the difference between the indicators was determined using the Student's t-test. The reliability of the difference was set at $p<0.05$. All statistical analyses were performed using SPSS software, version 10.0, adapted for medical and biological research.

ETHICS

The procedure for organizing the study and the topic of the article were previously agreed with the Committee on compliance with Academic Integrity and Ethics of the NAIA. Also this study followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all participants who took part in this study.

RESULTS

Assessment of the level of stress (according to the method of Shcherbatykh V.Yu.) shows that at the beginning of the research there were no statistical differences between all groups ($p>0.05$). During the research period, the cadets engaged in sports clubs during their sporting and mass participation events (groups 1-4) showed positive changes in stress indicators – the stress level decreased by 1.3-1.5 points during the research period. Still, there were no statistically significant changes ($p>0.05$). In group5, on the contrary, the level of stress increased by 1.7 points, and the changes were statistically significant ($p\leq0.05$) (Table 1).

Table 1. Dynamics of the level of stress (according to the method of V. Yu. Shcherbatykh) in cadets engaged in different types of motor activity (n=203) during their martial law academic training, points

Groups of cadets	Research stages		Δ	t / p
	The beginning	The end		
Group 1 (n=33)	10.3±0.87	8.8±0.84***	-1.5	1.24/>0.05
Group 2 (n=25)	10.8±0.96	9.5±0.95**	-1.3	1.01/>0.05
Group 3 (n=29)	10.7±0.91	9.3±0.89**	-1.4	1.10/>0.05
Group 4 (n=27)	10.5±0.95	9.1±0.93**	-1.4	1.05/>0.05
Group 5 (n=89)	11.2±0.57	12.9±0.61	+1.7	2.04/≤0.05

*Note: Δ – difference between the studied indicators; t – value of Student's t-test; p – level of statistical significance of differences; *, **, *** – statistically significant differences between the indicators of groups 1, 2, 3, 4 and group 5 at the level of p≤0.05; p≤0.01; p≤0.001.*

Table 2. Manifestation of the main psychosomatic symptoms of stress in cadets engaged in various types of motor activity (n=203) during martial law training,%

Symptoms of stress	Groups of cadets				
	Group 1 (n=33)	Group 2 (n=25)	Group 3 (n=29)	Group 4 (n=27)	Group 5 (n=89)
Problems with sleep	3.1	4.0	6.9	7.4	15.7
Fear, anxiety	12.1	12.0	10.3	14.8	23.6
Irritability, anger	6.1	8.0	6.9	11.1	19.1
Aggressiveness	6.1	8.0	10.3	7.4	15.7
Problems in relationships with colleagues	3.1	12.0	13.8	11.1	21.3
Loss of appetite	0	0	0	0	6.7
Headache	6.1	8.0	10.3	7.4	16.9
Digestion disorders	6.1	8.0	6.9	7.4	11.2
Colds and flu diseases	15.2	16.0	13.8	14.8	26.9

A comparative analysis of the stress level in cadets at the end of the research period showed that the lowest stress level was found in cadets who were engaged in sports games (8.8 points). Still, no statistically significant differences existed between groups 1, 2, 3 and 4 (p>0.05). Instead, comparing the level of stress in cadets who were engaged in various types of motor activity and cadets who were engaged in the current integrated sporting and mass participation events methodology, a statistically lower level of stress was found in groups 1, 2, 3, and 4 than in group 5, by 4.1 (p≤0.001), 3.4 (p≤0.01), 3.6 (p≤0.01) and 3.8 (p≤0.01) points, respectively. This indicates the positive impact of various types of motor activity on preventing stress in cadets, restoring their psycho-emotional state during training under martial law.

A detailed analysis of the results of Shcherbatykh's V.Yu. method shows that cadets of all groups without exception experience psychosomatic symptoms of stress in the process of their educational activities under martial law. However, the frequency of manifestation of stress symptoms in cadets who additionally engaged in selected sports in sports clubs (groups 1, 2, 3, and 4) is somewhat lower than in cadets of group 5, which indicates the effectiveness of any motor activity in reducing the negative impact of stress on the body of cadets during their training under martial law. The main most frequently expressed psychosomatic symptoms of stress in cadets of different groups, which were identified during the survey at the end of the research, are presented in Table 2.

According to the results of Table 2, 3.1-7.4% of cadets who attend sports clubs experienced sleep problems and insomnia during the war, while 15.7% of cadets who did not do sports had this symptom; fear and anxiety were experienced by 10.3-14.8% of cadets in groups 1-4 and 23.6% in group 5; irritability, anger – 6.9-11.1% in groups 1-4 and 19.1% in group 5; headaches – 6.1-10.3% in groups 1-4 and 16.9% in group 5; colds and flu diseases – 13.8-16.0 % in groups 1-4 and 26.9% in group 5. Interestingly, such a symptom as loss of appetite was not detected in cadets who also engage in sports, unlike cadets in group 5 (6.7%). It is also important to note that problems in relationships with colleagues were the least pronounced among cadets

Table 3. Dynamics of the level of somatic health (according to the method of Apanasenko H.L.) in cadets engaged in different types of motor activity (n=203) during their martial law academic training, points

Groups of cadets	Research stages		Δ	t / p
	The beginning	The end		
Group 1 (n=33)	5.86±0.29	6.54±0.27**	+0.68	1.72/>0.05
Group 2 (n=25)	5.79±0.31	6.34±0.30*	+0.55	1.27/>0.05
Group 3 (n=29)	5.82±0.27	6.38±0.26*	+0.56	1.49/>0.05
Group 4 (n=27)	5.95±0.25	6.73±0.24***	+0.78	2.25/≤0.05
Group 5 (n=89)	5.67±0.16	5.59±0.15	-0.08	0.36/>0.05

*Note: Δ – difference between the studied indicators; t – value of Student's t-test; p – level of statistical significance of differences; *, **, *** – statistically significant differences between the indicators of groups 1, 2, 3, 4 and group 5 at the level of p≤0.05; p≤0.01; p≤0.001.*

involved in sports games (3.1%), compared to cadets in other sports clubs (11.1-13.8%) and cadets who did not do additional sports (21.3%). In addition, such psychological symptoms of stress as irritability and aggressiveness were also the least pronounced in cadets who played sports. This suggests that during sports games, there is a more intensive improvement in the psycho-emotional state of cadets compared to other sports, as well as team building, team spirit, and a sense of mutual assistance.

Assessment of the level of somatic health at the beginning of the research period shows the absence of statistically significant differences between the indicators of all five study groups (p>0.05). During the research period, the cadets of groups 1-4 improved their SHL by 0.55-0.78 points, but a statistically significant improvement was found only in group 4 (p≤0.05). In group 5, the SHL remained unchanged during the research period, even tending to deteriorate slightly by 0.08 points (p>0.05), (Table 3).

At the end of the research, in all groups where cadets were engaged in sports during their training, their SHL was statistically better compared to group 5 by 0.95 (p≤0.01), 0.75 (p≤0.05), 0.79 (p≤0.05) and 1.14 (p≤0.001) points, respectively. At the same time, the SHL in groups 1-4 do not have statistically significant differences (p>0.05), which emphasizes the effectiveness of any sport during training on improving the somatic health of cadets.

DISCUSSION

According to scientists [1, 5, 7], stress is manifested in heart rate increase, rise of respiratory rate, increased body temperature, redness or pallor of the skin, intense sweating, dry mouth, muscle tremors, changes in external activity (number, frequency and amplitude of movements), increased anxiety, vigilance, manifestations of anger and irritability, pronounced aggressiveness, self-doubt, etc. In a state of stress, significant changes occur in a person's motor activity: people begin to perform actions irrationally, with much greater effort than usual [20, 21]. Depending on the strength of the stressor and the individual psychological characteristics of the person, their actions may become inhibited, unmotivated and inappropriate, or they may accelerate significantly, but become chaotic and therefore less accurate. A person makes many more mistakes when performing specific professional tasks [22, 23]. According to experts [17], a significant excess of the level of danger over the level of stress resistance of a serviceman can lead to their complete inability to control themselves, respond to the requirements and orders of commanders, act according to the situation and even move. Under the strong influence of stressors, service members may forget to use their weapons in combat. Under such conditions, stress can cause complete incapacitation of a service member, and sometimes lead to the death of service members [6].

Since it is impossible to eliminate the source of stress during war, experts [17] believe it is necessary to learn to overcome its consequences and manage it through practical means and methods, among which motor activity plays an important role. Exercise (motor activity) helps the human body to relieve stress by simulating the consequences of the "fight or flight" reaction and assisting the body's systems to "let off steam" through the joint work of all organs during physical loads [2]. According to scientists [24], exercise and sports help eliminate muscle tension caused by stress hormones. Exercise has a calming and antidepressant effect, normalizes the level of anxiety and aggression, improves cognitive abilities, and boosts self-esteem [25]. In addition, regular exercise can help a person lose weight, increase strength and endurance, and improve well-being, which will help to gain awareness of control over the body and the situation, as well as self-confidence [26, 27].

According to research by experts [5], today about 20% of the population of economically developed countries use regular exercise to cope with stress, anxiety, and depression. Motor activity is the best medicine for relieving psycho-emotional tension, overcoming stress, preventing diseases, and improving young people's health. Exercise helps improve mood, gain confidence, bring the body's functional state to an optimal level, and improve academic performance [28]. Conversely, a decrease in motor activity during the war leads to disorders of the musculoskeletal system, reduced functional working capacity and efficiency of the heart, and an increased risk of cardiovascular disease [8]. Suppose we add that the lack of systematic motor activity is associated

with changes in brain activity. In that case, it becomes clear why the body's overall defenses decrease and why there is increased fatigue, sleep disturbance, and a reduced ability to maintain mental and physical performance [29]. Thus, according to the results of many studies [17, 30], regular motor activity has many benefits: stress prevention and mood improvement; strengthening of the cardiovascular and respiratory systems; normalization of cholesterol, blood glucose and blood pressure; strengthening of muscles, bones and ligaments; reducing the risk of injury, strengthening the musculoskeletal system, developing physical qualities; improving brain activity, increasing oxygen supply to the brain; improving creativity. The results of our research confirm and extend the findings of many scientists.

CONCLUSIONS

It has been found that cadets who systematically and consciously practiced the selected sports during their training had a significantly lower level of stress ($p \leq 0.01$-0.001) than cadets who practiced the traditional complex method of motor activity. At the same time, there was no significant difference between the indicators of the groups of cadets who were engaged in different sports ($p > 0.05$). It has also been found that the frequency of psychosomatic symptoms of stress, such as fear, anxiety, irritability, anger, aggressiveness, problems in relationships with colleagues, and colds and flu diseases in cadets who additionally practiced the selected sports in sports clubs was lower than in cadets who practiced according to the traditional method. At the end of the research, in all groups where cadets played sports in sports clubs during their training, the level of somatic health was also significantly ($p \leq 0.01$-0.001) better. All this indicates the effectiveness of any motor activity in reducing the negative impact of stress on the body of cadets during their training in stressful conditions of war. The results should be considered when organizing various forms of physical education in higher educational institutions where cadets are trained.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Ivan M. Okhrimenko
National Academy of Internal Affairs, Kyiv, Ukraine
e-mail: ivango-07@ukr.net

ORCID AND CONTRIBUTIONSHIP
Oleksandr S. Kolesnichenko: 0000-0001-6406-1935 A B
Iryna V. Zhdanova: 0000-0002-6361-3029 D
Valentyna O. Tyurina: 0000-0003-2308-1977 C
Valerii V. Sereda: 0000-0002-7249-0323 E
Ivan M. Okhrimenko: 0000-0002-8813-5107 B
Yevhen V. Karpenko: 0000-0002-4046-0410 D
Anna O. Slashchylina: 0009-0008-6606-6009 F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 15.12.2024
ACCEPTED: 14.03.2025

ORIGINAL ARTICLE

Effect of a series of whole-body cryostimulation treatments on vaspin levels in subjects with different body mass indexes

Adrianna Dzidek, Olga Czerwińska-Ledwig, Roxana Zuziak, Joanna Kryst, Marta Morawiec, Anna Piotrowska

UNIVERSITY OF PHYSICAL CULTURE, KRAKOW, POLAND

ABSTRACT

Aim: To analyze the effect of WBC treatment on waspin levels in subjects with normal and elevated BMI.

Materials and Methods: Twenty-three participants were divided into a study group (BMI >27) and a control group (BMI: 18.5-25). Blood samples were collected before 1st (I), after 9th (II) and 19th (III) treatment and 2 weeks after the serie was completed (IV).

Results: Changes in vaspin levelss have been reported in study group (p=0.026). Initially, an increase in adipokine level was observed (I vs. II; p=0.013), with a subsequent decrease (II vs. III; p=0.062) after 20 sessions WBC.

Conclusions: The effect of WBC on vaspin regulation and its potential use in obesity treatment will depend on the number of treatments and BMI.

KEYWORDS: obesity, adipokines, vaspin, whole body cyrotherapy, cryostimulation

Acta Balneol. 2025;67(2):114-120. doi: 10.36740/ABAL202502106

INTRODUCION

According to the World Health Organization (WHO), in 2022. 16% of adults characterized by obesity and 43% overweight [1]. The global epidemic of obesity has fueled research on adipose tissue and the factors that influence it. There is now a growing body of data in the literature on the potential of whole body cryotherapy (WBC) as a non-pharmacological adjunct to the treatment of obesity, metabolic disorders [2,3] and improvement of lipid profile [4, 5].

WBC is defined as the technique of extreme cooling of the body (below -100°C) for a short period of time (1-3 min) to induce a physiological response to the cold [6]. The analgesic, anti-edema, anti-hemorrhagic, anti-inflammatory and anti-oxidative effects of cryogenic temperatures are indicated [7–9]. Positive effects on sleep quality are also indicated [10]. The purpose of cryotherapy is not to cool the tissue, but to induce mechanisms to transfer heat from warmer tissue to lower temperature tissue [11].

Adipose tissue is made up of adipocytes and is constantly undergoing remodeling. It is characterized by almost unlimited hypertrophy. It has storage, thermoregulatory and protective functions for internal organs. It is also an endocrine organ that secretes chemokines, cytokines and adipokines [12].

Adipokines are biologically active substances secreted under the influence of various stimuli. Their source is mainly white adipose tissue (WAT) and often the amount of adipokines released is correlated with the amount of WAT. Within adipose tissue, adipokines have been shown to modulate adipogenesis, immune cell migration into adipose tissue, and adipocyte metabolism and function [13]. They also have the ability to affect farther organs and tissues [14]. Obese individuals are characterized by an imbalance of pro- and anti-inflammatory adipokines. This dysregulation contributes to the chronic low-grade inflammation characteristic of obesity [15].

Vaspin (VASP, visceral adipose tissue-derived serpin), a serpin 12 derived from visceral adipose tissue, was discovered in 2005 [16]. It is produced in VAT and subcutaneous adipose tissue, skin, liver, pancreas, placenta, stomach, cerebrospinal fluid, hypothalamus and ovaries [17]. WAT has been identified as one of waspin's target organs of action, and the mechanism likely involves normalizing the mRNA expression of glucose transporter-4 (GLUT4), leptin, resistin and adiponectin [16]. This serpin has protease activity and it has been indicated that its targets are calicrein 7 and 14, which are involved in skin exfoliation. Vaspin-heparin interactions have also been described, which accelerate the inhibition of kallikrein 7 [18].

Blood levels of VASP vary with the amount of body fat and are positively correlated with BMI. Significantly lower levels of waspin were observed in the serum of underweight children compared to controls, while gene expression for this serpin is up-regulated with increasing body weight [18]. Higher levels of waspin are indicated in people with insulin resistance and type II diabetes [19]. Chang et al.[20] noted that with moderate weight loss, serum waspin levelss decreased, accompanied by improvements in insulin resistance-related parameters.

VASP is also involved in appetite regulation and its level fluctuates diurnally [21]. Based on studies in rats

and humans, several regulators of VASP expression in VAT have been described. Its serum levels increased with insulin resistance, obesity and elevated leptin levels and decreased with weight loss [18]. Up-regulation was observed in liver and brown adipose tissue (BAT) after exposure to a high-fat diet [18]. And although little is still known about the physiological stimuli affecting the expression and secretion of VASP, the possibility of its up-regulation points to potential applications in the treatment of obesity and related diseases.

AIM

The aim of the present study was to analyze the effects of a single treatment, as well as a series of 10th and 20th treatments of systemic cryotherapy, on the VASP profile in subjects with normal and elevated BMI.

MATERIALS AND METHODS

STUDY GROUP

A group of volunteers was recruited for the study, from which normal-weight and overweight or obese subjects were selected [23]. A medical history was taken in each group to verify inclusion and exclusion criteria (Table 1).

Study volunteers were grouped according to the indicated criteria – a study group (SG) with a BMI (Body Mass Index) above 27 and a control group (CG) with a BMI within the normal range (18-25). The study group (SG), which consisted of individuals with increased body fat, was matched on a pairing basis (age, gender) with participants who constituted the control group (CG). Ultimately, 23 subjects completed the project (Fig.1).

Participants were familiarized with the study protocol and signed consent forms before the study began. Participation was completely voluntary. Each volunteer was informed that he or she could withdraw from the project at any stage of the project, without giving a reason. The project protocol was approved by the Bioethics Committee of the Regional Medical Chamber of Cracow (177/KBL/OIL/2023 dated 25/09/2023).

RESEARCH PROTOCOL

The study was preceded by a medical consultation, and included a series of 20 WBC treatments held daily (4 weeks excluding Saturdays and Sundays). It was permissible to miss a treatment once; with more absences, the participant was eliminated from the project. Prior to each entry into the cryochamber, blood pressure was checked (blood pressure above 160/100 mmHg prevented continued participation in the project).

Body composition measurements and blood draws were taken: before the first, 10th and 20th WBC treatments, and 2 weeks after completion of the entire series (Fig. 2).

BLOOD COLLECTION AND BIOCHEMICAL TESTS

Venous blood samples were collected by a laboratory diagnostician from the veins of the parietal fossa using a vacuum system (Vacumed). Blood was collected on an empty stomach. To obtain serum, blood was collected into tubes containing a clotting activator, clotted, then centrifuged and pipetted into cryoprobes. Until laboratory testing, the material was stored at -80°C. VASP determinations were carried out using ready-made, high-sensitivity reagent kits by immunoenzymatic assay (ELISA).

ANTHROPOMETRIC MEASUREMENTS

Height of the body was measured once using a Seca 216 (Germany) growth meter with an accuracy of 5mm. Body weight was measured using a Jawon Medical IOI-353-CE0197 scale (Korea). BMI was calculated for each volunteer.

CRYOTHERAPY

Preparation for the procedure was conducted according to generally accepted standards. Volunteers were asked to remove jewelry, glasses, and dress in appropriate attire: a cap, a mask covering the nose and mouth, a bathing suit/shorts, gloves, gaiters or long socks covering the tibias and knee joint, and clogs with a thick sole. Each WBC procedure included a 30-second acclimatization in the cryochamber atrium (-60°C) and a 3-minute treatment in the cryochamber proper (-120°C). Volunteers moved one behind the other, changing walking direction every 30 seconds. They also exited the cryochamber through its atrium. Immediately after the treatment, the probationers performed aerobic exercises. Each treatment took place under the supervision of a specialist. Participants were informed that they could leave the cryochamber early if they felt unwell.

STATISTICAL ANALYSIS

The analysis was performed using JASP 0.16.4 software (University of Amsterdam, Amsterdam, the Netherlands). The results obtained were presented using basic descriptive

Table 1. Criteria considered in the process of qualifying participants for the project

Inclusion criteria	Exclusion criteria
– BMI > 27 for the study group; – BMI 18.5 - 25 for the comparison group; – No use of winter baths during the study and at least 6 months before; – Non-use of systemic cryotherapy at least 6 months prior; – Written consent for voluntary participation in the study; – Consent of the qualifying physician.	– Chronic endocrine and dermatological diseases; – Skin conditions of fungal, bacterial or viral origin; – Health problems (neurological, orthopedic) that prevent independent movement; – Taking anti-inflammatory medications and supplements containing vitamins and antioxidants; – Lack of consent to participate in the study.

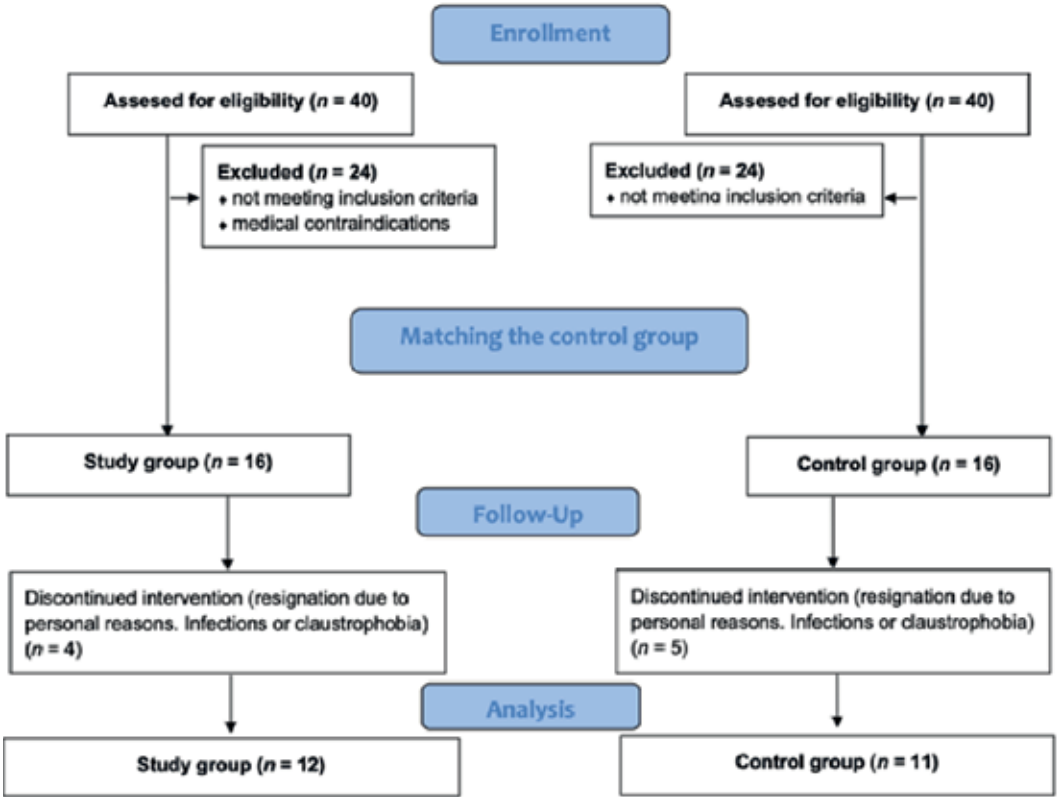

Fig.1. Patient flow chart.

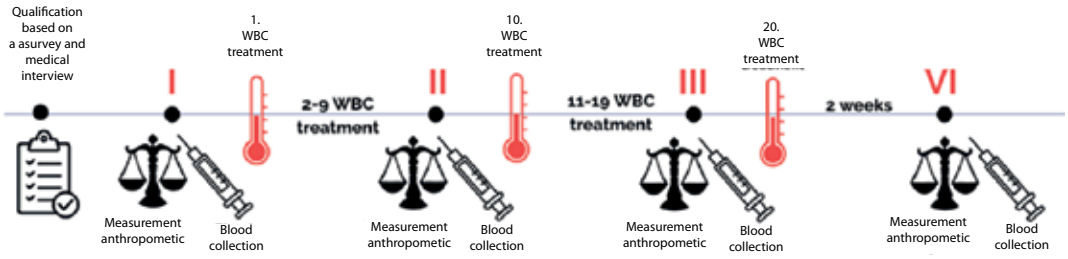

Fig. 2. Research flow chart.

statistics. The type of distribution of variables was analyzed using the Shapiro-Wilk test. Group characteristics were compared using Student's t-tests. ANOVA analysis with repeated measures (RMANOVA) was performed. If the assumption of sphericity was violated (Mauchly test), Greenhouse-Geisser corrections were applied. For variables with a non-normal distribution, the nonparametric Friedman test was used, with Conover's test as a post hoc test. Effect sizes were calculated using the Omega2 coefficient (ω2) and interpreted as follows: 0.01 – small, 0.06 – medium and 0.14 – large effect. The presence of correlation was checked using Spearman's test (rho). The level of significance (α) was set at $p<0.05$ in each case.

RESULTS

CHARACTERISTICS OF THE GROUPS

The study group (SG) consisted of 6 women and 6 men. The control group (CG) consisted of 8 women and 3 men. Details are provided in Table 2.

VASP LEVELS IN THE NORMAL AND ELEVATED BMI GROUPS

The results of VASP levels are shown in Table 3. and Fig. 3. No significant differences were indicated between the baseline VASP levels for the two groups. The lack of differences between the study and control groups persisted at each measurement point.

EFFECT OF SERIES OF SYSTEMIC CRYOTHERAPY TREATMENTS ON VASP LEVEL

To illustrate the effect of a series of cryotherapy treatments on VASP level, the results performed in consecutive measurements (I-IV) were compared with each other (Fig. 4). There was a difference at the trend level ($p=0.059$) between the 1st and 2nd measurements. Further analysis indicated a significant change in VASP level in SG ($p=0.026$). Subsequent tests indicated a significant increase in adipokine level after a series of 10 treatments ($p=0.003$), with a subsequent decrease after a series of 20 treatments (within the range

Table 2. Characteristics of the group

	SG		CG		p SG vs. CG
	$\bar{\chi}$	SD	$\bar{\chi}$	SD	
Age [years]	43.92	13.08	43.55	11.5	0.989
Weight [kg]	92.7	12.96	69.13	10.34	0.006
Height [cm]	171.67	8.34	171.36	8.65	0.839
BMI [kg/m^2]	31.34	2.57	23.47	2.29	<0.001

SG – study group, GC – control group, $\bar{\chi}$ – average, SD – standard deviation, BMI – body mass index

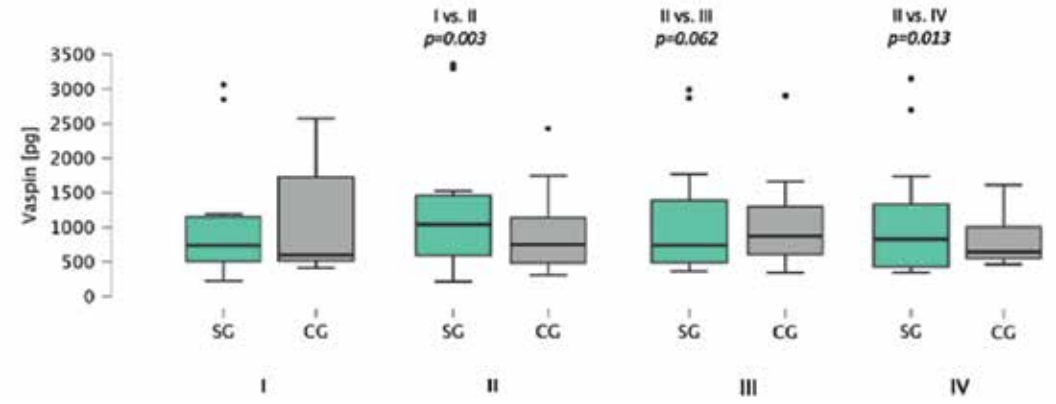

Fig. 3. Changes in VASP level over time in SG (study group) and CG (control group).

Table 3. Results of waspin level (pg) before the project (I) before 10 (II) and 20 systemic cryotherapy treatments (III) and 2 weeks after the treatment series was completed (IV)

	SG					CG					p SG vs. CG
	$\bar{\chi}$	SD	Med	Min	Max	$\bar{\chi}$	SD	Med	Min	Max	
I	1075.06	935.26	734.50	227.83	3064.50	1085.11	809.80	602.83	411.17	2569.50	0.978
II	1300.06	1023.77	1038.67	212.83	3356.17	942.98	649.07	746.17	302.83	2426.17	0.334
III	1148.94	938.47	737.00	362.83	2989.50	1076.49	733.29	877.75	351.17	2906.17	0.840
IV	1124.92	941.70	827.00	344.50	3149.50	843.31	377.04	657.75	477.75	1622.75	0.410

*SG – test group, GC – control group, $\bar{\chi}$ – mean, SD – standard deviation, Med – median, Min – minimum value, Max – maximum value, * $p < 0.05$*

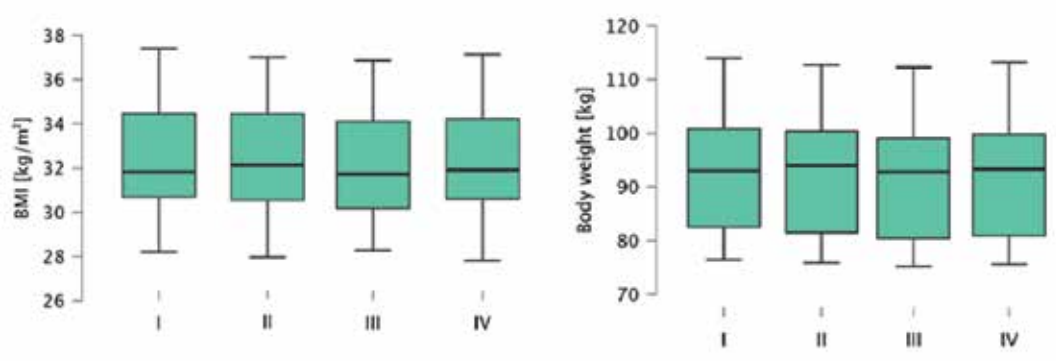

Fig. 4. Changes in BMI and weight in SG (study group).

of staystance trend: p=0.062). Results obser ved two weeks after the completed series indicated a further decrease in adipokine levels compared to the 2nd measurement (p=0.013). For the control group, there were no significant differences in any of the time measurements.

There was a statistically significant difference in BMI changes in the SG group (p=0.028; ω^2=0.001), but further analysis did not indicate a significant difference between. A similar relationship was noted for SG weight (p=0.030; ω^2<0.001). No differences were noted in CG.

No correlation was noted between VASP level and BMI. There was also no correlation indicated between adipokine levels and gender.

DISCUSSION

With the increasing popularity of winter water bathing and the use of cryotherapy treatments, there is an increase in research on the effects of cryogenic temperatures on the human body. These studies include the outer shell – the skin [22-24], which is the first organ to come into contact with the cold, and the inner shell – the adipose tissue [25] an important insulator that limits the effects of cryogenic temperatures and the factors it secretes [26].

Chronic cold exposure causes an increase in the activity and size of brown adipose tissue (BAT), initiating the processes of non-drone thermogenesis to maintain a constant body temperature [27]. Increased caloric intake also produces a similar effect, referred to as diet-induced thermogenesis [28]. On the other hand, adipocytes are assumed to be more sensitive to cooling than other cell types. Topical application of low temperatures initiates apoptosis of adipocytes while not affecting surrounding tissues. Subsequently, adipocytes are engulfed by macrophages and digested. The final result is a reduction in subcutaneous adipose tissue at the site of the stimulus [29].

Weiner et al. [30] reported an increase in VASP gene expression in cold-activated BAT in animal model studies. Although mRNA expression was increased, plasma VASP levels were reduced after cold exposure. Regarding the endocrine functions of VASP [16,18,31], increased expression of target proteases by cold exposure may increase VASP consumption and result in lower levels of this adipokine in the bloodstream [30].

Initially, there was a significant increase in VASP levels in SG, which may have just been related to the activation of adipose tissue in response to cold. After the next 10 treatments, there was a significant decrease in VASP level. This could be an expression of the body's adaptation to the cryogenic stimulus that occurred over time, or, as suggested by earlier authors, a consequence of increased protease expression under the influence of cryogenic temperatures [30].

In the current project, the effect of the treatments on BMI was indicated, however, only in the group with impaired values of this variable (SG). An earlier study [25] z noted a reduction in body fat after a series of 20 WBC treatments. The decrease in VASP level after the final series of treatments, which persisted further in the follow-up measurement, may have been precisely related to the decrease in body fat observable by Więcek et al. in obese subjects under the influence of WBC [25] or related to the increased gene expression and subsequent protein utilization previously described in the literature [30].

It has previously been pointed out [26, 32], hat the effect of low-temperature treatments on the human body is dependent on body composition, which is most likely related to the presence of adipose tissue acting as a thermal insulator. A study [24], on the effect of a series of WBCs on skin characteristics, also notes a similar relationship – the skin of obese people responded differently to a series of treatments than the skin of people with a normal BMI. In the group of people with a normal BMI, no significant changes were observed regarding VASP levels. And although the observed changes were statistically insignificant, the dynamics of change observed in Figure No.3 were different from those in SG.

The results of studies on VASP levels in obese and lean subjects are divergent [33, 34]. In the present study, it was noted that normal-weight subjects had lower VASP levels throughout the study period, but there were no significant correlations between VASP levels and BMI at any of the measurement points to support this claim. Korner et al. also noted no correlation between BMI and plasma VASP levels, but in their case the opposite relationship was noted – obese subjects had lower VASP levels.

On the other hand, some authors also note a sexual dimorphism regarding the value of circulating VASP levels in serum. Higher levels in women compared to men are indicated [19, 34]. Choi et al. [33] indicated a positive correlation between plasma VASP levels and BMI among men, but this relationship was not found in women. In the present study, both groups consisted of both men and women, which may have influenced the results. Subsequent studies including subjects with greater variation in BMI and gender could provide more insight into this topic.

CONCLUSIONS

Analysis of the data taken indicates that the effect of systemic cryostimulation on plasma VASP level is dependent on the BMI of the participants and the number of treatments applied in a series. The obese and overweight group was more sensitive to the cryogenic stimulus. A significant increase in the level of the tested serpin before the 10th treatment was observed in those with an increased BMI, while prolonging the series no longer yielded significant changes in the level of waspin. The profile of changes in subjects with a normal BMI appears different, but further studies with gender breakdown, greater group differentiation and larger numbers are needed.

STUDY LIMITATION

The strength of the present study is its innovation: for the first time, the effect of WBC treatments applied in a standard (10 treatments) and extended (20 treatments) series on the plasma VASP profile was observed. The study

also has some limitations. Study participants were matched on a pairing basis in terms of study group characteristics. However, the final sizes of the two groups were small. Also, changes in vaspin levels were not studied in subjects who did not use WBC at the same time (passive control group). Future projects should also consider gender and obesity type as variables that may affect the direction of WBC-induced changes.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Adrianna Dzidek
University of Physical Culture
78 Jana Pawła II St., 31-571 Krakow, Poland
e-mail: Adrianna.dzidek@awf.krakow.pl

ORCID AND CONTRIBUTIONSHIP
Adrianna Dzidek: 0000-0001-8437-1308 A D F
Olga Czerwińska-Ledwig: 0000-0003-1855-1276 A B C F
Roxana Zuziak: 0000-0002-7544-6096 B C F
Joanna Kryst: 0000-0003-4516-8723 B D F
Marta Morawiec: 0000-0003-1711-5675 B D F
Anna Piotrowska: 0000-0002-9535-173X A B C E F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 29.01.2025
ACCEPTED: 07.04.2025

ORIGINAL ARTICLE

Effect of integrated Otago exercise and cognitive dual task training on fear and functional independence among young elderly patients with basophobia

Bhavaani Sree Dhandapani, Surya Vishnuram, Shenbaga Sundaram Subramanian, Akshya Sam

SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCES, CHENNAI (SIMATS), TAMILNADU, INDIA

ABSTRACT

Aim: The study aims to evaluate the efficacy of an integrated Otago exercise program combined with cognitive dual-task training on reducing basophobia by improving functional independence among basophobic young elders (ages 65-74 years).

Materials and Methods: A randomized controlled trial design was employed, under randomized simple sampling technique, 34 elders with basophobia aged between 65-74 years under selection criteria, experiment were done with intervention group (17) underwent 12-week program of integrated Otago Exercise Program with Cognitive Dual-Task Training, and control group (17) followed traditional physiotherapy.

Results: The intervention group showed significant improvements in both the MFS (Morse Fall Scale) and BBS (Berg Balance Scale) scores from pre-test to post-test. For the MFS, the pre-test score was 50.47 (SD = 2.18) decreased to 42.47 (SD = 2.34). The Z-ratio of -3.62 and a p-value below 0.05 indicate a statistically significant reduction in the MFS, with a large effect size of 3.53. For the BBS, the pre-test average was 41.82 (SD = 1.81), and the post-test score increased significantly to 53.11 (SD = 1.76). The Z-ratio of -3.62, with a p-value under 0.05, shows a significant improvement in balance, with a large effect size of 6.32.

Conclusions: The combined Otago exercise and cognitive dual-task training intervention led to significant improvements in functional independence and balance in younger elderly individuals with basophobia. The intervention group showed considerable gains in both motor function and balance compared to the control group. These results suggest that this approach could be an effective way to enhance physical function and reduce fear in this population.

KEYWORDS: basophobia, fear of falling, functional independence, Otago exercise, cognitive dual-task training

Acta Balneol. 2025;67(2):121-127. doi: 10.36740/ABAL202502107

INTRODUCTION

Basophobia is a concern of functional deterioration of the mechanisms and systems involved in automatisms of posture and walking, it's also defined as a mental barrier to involve activities of daily living and physical activities. Basophobia can or can't develop with previous history of falls or injuries as a result of a fall [1].According to recent studies, majority of those who fall (40-73%), have a fear of falling (FoF). Also, up to half of older people who have never fallen also have fear of fall under the factors of ageing or due to any other physical or psychological comorbidities [2].

The percentage of adults 65 and older made up 17% of the population in 2020 and is predicted to increase to 22% by 2040, Population Prospects 2019 predicts that by 2050, one in six people worldwide will be over 65, up from one in eleven in 2019 [3]. FoF extends beyond the physical risk of falls, affecting psychological health and leading to activity avoidance, social isolation, and a decline in quality of life. It is often associated with previous fall experiences, reduced muscle strength, balance impairments, and anxiety-related factors [4]. Every society in the world is experiencing a revolution in lifespan; some are less advanced than others, but they will all undergo this amazing change. One crucial concern is maintaining and enhancing elderly people's physical and mental health [5]. According to studies, non-traumatic complication in falls has a deleterious impact on older adults and can sometimes in still FoF or basophobia in them than traumatic concern. Additionally, basophobia has been connected to adverse outcomes like demographics, past falls, decreased daily living activities, physical health, lower economic resources, environmental hazards, morbidity, depression, living alone, anxiety, the influence of mood and exercise on fear of falling, fewer social interactions, and the cognitive status of older adults [6]. Various exercise protocol have reported as effective interventions for fear of falls prevention including balance training, resistant exercise, endurance training [7], flexibility exercises such as yoga, and sensorimotor exercises and these interventions differs in significant ways [8]. Therefore, a common exercise program targeting multi-component training would be more attractive.

The Otago Exercise Program (OEP) is one of the well-known exercise programs for preventing falls in elder adults [9]. Usually, it's designed as a home-based exercise program which includes exercise for lower limb muscle strengthening, balance training and ordination along with

walking [10]. This exercise regimen consists of approximately 45 minutes of moderate-therapeutic duration for three sessions in a week, and walking to be done on alternate days at least twice in a week. Various study have shown positive outcome on OEP for elderly individuals with fear of fall [11].

New Zealand, Campbell brought the concept of OEP by conducting pilot study on this exercise protocol with older women and attain better progression [12]. And now it's being one of the lead exercise program for fall prevention [13]. The therapeutic program of OEP contains of four major parts like warm-ups, strengthening activities, balance training with ordination and walking training, Five-minute warm-up exercises include stretching the back, moving the head, neck, trunk, and ankles; Five strength training exercises are sitting knee extension, standing hip abduction, standing knee flexion, tiptoe, and heel tiptoe; strength and balance exercises take around thirty minutes. Standing on one foot, walking in the shape of an eight, walking sideways, walking backward, training for standing to sit positions, knee bending, toe-to-heel standing, heel walking, toe-to-heel walking, toe-to-heel walking, toe-to-heel walking, toe-to-heel walking, toe-to-heel walking, toe-to-heel walking, toe-to-heel returning, and climbing stairs are among the twelve balance exercises [14]. Ten minutes of walking training are included in the final section to reinforce the benefits of muscle strength and balance training [15]. The intensity of the exercise is gradually increased and is separated into four ABCD levels; the frequency of exercise should not be less than three times per week. In terms of training monitoring, physiotherapists use home visits and online interviews to learn about older adults' training status and modify up to their needs [16,17].

Incorporating cognitive dual-task training exercises can enhance walking ability and accelerate motor skills in older adults with basophobia. By improving their capacity to divide attention and perform multiple tasks simultaneously, elderly individuals can better focus on balance and gait, boosting their ability to adapt to challenging environments like uneven terrain. This, in turn, greatly lowers the risk of falls, for healthy elderly, motor tasks performed in the dual-task concept allow better functional capacity index compared to motor tasks performed alone [18,19]. This is important because many daily activities involve the association of cognitive and motoric components [20].

AIM

The study aims to evaluate the efficacy of an integrated Otago exercise program combined with cognitive dual-task training on reducing basophobia by improving functional independence among basophobic young elders(ages 65-74 years).

MATERIALS AND METHODS

The study procedure is done with randomized controlled trial (RCT) to explore the efficacy of an combined protocol of Otago exercise and cognitive dual-task training program on balance with coordination and fall risk in 34 elderly individuals ages 65-74 diagnosed with basophobiausing Floor Transfer Test (FTT) [21,22], which evaluates lower limb strength, coordination, and mobility by transferring from standing to sitting on floor mat and then return one sequence less than 5 minutes is measured and the Single-Leg Stance Test (SLST) [23], which measures balance by timing how long a person can stand on one leg, with 10 seconds, under eligibility criteria includes at least one fall in the previous year, the ability to maintain static and dynamic balance without or with supporting devices with standardized fall scale score ≥45. Allocation of participants into two groups are done using randomized computer-generated sequence to ensure equality, the intervention set as group A(n=17), and control set as group B(n=17) and blinding was implemented for outcome assessors to maintain objectivity and reduce bias.

The study has received ethical approval from the Review Board, and all participants provide informed consent before joining. Throughout the study, any adverse events are carefully monitored and documented. The aim of this trial is to determine if combining Otago exercises with cognitive dual-task training is more effective in reducing fall risk and improving balance in elderly individuals with basophobia, compared to standard physiotherapy treatments [24].

Intervention Group A, includes12-week program of integrated Otago Exercise Program and Cognitive Dual-Task Training, alternating between the two protocols every other day. Each session lasts 45 minutes, with a focus on progressively improving both physical strength and cognitive-motor integration. The program begins with a foundation phase in weeks 1-4, where participants build basic strength and balance, and are introduced to simple cognitive tasks. The OEP sessions during this phase focus on exercises like knee bends, seated knee extensions, ankle movements, static balance, weight shifting, and marching in place (Fig. 1-3). The cognitive tasks include light walking while counting aloud or naming objects, spelling words backward while standing, and performing simple arithmetic during walking. During weeks 5-8, the program increases in intensity with exercises such as sit-to-stands without arm support, heel and toe raises, and single-leg stances. Balance training progresses with tandem walking, stepping over obstacles, and walking on different surfaces while changing direction. Cognitive tasks become more complex, incorporating walking around obstacles while answering yes/no questions, balancing while recalling items, and tossing a ball while performing verbal tasks. The final phase of the program (weeks 9-12) introduces advanced exercises such as deeper knee bends, step-ups, and resisted ankle movements with bands. Balance exercises become more dynamic with multi-directional stepping and balance with eyes closed, while functional training challenges gait variability and safe floor transfers. The cognitive dual-task training ramps up with balancing on unstable surfaces while answering rapid-fire questions, and multitasking with upper and lower body movements while completing verbal tasks. Throughout the 12 weeks, intensity increases

Fig. 1. Knee bends.

Fig. 2. Seated Knee Extension.

Fig. 3. Ankle movements.

gradually with added repetitions, reduced support, and the use of ankle weights. Modifications are made to suit the individual's abilities, ensuring safety and appropriate challenges. Supervision is recommended initially, particularly for balance exercises and more complex cognitive tasks, to reduce fall risk. The main goal is to improve strength, balance, and the integration of cognitive and motor skills, while also reducing the fear of falling. This, in turn, aims to increase confidence and promote greater independence in everyday activities.

Control Group B, includes traditional physiotherapy program targeting fall prevention. This program also lasts 12 weeks, with daily sessions for 45 minutes. It includes general strength training such as breathing exercise, walking, sit-to-stand exercises, balance exercises pointing on static balance and dynamic standing balance, gait training and relaxation accompanied by fall prevention education.

ASSESSMENT AND OUTCOME MEASURES

The study utilizes both primary and secondary outcome measures to evaluate the impact of the interventions. Baseline data, including age, gender, fall history, and initial MFS and BBS scores, are collected before randomization. Assessments are conducted before the intervention (Week 0) and after it's completed (Week 12), with both time points showing similar characteristics. Data analysis includes paired t-tests to compare scores within each group before and after the intervention, independent t-tests to compare changes between groups, and calculation of effect size using Cohen's d to evaluate the impact of the intervention. Statistical significance is defined as $p < 0.05$. The primary outcome measures at the start of the

study are the Morse Fall Scale (MFS) and the Berg Balance Scale (BBS).The MFS assesses fall risk based on factors such as fall history, higher scores on the MFS indicate a greater risk of falls[24], with a high-risk at ≥45, the BBS assesses balance and coordination which as 14-item scale used to assess static and dynamic balance, with a maximum score of 56, where a score below 45 suggests a high risk of falls and secondary outcome measures at end of 12 week.

RESULTS

This study examined how integrated Otago exercise and cognitive dual-task training affected fear and functional independence in younger elderly individuals with basophobia. The results revealed significant improvements in motor function and balance in the intervention group when compared to the control group.

The intervention group showed significant improvements in both the Morse Fall Scale (MFS) and Berg Balance Scale (BBS) scores from pre-test to post-test. For the MFS, the average pre-test score was 50.47 (SD = 2.18), which decreased to 42.47 (SD = 2.34) post-test. The Z-ratio of -3.62 and a p-value below 0.05 indicate a statistically significant reduction in the MFS, with a large effect size of 3.53. For the BBS, the pre-test average was 41.82 (SD = 1.81), and the post-test score increased significantly to 53.11 (SD = 1.76). The Z-ratio of -3.62, with a p-value under 0.05, shows a significant improvement in balance, with a large effect size of 6.32. Both outcome measures reveal substantial improvements following the intervention, demonstrating its effectiveness (Table 1).

In the control group, both the MFS and BBS showed some changes from pre-test to post-test, but the improvements were less significant than those in the intervention group. For the MFS, the pre-test mean was 49.76 (SD = 1.92), and the post-test mean slightly decreased to 48.47 (SD = 1.81). The Z-ratio of -3.62 with a p-value under 0.05 indicates a statistically significant reduction in the MFS, but with a small effect size of 0.69. For the BBS, the pre-test mean was 42.35 (SD = 1.53), and the post-test mean increased to 45.29 (SD = 1.31). The Z-ratio of -3.62 and a p-value below 0.05 indicate a significant improvement in balance, with a moderate effect size of 2.07. While the control group experienced some improvements, the changes were smaller compared to those in the intervention group (Table 2).

The pre-test scores for the MFS were similar between the intervention and control groups. The intervention group had a mean score of 50.47 (SD = 2.18), while the control group's mean was slightly lower at 48.47 (SD = 1.92). The

Table 1. Pre and Post-test value of MFS and BBS for Intervention Group

Outcome Measure		Mean	Standard deviation	Z-ratio	P value	Effect size
MFS	Pre-Test	50.47	2.18	-3.62	<0.05	3.53
	Post-Test	42.47	2.34			
BBS	Pre-Test	41.82	1.81	-3.62	<0.05	6.32
	Post-Test	53.11	1.76			

Table 2. Pre and Post-test value of MFS and BBS for Control Group

Outcome Measure		Mean	Standard deviation	Z-ratio	P value	Effect size
MFS	Pre-Test	49.76	1.92	-3.62	<0.05	0.69
	Post-Test	48.47	1.81			
BBS	Pre-Test	42.35	1.53	-3.62	<0.05	2.07
	Post-Test	45.29	1.31			

Table 3. Pre-test value of MFS for Intervention and Control Group

Outcome Measure		Mean	Standard deviation	U-ratio	P value	Effect size
MFS	(Intervention Group) Pre-Test	50.47	2.18	119	>0.05	0.34
	(Control Group) Pre-Test	48.47	1.92			

Table 4. Pre-test value of BBS for Intervention and Control Group

Outcome Measure		Mean	Standard deviation	U-ratio	P value	Effect size
BBS	(Intervention Group) Pre-Test	41.82	1.81	117.5	>0.05	0.31
	(Control Group) Pre-Test	42.35	1.53			

Table 5. Post-test value of MFS for Intervention and Control Group

Outcome Measure		Mean	Standard deviation	U-ratio	P value	Effect size
MFS	(Intervention Group) Post-Test	42.47	2.34	0.0	<0.05	2.86
	(Control Group) Post-Test	48.47	1.81			

Table 6. Post-test value of BBS for Intervention and Control Group

Outcome Measure		Mean	Standard deviation	U-ratio	P value	Effect size
BBS	(Intervention Group) Post-Test	53.11	1.76	5.0	<0.05	5.04
	(Control Group) Post-Test	45.29	1.311			

U-ratio of 119 and a p-value greater than 0.05 show that the difference in pre-test scores between the two groups is not statistically significant. Additionally, the effect size of 0.34 indicates a small effect, further suggesting no meaningful difference between the groups at baseline (Table 3).

The pre-test scores for the BBS were also similar between the intervention and control groups. The intervention group had a mean score of 41.82 (SD = 1.81), while the control group's mean was slightly higher at 42.35 (SD = 1.53). With a U-ratio of 117.5 and a p-value greater than 0.05, there was no statistically significant difference between the two groups' pre-test scores. The effect size of 0.31 indicates a small effect, further supporting the conclusion that there was no significant difference in balance scores at baseline (Table 4).

The post-test scores for the MFS showed a significant difference between the intervention and control groups. The intervention group had a mean post-test score of 42.47 (SD = 2.34), while the control group's mean was higher at 48.47 (SD = 1.81). With a U-ratio of 0.0 and a p-value less than 0.05, the difference between the groups was statistically significant, with the intervention group scoring lower. The large effect size of 2.86 indicates a substantial difference, with the intervention group showing a more significant improvement in motor function compared to the control group (Table 5). The post-test scores for the BBS (Berg Balance Scale) showed a significant difference between the intervention and control groups. The intervention group had a mean post-test score of 53.11 (SD = 1.76), while the control group's mean was lower at 45.29 (SD = 1.31). The U-ratio of 5.0 and a p-value less than 0.05 indicate a statistically significant difference, with the intervention group achieving a higher score. The large effect size of 5.04 demonstrates a substantial improvement in balance for the intervention group compared to the control group, emphasizing the significant impact of the intervention on balance performance (Table 6).

For the MFS, the intervention group showed a significant reduction in their post-test score (mean = 42.47, SD = 2.34) compared to the pre-test score (mean = 50.47, SD = 2.18), with a Z-ratio of -3.62 and a large effect size of 3.53. This indicates a significant improvement in motor function as a result of the intervention. On the other hand, the control group only experienced a slight decrease in MFS (pre-test mean = 49.76, SD = 1.92; post-test mean = 48.47, SD = 1.81), with a small effect size of 0.69, suggesting minimal change.

The results from the BBS further emphasize the effectiveness of the intervention. The intervention group showed a significant improvement, with a post-test score of 53.11 (SD = 1.76) compared to a pre-test score of 41.82 (SD = 1.81). This change was statistically significant, with a Z-ratio of -3.62 and a large effect size of 6.32. In contrast, the control group experienced a moderate improvement in

balance, moving from a pre-test score of 42.35 (SD = 1.53) to a post-test score of 45.29 (SD = 1.31), with a moderate effect size of 2.07.

At baseline, there were no statistically significant differences between the two groups. The pre-test scores for both MFS and BBS were similar, with small effect sizes of 0.34 and 0.31, respectively. However, the post-test results showed significant differences, with the intervention group outperforming the control group in both MFS and BBS, demonstrating greater improvements in motor function and balance.

In summary, the combined Otago exercise and cognitive dual-task training intervention led to significant improvements in functional independence and balance in younger elderly individuals with basophobia. The intervention group showed considerable gains in both motor function and balance compared to the control group. These results suggest that this approach could be an effective way to enhance physical function and reduce fear in this population.

CONCLUSIONS

In conclusion, the integrated Otago exercise and cognitive dual-task training intervention showed significant improvements in functional independence, motor function, and balance among younger elderly individuals with basophobia. The intervention group experienced notable gains in both the MFS (Morse Fall Scale) and BBS (Berg Balance Scale), while the control group showed only minimal changes. The intervention led to a significant reduction in the fear of falling and a marked improvement in balance and motor function, demonstrating the effectiveness of this combined approach in addressing both physical and cognitive aspects of functional independence. These findings suggest that integrating cognitive dual-task training with physical exercise could be a promising strategy to improve mobility and reduce the fear of falling, especially for those with basophobia. Future studies should focus on exploring the long-term effects and broader applicability of this intervention to other elderly populations.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Surya Vishnuram
Saveetha Institute of Medical and Technical Sciences
Chennai (SIMATS), Tamilnadu, India
e-mail: suryavishnuram@gmail.com

ORCID AND CONTRIBUTIONSHIP
Bhavaani Sree Dhandapani: 0009-0006-1445-3598 A B C D
Surya Vishnuram: 0000-0002-7381-967X C D E
Shenbaga Sundaram Subramanian: 0000-0002-6150-0928 A E F
Akshya Sam: 0009-0007-5729-8468 C D

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 28.01.2025
ACCEPTED: 07.04.2025

ORIGINAL ARTICLE

Hygienic assessment of summer weather conditions as a factor of rehabilitation in the main resorts of Ukraine

Anna V. Blagaia[1], Mykola Kondratiuk[1], Oksana Poliukhovich[1], Olena Nesterenko[2], Yelyzaveta Volodko[2]

[1]BOGOMOLETS NATIONAL MEDICAL UNIVERSITY, KYIV, UKRAINE
[2]KYIV NATIONAL UNIVERSITY OF CONSTRUCTION AND ARCHITECTURE, KYIV, UKRAINE

ABSTRACT

Aim: The research aims to evaluate weather patterns in the most visited Ukrainian rehabilitation resorts considering medical weather classification and subsequently development of relevant preventive recommendations.

Materials and Methods: Data from the State Agency for Tourism Development of Ukraine on medical tourism hotspots; NASA Earthdata «30-Meter SRTM» satellite imagery; Data on P – an atmospheric pressure (mb); R – a relative humidity (%); e – an absolute humidity (mb); T – an air temperature (°C); O2 – oxygen concentration in the air (g/m3) were the materials in our study. Methods of hygienic description, photogrammetric method (a terrain model was constructed using NASA Earthdata «30-Meter SRTM» satellite imagery and QGIS software), and statistical data procession were used in the research.

Results: Five locations, considering their representation of rehabilitation-promising areas of Ukraine were chosen (Zatoka; Myrhorod; Morshyn; Solotvyno; Khmilnyk). Most days with weather types requiring medical attention were in the Morshyn resort (70.7%), Myrhorod - 67.4%, Khmilnyk -52.8%, as well as Solotvyno - 54%, Zatoka - 61.7%. By biotropicity, statistical significances were found in temperature, relative humidity, and oxygen concentration.

Conclusions: Weather patterns in the five most visited Ukrainian rehabilitation resorts were characterised by variability. Such findings must be considered for patients' health monitoring while performing preventive medical examinations (it is better to organise them upon patients' arrival at resorts) and giving relevant medical recommendations for risk groups. Morshyn and Myrhorod Resorts, considering the received data, should be provided with additional medical attention and weather-informing services, stressing the importance of medical-preventive measures.

KEY WORDS: weather, public health, rehabilitation, preventive measures, weather factors, medical control

Acta Balneol. 2025;67(2):128-133. doi: 10.36740/ABAL202502108

INTRODUCTION

The influence of weather on human health and the connection between its fluctuations and well-being have been noted since ancient times. In ancient Greek and Roman medical knowledge, weather conditions were one of the fundamental components of health or illness [1]. The majority of the world's population, at least once in their lives, has experienced specific and nonspecific symptoms of specific so-called heliometeotropic reactions, such as weakness, irritability, sleep problems, persistent dermographism, rapid fatigue, frequent headaches, sharp increases or decreases in blood pressure, etc.

The impact of weather on human health has been studied for decades. Many studies have been conducted and they indicate the relationship between individual weather factors and the occurrence of diseases or exacerbation of existing chronic diseases. Several scientific studies have shown the unidirectional effect of weather factors on specific organs and systems during these changes [2-4].

This is an especially acute problem for people who have health issues with the cardiovascular, nervous and respiratory systems. The influence of weather on human organisms is a proven fact since such factors as temperature, humidity, pressure, etc., can directly affect the human body. Scientific findings indicate that people having chronic diseases as a background health condition are even more sensitive to weather changes. Thus, studies have been conducted that show a correlation between geomagnetic storms and the risk of stroke in specific population groups, myocardial infarction and other pathological manifestations.

But weather description, considering its medical aspects, is often a case of misinformation and misinterpretation. Thus, requires an unbiased approach based on bare numbers, received from reliable sources of information.

AIM

Our research aims to evaluate weather patterns in the five most visited Ukrainian rehabilitation resorts, considering medical weather classification and subsequent development of relevant preventive recommendations. A set of tasks was defined to achieve these goals, including the following. 1) Choice of locations for evaluation, 2) a collection of weather factors data in the chosen locations throughout the summertime, 3) a statistical procession of received results, 4) making a conclusion about the weather types in these locations, and 5) giving medical recommendations on the rehabilitation improvement if necessary.

MATERIAL AND METHODS

Data from the State Agency for Tourism Development of Ukraine, including a Report on the Results of the Survey

«Conducting a Study on Domestic and Outbound Tourism of Ukrainians.» and Report on the Results of the Survey «Conducting Quantitative Research on Inbound Tourism at Border Crossing Points» was used to determine medical tourism hotspots for choosing locations for our research [5]. The geographical position and peculiarities of their location and classifications of chosen places were described. A terrain model was constructed using NASA Earthdata «30-Meter SRTM» satellite imagery and QGIS software [6-7]. Classification and hygienic description of weather conditions from medical and hygienic standpoints, considering the intensity degree of the weather elements' interdiurnal variability, were performed using the Ovcharova et al. table, which includes data on P – an atmospheric pressure (mb); R – a relative humidity (%); e – an absolute humidity (mb); T – an air temperature (°C); O_2 – oxygen concentration in the air (g/m^3) [8]. Data for these parameters was collected on a daily basis at 12.00 from one state source and one private patented source aggregator [9-10]. The observation was carried out from June 1 to August 31, 2024. Every day, in the above-mentioned date range at 12 o'clock, the weather conditions were recorded. Statistical analysis of the received data included interval estimation with the calculation of mean percentage values and 95% confidence intervals (Fisher's Angular Transformation Method (with Yates' Correction)). Categorical variables were compared using Pearson's chi-squared (χ^2) test, and effect size was assessed using Cramér's V. Statistical power was set at 80% with a significance level of 0.05. Weather types included such seven kinds as Stable indifferent, Unstable, passing from indifferent to "spastic" type, "Spastic" type, Unstable „spastic" type with elements of „hypoxic" type, "Hypoxic" type, Unstable „hypoxic" type with elements of „spastic" type of weather, "Spastic" type weather passing to stable indifferent, which can pass one to another based on the weather pattern characteristics, and the main meteorological elements tendencies.

RESULTS

Analysis of the most visited rehabilitation resorts in Ukraine allowed us to choose a diverse set of five main locations, which included Myrhorod (49°58′ N 33°36′ E), Khmilnyk (49°33′ 25″ N 27°57′ 26″ E), Morshyn (49°09′ 0″ N 23°52′ 0″ E), Solotvyno (47°57′ 20″ N 23°52′ 16″ E), and Zatoka (46°4′ 2″ N 30°27′ 25″ E). Their geographical peculiarities are given in Fig. 1, Fig. 2, Fig. 3, Fig. 4, Fig. 5.

These locations pertain to such bioclimatic zones: Zatoka – Climatic region of the sea-coast; Myrhorod – Western climatic region; Morshyn – Predkarpathian lowland climatic region; Solotvyno – Climatic region of the mountainous part (Mountain Carpathian); Khmilnyk – Broad-leaved forest zone. These regions represent most rehabilitation-promising areas of Ukraine with a relatively large number of visitors yearly.

According to the data received on the parameters studied, weather patterns in chosen locations are characterised by the following: (Table 1).

Weather biotropicity based on the intensity degree of the weather elements' interdiurnal variability in studied locations is given in Table 2.

DISCUSSION

According to geographical and bioclimatic data, it was found that the pairs for the data of Morshyn and Myrhorod, as well as Khmilnyk and Solotvyn, are comparable, and during the statistical analysis, it was found that these criteria did not significantly affect even when multiple comparing all five cities simultaneously.

Discomforting weather conditions may hinder the use of recreation and tourism, which in turn may affect the efficacy of balneological treatment in the places chosen by people for rehabilitation purposes [11]. Most weather types that require medical attention are spastic, as it becomes moderate by biotropicity type even with a weak degree of

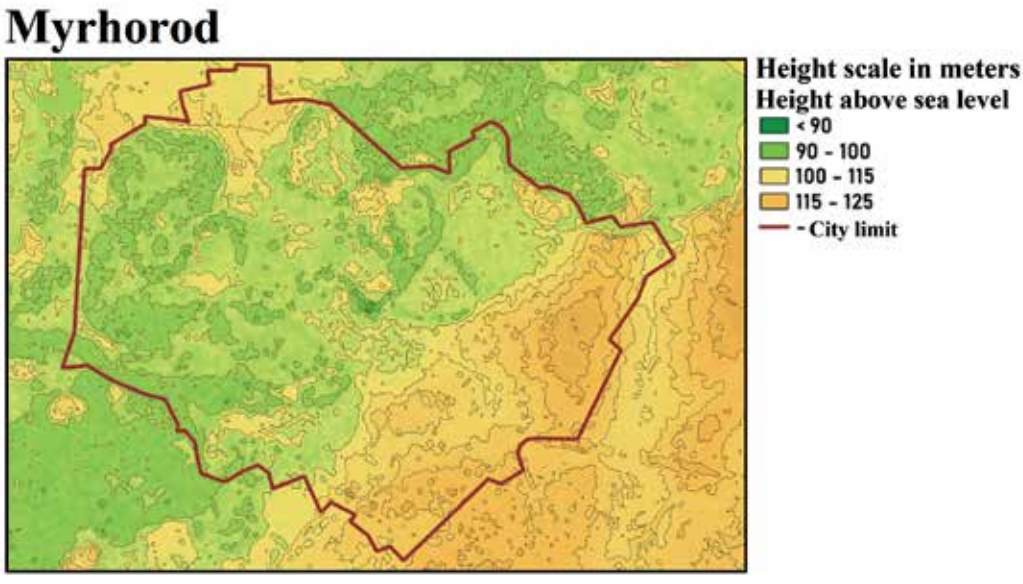

Fig. 1. Geographical peculiarities of Myrhorod.

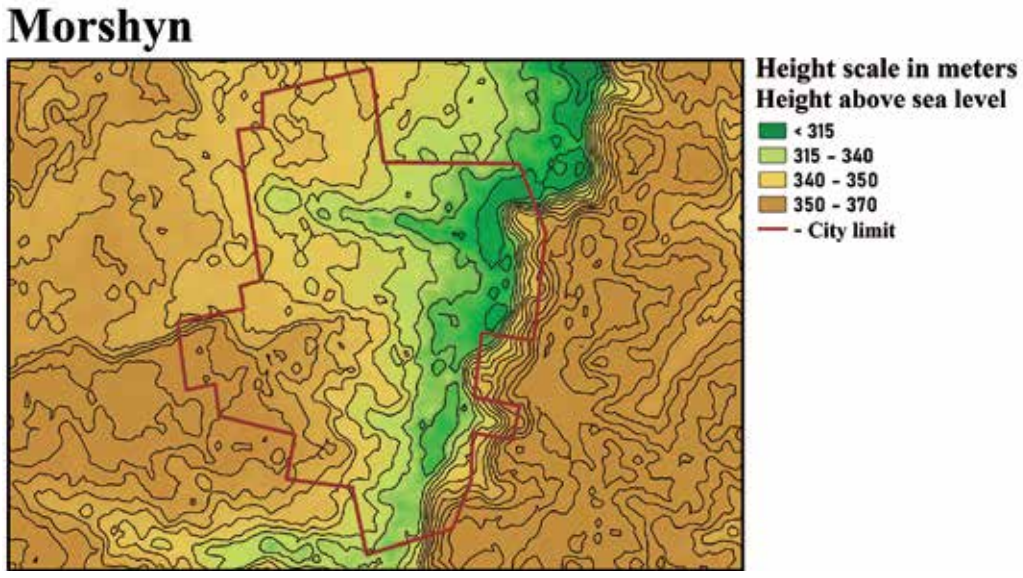

Fig. 2. Geographical peculiarities of Morshyn.

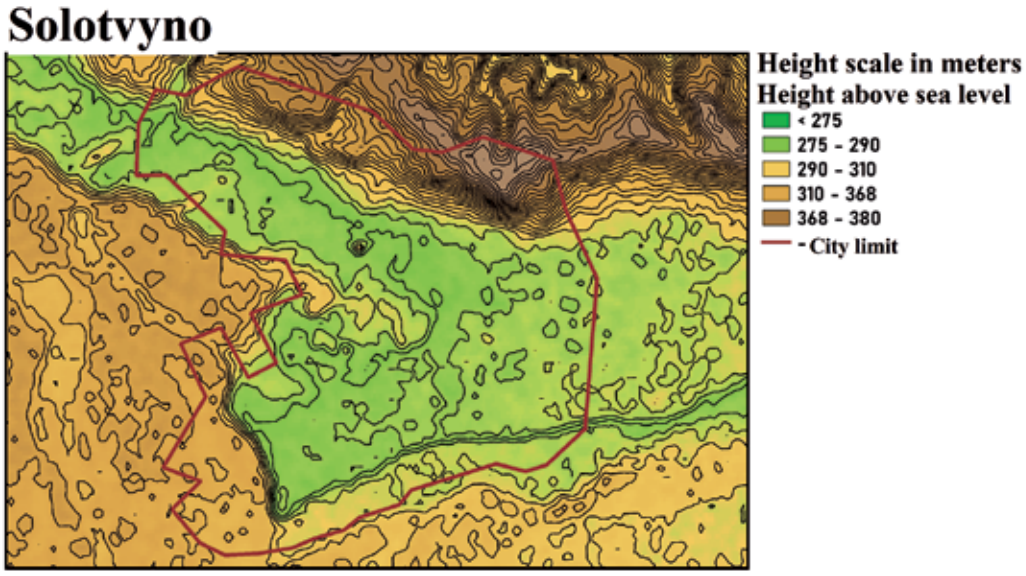

Fig. 3. Geographical peculiarities of Solotvyno.

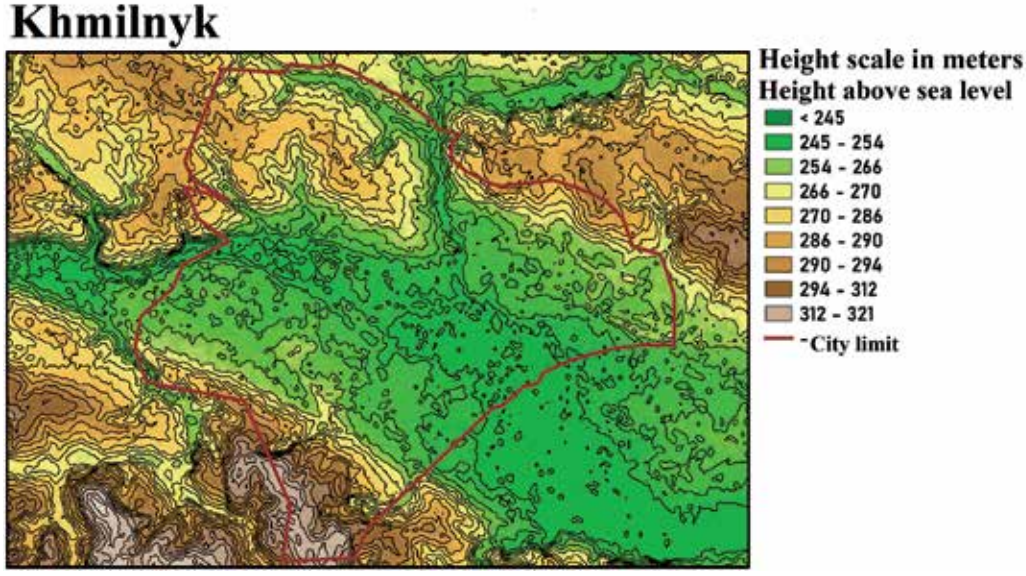

Fig. 4. Geographical peculiarities of Khmilnyk.

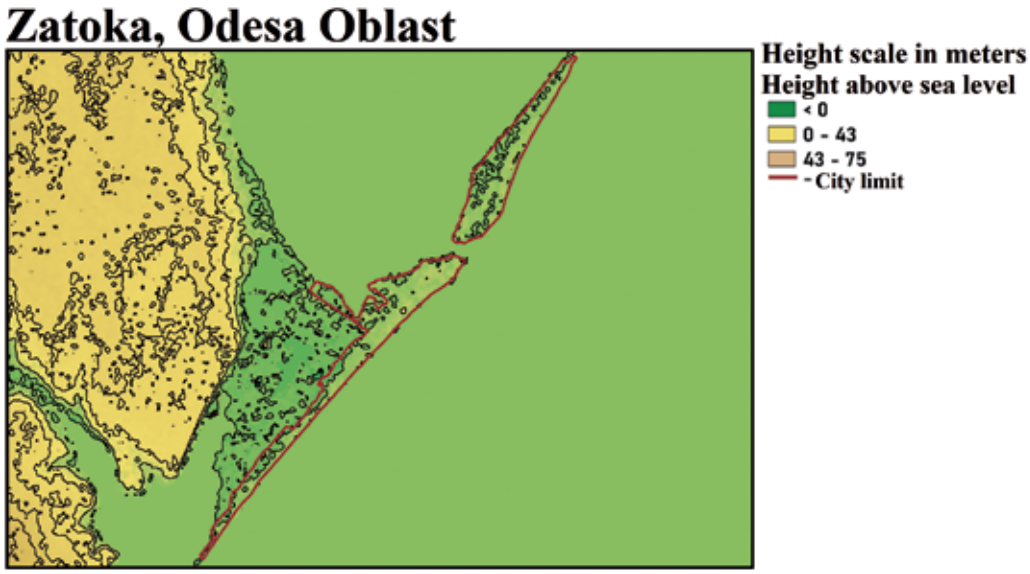

Fig. 5. Geographical peculiarities of Zatoka, Odesa oblast.

Table 1. Weather characteristics by types in the studied resorts (%)

Weather type	Myrhorod	Morshyn	Solotvino	Khmilnyk	Zatoka	χ^2	Cramér's V	p-value
1	3,4	0	4,5	2,2	3,4	3,94	0,09	0,414
	0.6-8.2	0.0-2.2	1.2-9.8	0.2-6.4	0.6-8.2			
2	3,4	2,2	3,4	3,4	2,2	0,48	0,03	0,976
	0.6-8.2	0.2-6.4	0.6-8.2	0.6-8.2	0.2-6.4			
3	14,6	5,6	15,7	15,7	4,5	11,49	0,16	0,022
	8.0-22.8	1.8-11.4	8.9-24.1	8.9-24.1	1.2-9.8			
4	30,3	40,4	23,6	25,8	34,8	7,73	0,13	0,102
	21.2-40.4	30.4-50.9	15.3-33.1	17.2-35.5	25.2-45.1			
5	10,1	19,1	19,1	24,7	25,8	8,73	0,14	0,068
	4.7-17.3	11.6-28.0	11.6-28.0	16.3-34.3	17.2-35.5			
6	33,7	28,1	27	23,6	24,7	2,78	0,08	0,595
	24.2-44.0	19.2-38.0	18.2-36.8	15.3-33.1	16.3-34.3			
7	5,6	5,6	7,9	5,6	5,6	0,63	0,04	0,960
	1.8-11.4	1.8-11.4	3.2-14.4	1.8-11.4	1.8-11.4			

Notes: 1. Stable indifferent; 2. Unstable indifferent-spastic; 3. Spastic; 4. Unstable spastic-hypoxic; 5. Hypoxic; 6. Unstable hypoxic-spastic; 7. Spastic-indifferent; χ^2 - 29.4, Cramér's V 0.13, p-value - 0,204 (the difference is not statistically significant)

the weather elements' interdiurnal variability for patients with cardiovascular diseases (acute attacks of hypertension strokes, angina pectoris, myocardial infarctions, strokes, and acute attacks of coronary heart diseases); meanwhile, hypoxic type of weather is affecting patients with respiratory system diseases (i.e. bronchial asthma) even with indifferent intensity degree. Transitional types may involve both specified conditions but with lesser prominent effects, while the most comfortable one is stable, indifferent weather.

As found by Lagowska-Batyra, A. et al, an alternative to pharmacological agents could be health resort therapies using various stimuli such as natural therapeutic agents, climate and physiotherapy [12].

In our research, we found that most days with weather types requiring medical attention were in the Morshyn resort, where such days prevailed in the summer of 2024 (70.7%). Myrhorod was characterised by the prevalence of transitional weather types (>64%), requiring both attention for cardiovascular and respiratory diseases and 67.4% in total. Khmilnyk was marked as the place with the most stable indifferent weather days (4.5%), and distribution of all other types was more even and less pronounced compared to other locations (52.8% in

Table 2. The intensity degree of the weather elements' interdiurnal variability

	Myrhorod	Morshyn	Solotvino	Khmilnyk	Zatoka	χ^2	Cramér's V	p-value	χ^2	Cramér's V	p-value
Temperature											
indifferent	60 (49,6-70,0)	50 (39,6-60,4)	65.6 (55,3-75,1)	56.7 (46,2-66,8)	71.1 (61,2-80,1)	9.93	0,15	0,042	23.66	0,11	0,023
weak	32.2 (22,9-42,3)	31.1 (21,9-41,1)	30 (20,9-40,0)	35.6 (25,9-45,8)	25.6 (17,0-35,2)	2.23	0,07	0,694			
moderate	7.8 (3,1-14,3)	17.8 (10,5-26,4)	4.4 (1,2-9,7)	7.8 (3,1-14,3)	3.3 (0,6-8,1)	15.49	0,19	0,004			
variable	0 (0,0-2,1)	1.1 (0,0-4,4)	0 (0,0-2,1)	0 (0,0-2,1)	0 (0,0-2,1)	4.01	0,09	0,405			
very variable	0 (0,0-2,1)	0 (0,0-2,1)	0 (0,0-2,1)	0 (0,0-2,1)	0 (0,0-2,1)	-	-	-			
Relative humidity											
indifferent	74.4 (64,8-83,0)	55.6 (45,1-65,8)	65.6 (55,3-75,1)	63.3 (53,0-73,1)	68.9 (58,9-78,1)	7.77	0,13	0,100	34.79	0,14	0,004
weak	15.6 (8,8-23,8)	18.9 (11,4-27,7)	30 (20,9-40,0)	21.1 (13,3-30,2)	22.2 (14,2-31,5)	6.12	0,12	0,190			
moderate	3.3 (0,6-8,1)	14.4 (7,9-22,5)	3.3 (0,6-8,1)	13.3 (7,1-21,2)	6.7 (2,4-12,8)	13.72	0,17	0,008			
variable	4.4 (1,2-9,7)	6.7 (2,4-12,8)	1.1 (0,0-4,4)	1.1 (0,0-4,4)	2.2 (0,2-6,3)	6.93	0,12	0,140			
very variable	2.2 (0,2-6,3)	4.4 (1,2-9,7)	0 (0,0-2,1)	1.1 (0,0-4,4)	0 (0,0-2,1)	8.13	0,13	0,087			
Atmospheric pressure											
indifferent	56.7 (46,2-66,8)	46.7 (36,4-57,1)	51.1 (40,7-61,5)	41.1 (31,1-51,5)	44.4 (34,2-54,9)	5.29	0,11	0,259	14.01	0,09	0,300
weak	31.1 (21,9-41,1)	41.1 (31,1-51,5)	35.6 (25,9-45,8)	41.1 (31,1-51,5)	43.3 (33,2-53,8)	3.81	0,09	0,432			
moderate	10 (4,6-17,1)	10 (4,6-17,1)	13.3 (7,1-21,2)	17.8 (10,5-26,4)	12.2 (6,2-19,9)	3.33	0,09	0,503			
variable	2.2 (0,2-6,3)	2.2 (0,2-6,3)	0 (0,0-2,1)	0 (0,0-2,1)	0 (0,0-2,1)	6.05	0,12	0,195			
very variable	0 (0,0-2,1)	0 (0,0-2,1)	0 (0,0-2,1)	0 (0,0-2,1)	0 (0,0-2,1)	-	-	-			
Absolute humidity											
indifferent	14.4 (7,9-22,5)	21.1 (13,3-30,2)	23.3 (15,1-32,7)	17.8 (10,5-26,4)	12.2 (6,2-19,9)	5.17	0,11	0,270	19.38	0,10	0,249
weak	14.4 (7,9-22,5)	15.6 (8,8-23,8)	15.6 (8,8-23,8)	18.9 (11,4-27,7)	15.6 (8,8-23,8)	0.76	0,04	0,944			
moderate	23.3 (15,1-32,7)	25.6 (17,0-35,2)	30 (20,9-40,0)	33.3 (23,9-43,5)	25.6 (17,0-35,2)	2.94	0,08	0,568			
variable	24.4 (14,2-31,5)	22.2 (14,2-31,5)	24.4 (16,1-33,9)	20 (12,3-29,0)	30 (20,9-40,0)	2.71	0,08	0,607			
very variable	23.3 (15,1-32,7)	15.6 (8,8-23,8)	6.7 (2,4-12,8)	10 (4,6-17,1)	16.7 (9,6-25,1)	12.05	0,16	0,017			
Oxygen concentration											
indifferent	51.1 (40,7-61,5)	37.8 (28,0-48,1)	52.2 (41,8-62,6)	48.9 (38,5-59,3)	56.7 (46,2-66,8)	7.17	0,13	0,127	25.52	0,12	0,013
weak	18.9 (11,4-27,7)	23.3 (15,1-32,7)	24.4 (16,1-33,9)	25.6 (17,0-35,2)	28.9 (19,9-38,8)	2.59	0,08	0,628			
moderate	24.4 (16,1-33,9)	27.8 (19,0-37,6)	22.2 (14,2-31,5)	21.1 (13,3-30,2)	14.4 (7,9-22,5)	5.1	0,11	0,277			
variable	4.4 (1,2-9,7)	11.1 (5,4-18,5)	1.1 (0,0-4,4)	4.4 (1,2-9,7)	0 (0,0-2,1)	16.71	0,19	0,002			
very variable	0 (0,0-2,1)	0 (0,0-2,1)	0 (0,0-2,1)	0 (0,0-2,1)	0 (0,0-2,1)	-	-	-			

total), as well as Solotvyno, where the weather had similar patterns (54%). Zatoka was characterised by intermediate position by these parameters (61.7%).

By biotropicity, statistical significances were found in temperature, relative humidity, and oxygen concentration. In general, patterns were characterised by the absence of very variable fluctuations in temperature, atmospheric pressure, and oxygen concentrations. At the same time, moderate intensity degree prevailed statistically significant in Morshyn (17.8%), as well as relative humidity (14.4%), and oxygen concentration (11.1%).

CONCLUSIONS

Taking into account all studied factors, it was established that weather patterns in the five most visited Ukrainian rehabilitation resorts were characterised by variability. Such findings must be considered for patients' health monitoring while performing preventive medical examinations (it is better to organise them upon patients' arrival at resorts) and giving relevant medical recommendations for risk groups. Morshyn and Myrhorod Resorts, considering the received data, should be provided with additional weather-informing services, spreading warnings for adverse weather types approaching, and doctors have to organise educational events for patients arriving for rehabilitation, stressing the importance of medical-preventive measures. Such measures include regular blood pressure monitoring, a mild rest regimen for health, excluding bad habits, and light to moderate physical activity under the doctor's control.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Anna V. Blagaia
Bogomolets National Medical University, Kyiv, Ukraine
e-mail: profilactika@hotmail.com

ORCID AND CONTRIBUTIONSHIP

Anna V, Blagaia: 0000-0002-2451-9689 A D E F
Mykola Kondratiuk: 0000-0001-5500-6352 B C
Oksana Poliukhovich: 0009-0001-8243-494X B
Olena Nesterenko: 0000-0001-6908-5821 B C
Yelyzaveta Volodko: 0009-0006-9433-2840 B

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 11.01.2025
ACCEPTED: 28.03.2025

ORIGINAL ARTICLE

The impact of rehabilitation on limb circumferences in patients after cardiac surgery

Joanna Łuczak[1,2,3], Anna Lubkowska[2], Aleksandra Radecka[2], Aleksandra Szabert-Kajkowska[3]

[1]DEPARTMENT OF MEDICAL REHABILITATION, STATE MEDICAL INSTITUTE OF THE MINISTRY OF INTERIOR AND ADMINISTRATION IN WARSAW, WARSAW, POLAND
[2]DEPARTMENT OF FUNCTIONAL DIAGNOSTICS AND PHYSICAL MEDICINE, FACULTY OF HEALTH SCIENCES, POMERANIAN MEDICAL UNIVERSITY IN SZCZECIN, SZCZECIN, POLAND
[3]MAZOVIAN ACADEMY IN PLOCK, PLOCK, POLAND

ABSTRACT

Aim: The aim of the study was to analyze limb circumferences in patients after coronary artery bypass grafting and minor thoracotomy.

Materials and Methods: The study group consisted of 144 patients who underwent cardiac surgery, and were subjected to physiotherapy for 3 to 5 weeks at the Cardiac Rehabilitation Department of the State Medical Institute of the Ministry of Interior and Administration in Warsaw. The rehabilitation included respiratory exercises and active free exercises in positions depending on the week of rehabilitation and the patient's capabilities, walking training from Monday to Saturday educational sessions regarding physical effort, exercise possibilities, their justification and wound care. Before and after the therapy, measurements of the circumferences of the upper and lower limbs were taken. The Bioethical Commission of the Hospital gave consent to conduct the research.

Results: The average circumference of the left leg in the study group decreased by 2.493 cm, while the circumference of the right leg decreased by 2.963. The average circumference of the upper limb decreased by 5.33 cm. A weak correlation was found between the duration of the rehabilitation stay and the change in the circumference of the lower limbs (correlation coefficient $r = -0.10$; $p = 0.227$) and upper limbs (correlation coefficient $r = -0.13$; $p = 0.744$).

Conclusions: The implementation of cardiac rehabilitation in patients after cardiac surgery had a weak impact on the reduction of the upper and lower limbs circumferences.

Keywords: cardiac rehabilitation, post-surgery wound, lower limb circumferences, upper limb circumferences, coronary artery bypass grafting, CABG, minor thoracotomy, small incision under the breast, valve

Acta Balneol. 2025;67(2):134-137. doi: 10.36740/ABAL202502109

INTRODUCTION

Cardiac rehabilitation, specifically physical exercise, has a positive impact on all patients, including those after cardiac surgery [1-7]. Discussions do not concern whether physiotherapy should be used, but rather how early and in what way to organize it on an outpatient basis [8-12]. Depending on the surgery, the patient has scars that affect their physical fitness [13]. For 3 years, the State Medical Institute of the Ministry of Interior and Administration conducted research in the Department of Cardiac Rehabilitation in patients after cardiac surgeries at the same hospital.

MATERIALS AND METHODS

The study group consisted of 144 (mean age 68.36 years) patients of the Cardiac Rehabilitation Department who underwent the following procedures: coronary artery bypass grafting (CABG) or valve replacement (so-called minor thoracotomy, i.e. a small incision under the breast). The study group consisted of 63.2% of men and 36.8% of women.

Participation in the study was completely voluntary, each participant signed an informed consent form and was qualified by a doctor. Before and after the therapy, a physiotherapy consultation took place and measurements of the circumferences of the upper and lower limbs were taken. The measurements included: circumferences of the lower limbs (knee joint, calf, ankle joint and right and left metatarsus), upper limbs (elbow joint, forearm at the same height from the olecranon of the right and left limbs, wrist joint and metacarpus). Based on the analysis of the measurements taken, a rehabilitation program was developed, lasting from 3 to 5 weeks. All participants practised breathing exercises and active free exercises in sitting and standing positions at a chair, depending on the week of rehabilitation and the patient's capabilities, with walking training from Monday to Saturday (excluding Sundays). Weekly discussions were held regarding physical exertion, possibilities for physical exercises, their justification and how to care for the wound. The Bioethical Commission of the Hospital approved the conduct the study.

RESULTS

The Change in the Circumference of the Lower Limbs before and after Rehabilitation was calculated. The calculations were performed for the entire group (144 people). The reliability (Cronbach's α) of this scale is very high, equal to 0.827. The average circumference of the left leg in the study group decreased to 2.493 cm, while the circumference of the right leg decreased to 2.963 (Table 1, 2).

The change in the circumference of the upper limbs before and after rehabilitation was calculated. The calculations were performed on the entire group (144 people). The reliability (Cronbach's α) of this scale is moderate, equal to 0.576. The average circumference of the upper limbs decreased by 5.33 cm. (Table 3).

A weak correlation was found between the duration of the rehabilitation stay and the change in the circumference of the lower limbs (correlation coefficient r = –0.10; p = 0.227) and upper limbs (correlation coefficient r = –0.13; p = 0.744).

It was determined that age does not affect the change in limb circumference (correlation coefficient r = 0.01; p = 0.903).

No differences were found in the average circumferences of the lower limbs between the groups of patients without a split sternum and with a split sternum (t = 0.68; p = 0.4971).

DISCUSSION

The patient's condition before surgery is the starting point for the effectiveness and efficiency of the procedure and subsequent rehabilitation. A patient undergoing cardiac surgery suffers a huge trauma. The surgical wounds, especially in the case of coronary artery bypass grafting, require enormous energy expenditure from the body during the healing process. The material used for

Table 1. Change in left leg circumference

	Mean	Standard Deviation	Cronbach's α
Change in left leg circumference	-2,493	3,534	0,649
Change of left knee joint circumference–	-0,544	1,025	0,587
Change of the left calf circumference	-0,904	1,549	0,476
Change of the left ankle joint circumference	-0,559	1,434	0,598
Change of the left metatarsus circumference-	-0,485	0,951	0,629

Table 2. Change in right leg circumference

	Mean	Standard Deviation	Cronbach's α
Change in right leg circumference	-2,963	3,585	0,704
Change in circumference of the right knee joint	-0,647	0,970	0,603
Change in right calf circumference	-1,081	1,647	0,567
Change in circumference of the right ankle joint	-0,713	1,270	0,619
Change in circumference of the right metatarsus	-0,522	0,894	0,727

Table 3. Change-in the circumference of the upper limbs

	Mean	Standard Deviation	Cronbach's α
Change in the circumference of the upper limbs	-5,33	4,36	0,576
Change in the circumference of the right forearm	-2,222	1,224	0,697
Change in the circumference of the right wrist joint	-0,111	0,601	0,578
Change in the circumference of the right metacarpus	-0,333	0,500	0,488
Change in the circumference of the right elbow joint	-0,556	0,527	0,555
Change in the circumference of the left forearm	-2,444	1,014	0,568
Change in the circumference of the left wrist joint	-0,778	0,972	0,436
Change in the circumference of the left metacarpus	-0,000	0,500	0,596
Change in the circumference of the left elbow joint	-0,889	1,167	0,416

creating a bypass may be the great saphenous vein, taken from the patient's calf, and in selected cases, the radial artery, taken from the forearm. The size and number of scars affect the patient's activity as well as the physical exercise program. Precautions also apply to the sternum, which -are modified to be less restrictive, but the wound and scar remain [13]. After surgery, patients are routinely restricted to limit the activities of-their arms and torso to prevent sternum complications. Unfortunately, overly restrictive sternum precautions can deepen the-loss of independence. Immobility and deconditioning associated with activity restrictions can lower physical and psychosocial functioning as well as quality of life. The interpretation of the clinical impact of sternum precautions is difficult due to inconsistent definitions. Typical guidelines include restriction of shoulder joint movement during lifting, pushing, and pulling with-a load for 6 to 8 weeks. Early implementation and appropriate upper body exercises for patients provide invaluable benefits [14]. The saphenous vein is the most commonly used conduit for coronary artery bypass grafting. Using the conventional technique, the saphenous vein is harvested through a large ,open incision and cut in a way that causes a vascular injury. Endoscopic vein harvesting reduces the risk of wound healing complications but may have a negative impact on graft performance due to vascular injury associated with applying forces to the vein that are typically avoided during open vein harvesting, including traction, adventitial stripping, and venous compression. The effect of these techniques on vein graft patency has not been described, with the potential to produce a better graft with fewer wound complications [15-20]. In selected cases, the radial artery is harvested from the forearm either as a T graft or as a free radial graft, similar to a saphenous vein graft. In addition to the neurological function of the hand after radial artery harvesting, which is questionable especially in the long term,-this affects the patients' lifestyle [21-22]. Unlike the classical access to the heart during mitral and tricuspid valve surgeries, which involves a longitudinal section of the sternum, the mini-thoracotomy technique involves a few-centimeter incision in the anterior mid-chest. Mini-thoracotomy reduces postoperative pain for the patient, accelerates healing, shortens the time of convalescence and postoperative rehabilitation time. The patient avoids the need to sleep on their back for three months after the procedure and a few months of restricted ability to drive Various types of wounds heal with natural components of the healing process, and liquid components of plasma cause swelling in the area. This fluid appears at the site of injury as a result of increased permeability of small capillaries. On the other hand, swelling occurs as a result of impaired drainage of-excessive lymph, which is a substance containing water and lymphocytes, at the tissue damage site. This happens because the lymphatic and blood vessels are damaged, making it difficult for the accumulating fluid to drain. Physical activity adjusted to the patient's capabilities promotes the process of recovery, reduces swelling, and its restriction is not beneficial [23, 24].

CONCLUSIONS

The use of cardiac rehabilitation in patients after cardiac surgery resulted in a reduction of the circumference of the upper and lower limbs. The average circumference of the left leg in the study group decreased to 2.493 cm, while the circumference of the right leg decreased to 2.963. The circumference of the upper limbs decreased to 5.33 cm.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Joanna Łuczak
Centrum Usprawniania Leczniczego
PIM MSWiA, Warsaw, Poland
e-mail: joasialuczak@op.pl

ORCID AND CONTRIBUTIONSHIP

Joanna Łuczak: 0000-0003-3635-4700 A B C D E F
Anna Lubkowska: 0000-0002-5378-5409 B E F
Aleksandra Radecka: 0000-0001-7315-7461 B E F
Aleksandra Szabert-Kajkowska: 0009-0008-1978-7663 B E F

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 14.12.2024
ACCEPTED: 24.03.2025

REVIEW ARTICLE

Rehabilitation as an important component of universal health coverage

Nataliia V. Kharchenko[1], Tatyana V. Pluzhnikova[1], Nataliia Liakhova[2], Alla M. Podvyn[2]

[1]POLTAVA V.G. KOROLENKO NATIONAL PEDAGOGICAL UNIVERSITY, POLTAVA, UKRAINE
[2]POLTAVA STATE MEDICAL UNIVERSITY, POLTAVA, UKRAINE

ABSTRACT

Numerous scientific papers have been published demonstrating new, previously unknown therapeutic effects and indications for the use of rehabilitation.We summarized the results of the development of physiotherapy and determined the role of physical medicine and rehabilitation in modern medicine by analyzing and summarizing literary sources and Internet data on the implementation of rehabilitation services. Rehabilitation is without a doubt a critical aspect of health, aimed at improving function and independence. As a field of health care, it has evolved through various stages before arriving at its current model, which includes various components of biological, social and contextual factors that influence the health and functioning of people experiencing various health problems. Regardless of who the beneficiary is, who is providing it, or in what context the rehabilitation is performed, optimizing function is the ultimate goal of rehabilitation and plays an important role in the well-being of the patient, regardless of the underlying health condition.

KEY WORDS: physical medicine and rehabilitation, physiatry, occupational therapy, physiotherapy

Acta Balneol. 2025;67(2):138-142. doi: 10.36740/ABAL202502110

INTRODUCTION

Rehabilitation is a widely discussed concept across the globe. This is not surprising, as over a billion people live with some form of disability, accounting for more than 15% of the world's population. Furthermore, recent reports indicate that 2.41 billion individuals worldwide experience conditions that impair their daily functioning and could benefit from rehabilitation services. This means that approximately one in three people will require rehabilitation services at some point in their lives due to illness or injury [1].

In the next 30 years, the proportion of the global population aged 60 and above is expected to double, with the majority affected by chronic illnesses, particularly non-communicable diseases. These shifting health and demographic trends are driving a rapid rise in the number of individuals experiencing functional decline, leading to a substantial unmet demand for rehabilitation services. This gap is most pronounced among the poorest and most vulnerable populations, especially in low- and middle-income countries and regions affected by conflict, where healthcare systems often struggle to accommodate the increasing need for rehabilitation [2, 3].

The World Health Organization (WHO) recognizes rehabilitation as a fundamental element of universal health coverage (UHC), which encompasses "the promotion of good health, disease prevention, treatment, and palliative care" [2]. Rehabilitation, therefore, plays a crucial role in enabling individuals to regain functional independence in daily activities, participate in work, education, and recreation, and engage meaningfully in society [2]. It is evident that rehabilitation is not only essential for individual well-being but also contributes significantly to the broader goal of fostering a healthy and functional global population.

AIM

The goal of rehabilitation is to complete tasks. Rehabilitation objectives include:

- Prevent loss of function.
- Slowing the rate of loss of function.
- Improvement or restoration of function.
- Compensation for loss of function (compensatory strategies).
- Maintain current function.

MATERIALS AND METHODS

This article draws on information from systematic reviews supporting the effectiveness of rehabilitation to identify key features and develop an empirical definition. We summarized the results of the development of physiotherapy and determined the role of physical medicine and rehabilitation in modern medicine by analyzing and summarizing literary sources and Internet data on the implementation of rehabilitation services.

REVIEW AND DISCUSSION

At its core, rehabilitation is founded on the principle that every individual possesses an intrinsic right and tendency to be an active participant in managing their own health [4, 5]. This distinction highlights the fundamental difference

between acute care and rehabilitation: while acute care focuses on ensuring a patient's survival, rehabilitation is centered on equipping individuals with the knowledge and skills necessary to regain independence in daily activities, thereby fostering self-care and functional autonomy [2, 6].

However, there remains no universally accepted definition or standardized understanding of rehabilitation. Its interpretation varies depending on the context, encompassing perspectives such as a developmental concern, a disability-related issue, a healthcare necessity, a human rights matter, a substance abuse challenge, or even a security-related matter, among others [7].

Rehabilitation is a structured process aimed at enabling individuals to achieve the highest possible level of functionality, independence, and overall quality of life. While it does not reverse the damage caused by illness or injury, it plays a crucial role in restoring a person's optimal health, functional abilities, and well-being [8-10].

According to the World Health Organization (WHO), rehabilitation is defined as "a set of interventions designed to assist individuals who experience or are at risk of experiencing disability in achieving and maintaining optimal functioning within their environment" [11].

In this sense, rehabilitation comprises "a series of measures aimed at optimizing the functional capacity of individuals with disabilities in interaction with their surroundings." Health conditions that may necessitate rehabilitation include acute or chronic illnesses, injuries, and various other circumstances such as pregnancy, aging, stress, congenital anomalies, or genetic predispositions. Anyone experiencing functional limitations—whether related to mobility, vision, cognition, or other impairments—may require rehabilitation. The most effective rehabilitation approach is guided by the biopsychosocial model, which incorporates interventions that address impairments, activity restrictions, and participation barriers. This approach also considers both personal and environmental factors, including assistive technologies, that influence an individual's overall functioning.

Rehabilitation is a healthcare strategy centered around the individual, ensuring that treatment aligns with both the underlying health condition and the user's personal goals and preferences. Functional information plays a crucial role in decision-making at all levels of the healthcare system, as rehabilitation aims to optimize functioning despite impairments, injuries, or acute and chronic diseases [12-16]:

- At the individual level, functional assessments help set rehabilitation goals and evaluate outcomes throughout the different stages of care, including primary, secondary, and tertiary rehabilitation, as well as acute, post-acute, and long-term care.
- At the facility or program level, aggregated user performance data aids in monitoring clinical outcomes, improving service planning, and ensuring quality standards.
- At the policy level, comprehensive functional data provides evidence for policymakers to design and evaluate health and rehabilitation services.

Rehabilitation is a lifelong process, spanning from infancy to old age. It can take place at various stages – before the onset of a condition (preventive "prehabilitation"), during acute care, post-acute recovery, or as part of long-term management. Rehabilitation is provided by a range of medical and non-medical professionals, as well as by individuals themselves, their families, and caregivers. By restoring, preventing, or slowing functional decline – whether sensory, physical, intellectual, cognitive, mental, or social – rehabilitation places the individual at the center of care, helping them reach their full potential and participate actively in society. Consequently, its impact extends beyond individuals, benefiting families, communities, and economies.

Dietz [17] identified four key elements of rehabilitation, originally developed for cancer patients but now widely applied across various conditions: preventive, restorative, supportive, and palliative rehabilitation.

- Preventive Rehabilitation: Implemented soon after a diagnosis or the emergence of a condition, this approach focuses on education, counseling, and interventions to prevent further impairments and maintain functionality. It is commonly used for chronic diseases such as cancer, chronic obstructive pulmonary disease (COPD), diabetes, and neurological disorders. It also forms the basis of supported self-management, including strategies to sustain function for as long as possible.
- Restorative Rehabilitation: This approach emphasizes interventions aimed at improving impairments such as muscle strength, respiratory function, or cognitive abilities to maximize functional recovery. It is widely used following surgery, illness, or acute events like severe injuries or strokes, with the primary goal of restoring functionality.
- Supportive Rehabilitation: Aimed at enhancing self-care and mobility, this approach includes providing assistive devices, teaching compensatory techniques, and modifying environments to facilitate independence. Sometimes referred to as adaptive rehabilitation, it focuses on helping individuals perform daily activities more effectively [19].
- Palliative Rehabilitation: Designed for individuals with life-limiting conditions, palliative rehabilitation enhances physical, psychological, and social well-being while respecting personal preferences. It prioritizes symptom relief – such as pain management, breathlessness, and swelling – alongside strategies to prevent contractures, support breathing, and improve comfort and dignity. Assistive devices and relaxation techniques are often incorporated to maximize independence and maintain quality of life [19].

Rehabilitation services are fully accessible and free of charge, as they are entirely covered by the National Health Service of Ukraine under the Medical Guarantee Program.

With a focus on patient-centered care, individuals can independently select one of the 423 medical institutions contracted by the National Health Service after receiving an electronic referral. These institutions provide services under two specific packages: "Rehabilitation care for adults

and children in inpatient settings" and "Rehabilitation care for adults and children in outpatient settings".

To initiate the rehabilitation process in an outpatient setting, a patient simply needs to obtain an electronic referral from a family doctor or attending physician. Once the referral is received, any Ukrainian citizen can independently choose a medical facility that is most convenient for them. Upon arrival at the selected institution, a specialist in physical and rehabilitation medicine, along with a multidisciplinary team, will conduct an assessment. This team may include:

- A physical therapist.
- An occupational therapist.
- A rehabilitation nurse.
- A psychologist.
- A prosthetist (for individuals with amputations).
- A speech and language therapist (if required).

Based on the assessment, rehabilitation specialists will collaborate with the patient to develop a personalized rehabilitation plan. This "roadmap" will outline specific objectives that the patient aims to achieve by the end of the rehabilitation course.

The outpatient rehabilitation package ensures a comprehensive level of care, providing at least one hour of rehabilitation per day. The standard rehabilitation course lasts a minimum of 14 days, with patients entitled to two rehabilitation cycles per year.

For individuals requiring rehabilitation after a disease or injury, hospital-based rehabilitation services are also available. If necessary, patients can be transferred from one medical facility or clinical unit to another to ensure continuity of care. Early initiation of the recovery process is a key priority.

Inpatient rehabilitation is also accessible via an electronic referral, which can only be issued by the attending physician. The specialist providing the referral depends on the patient's specific medical condition or injury. Despite this, the final choice of hospital remains with the patient, ensuring they can select the most suitable facility for their recovery.

In a medical facility, a physical rehabilitation doctor, along with a complete team of specialists, participates in the evaluation of a patient requiring rehabilitation. The composition of this multidisciplinary team is similar to that of the outpatient rehabilitation package. Following the initial assessment, the specialists, in collaboration with the patient, develop an individual rehabilitation plan that outlines the specific outcomes the patient aims to achieve by the end of the rehabilitation process.

For a single rehabilitation cycle, it should last at least 14 calendar days. For two or more cycles, the duration should exceed 21 calendar days, with intensive sessions lasting at least 3 hours per day. Depending on the severity of the injury, each patient may undergo from two to eight rehabilitation cycles per year, free of charge [20].

Rehabilitation outcomes refer to the improvements and changes in a person's functioning over time, which can be attributed to a specific intervention or set of interventions. There is strong evidence that rehabilitation services not only lead to better health outcomes but also generate long-term cost savings and improve value and equity within the healthcare system. These benefits may include:

- Prevention and reduction of demand for medical services.
- Integration of out-of-hospital care, which reduces hospital stays and prevents unplanned hospitalizations.
- Fewer hospitalizations or readmissions.
- Reduced length of hospital stays.
- Increased independence.
- Improved self-monitoring of the condition.
- Reduced care burden.
- Return to roles or occupations appropriate for age, gender, and context (e.g., home care, school, work).
- Enhanced quality of life.

Effective rehabilitation:

- Focuses on achieving positive outcomes as defined by the patients, guided by their goals.
- Prioritizes individual needs rather than diagnoses.
- Sets ambitious goals and includes professional standards of results.
- Is an active and supportive process, rather than merely passive care.
- Relies on collaboration within an interdisciplinary team.
- Adapts to changes in the patient's needs.
- Integrates both specialized and general services.
- Requires strong leadership to drive transformational change.

Rehabilitation offers a wide array of possibilities for patients. It includes support in developing essential communication skills, engaging in exercises to improve or maintain overall health, well-being, and employment, as well as comprehensive neurological rehabilitation following severe injuries or strokes. Rehabilitation is applicable at any age, as a person's needs evolve throughout their life. For example, individuals may require assistance for:

- Development of new skills: Children may need habilitation services to overcome barriers from developmental challenges and health conditions, enabling them to achieve maximum health and independence [21].
- Maintaining skills and independence: For advanced conditions such as dementia, motor neurone disease, and terminal cancer, early diagnosis, evaluation, and rehabilitation can help individuals maintain their abilities and independence for as long as possible [22].
- Increased productivity: Rehabilitation can assist athletes and sportspeople in improving performance after an injury or a period of absence from sports.
- Recovery from unexpected illnesses: Rehabilitation helps individuals recover from conditions like depression, anxiety, psychosis, acute stroke, surgery, falls, chest infections, and heart disease [22].
- Recovery from severe injury: Rehabilitation aids in restoring and maximizing independence and skills, including returning to work after a significant injury.
- Chronic disease management: For individuals with chronic or long-term illnesses, rehabilitation helps them

regain or maximize their independence when they experience an unexpected illness or flare-up [22].
- Self-management of conditions: People with chronic or long-term illnesses can manage their health better, reducing the risk of secondary complications that impact their mental or physical well-being, such as strength loss, cardiovascular issues, contractures, bedsores, pain, anxiety, and depression [22].
- Advocacy for access: Vulnerable individuals needing support (such as those with cognitive impairment or communication difficulties) can receive advocacy as part of their rehabilitation plan.

There are several common misconceptions about rehabilitation that limit its potential impact on public health.
- Misconception: Rehabilitation is only for individuals with disabilities (as defined by the CRPD).
- Fact: Rehabilitation is essential for anyone with a health condition, impairment, or injury – whether acute or chronic – that limits their functioning.
- Misconception: Rehabilitation is just a highly specialized service for athletes or a service for returning to work after injury.
- Fact: Rehabilitation aims to meet the needs of a diverse range of individuals throughout their life.
- Misconception: Rehabilitation is a luxury medical service that can be overlooked due to competing demands for investment and resources.
- Fact: Rehabilitation is a crucial element of healthcare and is often necessary to optimize the results of other medical interventions, such as surgery [22-24].

CONCLUSIONS

Rehabilitation is undoubtedly a vital aspect of healthcare, aimed at improving function and independence. As a healthcare field, it has evolved through various stages, integrating biological, social, and contextual factors that affect the health and functioning of individuals with various health challenges. Regardless of the patient, the provider, or the setting, the primary objective of rehabilitation is to optimize function, significantly contributing to the patient's well-being, irrespective of their underlying health condition. By restoring, preventing, or slowing the decline in functioning (sensory, physical, intellectual, mental, cognitive, or social), rehabilitation places the person at the center of the process, fostering the full realization of their potential and participation in society. Therefore, its impact extends beyond individuals to their families, communities, and economies.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Nataliia Liakhova
Poltava State Medical University, Poltava, Ukraine
e-mail: NataNew2017@ukr.net

ORCID AND CONTRIBUTIONSHIP
Nataliia V. Kharchenko: 0000-0001-8668-1596 A B D
Tatyana V. Pluzhnikova: 0000-0001-8300-854X E F
Nataliia Liakhova: 0000-0003-0503-9935 E F
Alla M. Podvyn: 0009-0008-5946-7621 B C

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 15.12.2024
ACCEPTED: 14.02.2025

LETTER TO THE EDITOR

Virtual reality-based rehabilitation on improving balance and coordination in elderly patients

Shenbaga Sundaram Subramanian, Akshya Sam, Surya Vishnuram, Bhavaani Sree Dhandapani

SAVEETHA COLLEGE OF PHYSIOTHERAPY, SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCES (SIMATS), CHENNAI, TAMIL NADU, INDIA

Acta Balneol. 2025;67(2):143-145. doi: 10.36740/ABAL202502111

Dear Editor

As a postgraduate student specializing in Community, Geriatric and Palliative care I extend my sincere gratitude to the editorial board of Acta Balneologica for publishing a series of insightful and highly relevant articles that have significantly contributed to my research on effectiveness of virtual reality-based rehabilitation in improving balance and coordination in elderly patients with fear of fall. The studies provided crucial perspectives on postural control, fall prevention, and the integration of advanced technologies in rehabilitation. These works not only enhanced my understanding of evidence-based rehabilitation strategies but also helped guide the direction of my research. This letter serves to acknowledge the significance of these articles and their impact on my study while also highlighting key findings and the need for further research in this domain.

In conducting my research, I thoroughly reviewed articles published in Acta Balneologica on balance training, virtual reality in rehabilitation, and fall prevention interventions, which provided valuable insights and contributed to shaping my understanding of these topics, as outlined in Table 1. The research involved a comparative analysis of traditional rehabilitation techniques such as physiotherapy-based balance training and modern VR-based rehabilitation programs. Data from Acta Balneologica articles were instrumental in forming hypotheses and determining key outcome measures for my study. Traditional rehabilitation techniques demonstrated effectiveness in improving static and dynamic balance in elderly patients at risk of falls. However, VR-based rehabilitation programs showed superior outcomes in terms of patient engagement, adherence, and overall improvements in coordination. Patients undergoing VR-based rehabilitation reported greater confidence in movement and a reduced fear of falling, corroborating findings from Piejko et al [1]. Their findings suggest that reduced postural stability significantly increases the likelihood of falls, emphasizing the need for targeted rehabilitation programs to improve balance and coordination [2]. Kasprzak et al. emphasized the importance of incorporating modern rehabilitation technologies to enhance postural control and reduce fall risk in elderly patients. Their study highlighted how virtual reality and biofeedback-based interventions improve patient engagement and adherence to balance training programs [3]. The research findings reinforced the notion that VR-based rehabilitation has the potential to revolutionize balance training for patients with a fear of falling.

The ability to create immersive and engaging rehabilitation environments makes VR-based therapy a promising tool for improving postural control [4]. Bartczyk et al. investigated the impact of vibrational stimulation on motor variability, suggesting that integrating VR with such modalities may enhance rehabilitation outcomes [5]. The published works in Acta Balneologica played a pivotal role in shaping my understanding of this field, offering critical evidence that supported the observed benefits of VR-based rehabilitation.

Despite its advantages, VR-based rehabilitation is not without limitations. Studies such as those by Gutorova et al. (2018) highlight the legal and ethical considerations associated with VR interventions [6]. Additionally, accessibility and cost remain significant barriers to widespread adoption, as noted in articles discussing the financial and logistical challenges of integrating advanced rehabilitation technologies into standard clinical practice. Furthermore, the findings suggested that while VR-based rehabilitation enhances balance and coordination, a hybrid approach incorporating both traditional and VR-based training may be optimal. Articles such as those by Khubetova et al., emphasize the importance of combining different rehabilitation strategies to maximize patient outcomes, an idea that aligns with my study's conclusions [7].

The research conducted with the support of articles published in Acta Balneologica has provided strong evidence favoring the integration of modern rehabilitation techniques, particularly VR-based interventions, in improving balance and coordination in patients with fear of falling. The insights from these articles were invaluable in shaping my study, confirming the benefits of virtual reality in rehabilitation, and highlighting areas requiring further investigation.

While traditional rehabilitation methods remain effective, VR-based rehabilitation offers unique advantages such as enhanced engagement, real-time feedback, and greater adaptability to patient needs. However, further exploration

Table 1. Summary of Key Findings and Relevance to My Study

Reference	Population (P)	Intervention (I)	Comparison (C)	Outcome (O)	Relevance & Contribution to Study
Piejko et al. (2019)	Patients aged 65+ with increased fall risk	Virtual reality-based postural training	Traditional rehabilitation	Improved postural control and balance, reduced fall risk	Reinforced the role of VR in enhancing postural stability and reducing fear of falling.
Cieślik et al. (2015)	Patients with osteoporosis and history of falls	Balance training interventions	No specific intervention	Significant correlation between postural stability and fall occurrence	Supported the need for targeted rehabilitation to prevent falls in high-risk groups.
Kasprzak et al. (2019)	Elderly patients undergoing balance training	VR-based postural control exercises	Conventional physiotherapy	Increased adherence, improved engagement, better postural outcomes	Highlighted the superior patient engagement in VR-based therapy, reinforcing its potential benefits.
Pawlak et al. (2020)	Geriatric patients with balance impairments	Physiotherapy-based balance training	No physiotherapy	Improved postural stability and coordination	Strengthened the foundation of traditional rehabilitation as an effective intervention.
Bartczyk et al. (2020)	Patients with motor impairments	Vibrational stimulation in balance training	No vibrational stimulation	Increased motor variability and neuromuscular adaptation	Suggested that integrating VR with additional stimulation methods may enhance rehabilitation outcomes.
Gutorova et al. (2018)	Medical rehabilitation patients	Virtual/augmented reality interventions	Standard therapy	Ethical and legal concerns in VR applications	Addressed important considerations regarding the integration of VR into clinical practice.
Khubetova et al. (2023)	Patients with Parkinson's disease	Complex rehabilitation incorporating VR	Traditional physiotherapy	Improved functional mobility and coordination	Emphasized the benefits of combining traditional and VR-based approaches.
Donchenko et al. (2024)	Future occupational therapists	Education on modern rehabilitation technologies	Standard rehabilitation training	Improved readiness to implement VR-based rehabilitation	Highlighted the importance of integrating VR into clinical education and professional practice.

into cost-effectiveness, long-term outcomes, and patient-specific customization is necessary to ensure broader implementation in clinical settings.

Although my study contributed valuable findings, it had several limitations. The sample size was relatively small, limiting the generalizability of the results. Long-term follow-up was not conducted to assess the sustainability of the improvements. The cost and accessibility of VR-based rehabilitation were not analyzed in depth. There was limited exploration of patient preferences between traditional and VR-based methods. These limitations highlight the need for larger-scale studies with extended follow-ups to determine the long-term effectiveness and feasibility of VR-based rehabilitation programs.

While existing research has demonstrated the efficacy of VR-based rehabilitation, several aspects warrant further investigation. Long-term effects of VR-based training on postural control and fall prevention should be studied. Comparative cost-effectiveness between traditional rehabilitation and VR-based programs must be explored. The potential of hybrid rehabilitation models combining traditional and virtual reality-based therapies needs

further analysis. Customization of VR rehabilitation to accommodate individual patient needs and preferences is essential. Integration of AI and machine learning in VR-based rehabilitation to optimize real-time feedback and training adjustments could enhance its efficacy. Future research should focus on addressing these gaps to enhance the clinical applicability of VR-based rehabilitation and improve patient outcomes. As Donchenko et al emphasized integrating virtual reality and advanced rehabilitation tools into educational programs enhances the preparedness of future therapists to apply innovative treatment methods the healthcare professionals should consider integrating VR-based rehabilitation into clinical practice to enhance patient engagement, improve rehabilitation outcomes, and reduce fall-related risks [8].

However, it is essential to adopt a patient-centered approach, ensuring that rehabilitation programs are tailored to individual needs, accessible, and cost-effective. The insights gained from Acta Balneologica articles provide a strong foundation for the continued evolution of rehabilitation science, paving the way for innovative and effective interventions in physiotherapy and fall prevention.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Shenbaga Sundaram Subramanian
Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences (SIMATS),
Chennai, Tamil Nadu, India
e-mail: subramanian.scpt@saveetha.com

ORCID AND CONTRIBUTIONSHIP

Shenbaga Sundaram Subramanian: 0000-0002-6150-0928 E F
Akshya Sam: 0009-0007-5729-8468 A D
Surya Vishnuram: 0000-0002-7381-967X A B E F
Bhavaani Sree Dhandapani: 0009-0006-1445-3598 B C

A – Work concept and design, B – Data collection and analysis, C – Responsibility for statistical analysis, D – Writing the article, E – Critical review, F – Final approval of the article

RECEIVED: 15.01.2025
ACCEPTED: 10.03.2025

VARIA

Advanced balneology course for physicians – March 2025. Information regarding the completed course

The 27th edition of the Advanced Balneology Course for physicians was held between 3 and 14 March 2025. The topic of the course was "Balneology and Physical Medicine: Therapeutic Modalities and Selected Issues in Thermal Medicine".

The programme comprised a total of 80 instructional hours, including 76 hours of lectures and 4 hours of practical training at a balneotherapy facility. During the hands-on component of the course, the participants both administered and received balneotherapy and physiotherapy treatments, observing proper application techniques and gaining first-hand experience of their effects.

The goal of the two-week training was to familiarise physicians working in health resorts – or those planning to take up employment in thermal medicine facilities – with key issues in balneology, physiotherapy, and thermal medicine. The lectures, delivered at a high academic level, were designed to inspire further learning in the field of thermal medicine. A significant number of the participants expressed their intention to take up employment in Polish health resorts in the near future, while others – already working in this setting – sought to expand their expertise. The course was attended by 53 physicians from over 40 towns and cities across Poland. Most had a clinical specialisation, while only three were still in the process of completing their specialist training. The participants comprised a multi-specialty group, representing as many as 22 different medical disciplines, including family medicine, emergency medicine, internal diseases, gastroenterology, endocrinology, diabetology, paediatrics, cardiology, anaesthesiology and intensive care, geriatrics, neurology, radiology, medical rehabilitation, rheumatology, ophthalmology, and gynaecology.

The course covered basic topics in balneogeology, climatology, balneochemistry, indications and contraindications for thermal medicine interventions, medical thermal resort infrastructure, and a discussion of selected clinical fields in the context of thermal medicine, such as orthopaedics, rheumatology, arterial hypertension, cardiology, geriatrics and gerontology, hepatology, diabetology, endocrinology, gynaecology, and other clinical topics.

Furthermore, the participants were introduced to the key methods used in thermal medicine, including balneohydrotherapy, peloid therapy, balneogas therapy, hydrotherapy, kinesiotherapy, cryotherapy, ultrasound therapy, magnetotherapy, laser therapy, and electrotherapy. The programme featured a meeting with Dr Aleksandra Sędziak, Poland's National Consultant for Balneology and Physical Medicine, who provided expert insights on the organisational frameworks and future development trends in the Polish health resort sector. Lecturing at the event was also Prof. J. Głogowska-Szeląg, who holds the role of President of the Polish Society of Balneology and Physical Medicine. Thus, the participants had the opportunity to meet key figures in the field of balneology and physical medicine. At the conclusion of the course, the attendees met with Jarosław Jucewicz, Mayor of Ciechocinek, who discussed the unique aspects of managing and administering a town with health resort status. The lectures were delivered by distinguished specialists with extensive experience in the field. Most of them are academic and teaching professionals with specialisations in both clinical disciplines and balneology.


Prof. Irena Ponikowska and the participants. fot. Archive.

At the end of the course, the participants were required to take a test consisting of 41 sets of multiple-choice questions covering the topics discussed during the course. All the participants achieved good and very good results on their final assessment. On the last day, the attendees were formally awarded course completion certificates with professional accreditations amidst enthusiastic applause from the entire group.

It is satisfying to note that all the participants demonstrated exceptional commitment throughout the programme,

The course was attended by 53 physicians from over 40 towns and cities across Poland. fot. Archive.

actively participated in all educational sessions, and engaged in lively discussions after the lectures. These observations were shared by all the lecturers. The course participants also had the opportunity to purchase the two-volume reference book entitled "The Big Book of Balneology, Physical and Thermal Medicine" directly from the publisher, which will allow them to consolidate and expand the knowledge gained during the course.

Based on feedback from the physicians, the course was highly regarded for its high quality, interdisciplinary approach, and holistic perspective. The engaging delivery of topics through presentations was particularly well received. Some of the physicians participating in the course expressed a desire to deepen their knowledge within the specialisation of balneology and physical medicine. Thirty individuals submitted declarations of intent to join the Polish Society of Balneology and Physical Medicine.

The course took place in excellent facilities at St. George Family & Senior Thermal Resort in Ciechocinek, located in the heart of the health resort. I would like to thank the Owners and Staff of the facility for their commitment and for creating a pleasant atmosphere for the participants. The course fostered an exceptionally supportive and engaging learning environment. The Social Coordinator, selected by the physicians, collaborated seamlessly with the organisers, ensuring smooth execution of the programme. She also actively enriched the participants' free time with engaging coffee breaks and excursions to Toruń, which further strengthened the sense of unity and mutual support within the group. Prior to departure, the majority of the participants exchanged contact information to maintain both professional collaborations and personal connections. The course concluded with a commemorative group photograph and multiple smaller team portraits (selected samples attached).

I would like to thank all the participants and lecturers for their commitment and for fostering a collegial atmosphere, with special appreciation to the Social Coordinator, Dr Monika Donderska.

Scientific Director of the Course
Prof. Irena Ponikowska, MD, PhD

Safety First: Position of the Polish Society of Cryotherapy Regarding the Tragic Accident in a Cryosauna in Paris

The Polish Cryotherapy Society, committed to the quality of cryomedical devices and the safety of their users, cannot remain indifferent to the tragic accident that occurred in one of the Paris gyms.

As a result of the incident, two individuals using a cryosauna lost their lives.

We feel obliged to remind the public **that a cryosauna is not the same as a certified whole-body cryochamber** used in medicine. These terms are often confused, which can lead to dangerous simplifications and incorrect assumptions.

A whole-body cryochamber is a device intended for conducting whole-body cryotherapy and low-temperature stimulation. It should allow for temperature regulation in the range of -150°C to -100°C, enable the user to breathe atmospheric air, and provide continuous visual monitoring by trained personnel. Mandatory features include oxygen level sensors, alarm systems, emergency exits, and audio-visual communication systems.

The fundamental condition for using a cryochamber is ensuring patient safety. Users must be informed about contraindications and indications for treatment and adequately prepared for the procedure. Written confirmation is required to acknowledge that the user has read the device instructions, knows the location of emergency exits and safety buttons, and understands the behavior required in the event of light or sound alarms.

Patients must remain in constant visual and verbal contact with medical personnel via monitoring and audiovisual systems. A timer should also be present inside the cryochamber, allowing users to independently monitor the duration of the procedure. It is unacceptable to leave patients without continuous supervision.

In multi-person cryochambers, it is recommended that at least two people be present at the same time.

According to media reports, the tragic accident in Paris was related to, among other things, a failure in the nitrogen system, which led to fatal poisoning from liquid nitrogen vapors or oxygen deficiency in the room. This incident tragically highlights the dangers of using devices lacking appropriate certification, safety features, and proper technical and medical oversight.

In modern cryochambers, liquid nitrogen is used only in a closed technical loop, without any contact with the patient. The person undergoing treatment breathes safe, continuously monitored atmospheric air, and any threats trigger immediate device shutdown. In contrast, cryosaunas expose the user's body (excluding the head) to direct contact with liquid nitrogen vapors, posing a real health risk. These devices are not classified as medical devices and are therefore not subject to rigorous standards or certification.

Lack of proper insulation and an open nitrogen system can result in poisoning or suffocation. That is why constant supervision by trained personnel is essential – it allows for an immediate response in case of symptoms such as shortness of breath, extreme fatigue, nausea, vomiting, collapse, or disorientation.

A key element in ensuring the safety of cryotherapy is **the mandatory certification of cryogenic devices.** Certification guarantees compliance with the technical and medical standards necessary for safe treatment procedures.

As a scientific society, we emphasize that the effectiveness of whole-body cryotherapy procedures has been confirmed by numerous studies over the years - but only in relation to certified medical devices, namely whole-body cryochambers.

The Polish Society of Cryotherapy also participated in developing **the Position of the Committee for Rehabilitation, Physical Culture, and Social Integration of the Polish Academy of Sciences** regarding devices and the safety of cryotherapy procedures.

It has co-authored publications outlining the principles for the safe conduct of such treatments.

Prof. dr Agata Stanek
President of the Polish Society of Cryotherapy (PTKRIO)
Prof. dr Anna Skrzek
Vice-President of the Polish Society of Cryotherapy (PTKRIO)

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The main aim of the conference is to present trends and results of the latest scientific research in the field of complementary disciplines of physiotherapy, emphasizing their practical dimension/application in strengthening the professional competences of physiotherapists. We cordially invite representatives of medical, social, natural, technical and other sciences who, through their activities, can participate in the comprehensive rehabilitation process and strengthen patients' functional reserves.

Conference Topics:

- Biological sciences in the development of physiotherapy
- Social activation of people with disabilities
- Animal-assisted therapy and physiotherapy of animals
- Psychotherapy and occupational therapy in physiotherapy
- Professional profile of a physiotherapist – professional profile vs. social expectations
- Technical/engineering support in physiotherapy
- Varia – other topics related to new challenges of physiotherapy in clinical medicine of humans and animals

Workshops

The conference will include the following workshops:

- Low Pressure Fitness (a form of core muscle training using specific breathing techniques);
- Augmentative and Alternative Communication (AAC).

The project is co-financed by the government budget, allocated by the Minister of Science under the Excellent Science II Program. Grant amount: 58,410.00 PLN, total project value: 65,010.00 PLN – in accordance with the contract number KONF/SP/0105/2024/02.

The organizer will provide all registered participants with conference materials, the opportunity to take part in workshops, two lunches and coffee breaks; additionally for active participants (speech, poster): dinner on 22nd May 2025, overnight stay on 22nd-23rd May 2025, breakfast on 23rd May 2025.

Research and review works will be presented in Polish during the thematic sessions and the poster session. The poster session, addressed to young scientists (students and PhD students), will include a competition with prizes – the award for the best work.

The summary written in Polish should not exceed 150-250 words. In the case of research works, the summary should include the following sections: aim of the research, material and methods, results, conclusions and keywords. In the case of review works: description and keywords.

Registration* with an abstract should be sent electronically by 11th April 2025. The Scientific Committee will qualify the works for presentations at the Conference.

It is planned to prepare a reviewed post-conference monograph in 2025 published by the Publishing House of John Paul II University in Biała Podlaska. The deadline for submitting works for review, as well as the guidelines related to the layout and formatting of the works will be provided in the 2nd Announcement.

The publication fee of 100.00 PLN (applies only to active participants who will submit their work as a chapter in a post-conference monograph) must be paid after the work has been approved for printing (no later than 14 days from the date of receiving the decision).

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21-500 Biała Podlaska, 95/97 Sidorska Street
phone: +48 83 344 99 02
e-mail: r.rzeczkowska@akademiabialska.pl

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