Acta Balneologica

ISSN 2082 - 1867

Published since 1905

JOURNAL OF THE POLISH BALNEOLOGY AND PHYSICAL MEDICINE ASSOCIATION

2025 JULY-AUGUST VOL. LXVII ISSUE 4 (188)

THERMAL MEDICINE – THERAPY, PREVENTION, REHABILITATION

PHYSICAL THERAPY • BIOKLIMATOLOGY • BALNEOGEOLOGY • BALNEOCHEMISTRY

120 YEARS OF THE POLISH SOCIETY OF BALNEOLOGY AND PHYSICAL MEDICINE
120 YEARS OF THE JOURNAL "ACTA BALNEOLOGICA"

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

ISSN 2082-1867

Acta Balneologica

JOURNAL OF THE POLISH BALNEOLOGY AND PHYSICAL MEDICINE ASSOCIATION

2025 JULY-AUGUST VOL. LXVII ISSUE 4 (188)

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, Index Copernicus, EBSCO, Ministry of Science and Higher Education and the Polish Medical Bibliography

CONTENTS

ORIGINAL ARTICLES

REVIEW ARTICLES

ORIGINAL ARTICLE

Assessment of the quality of services provided by the Wieliczka Salt Mine Health Resort

Karolina Nowak[1], Karina Przybyło-Kisielewska[2]

[1]FACULTY OF TOURISM AND RECREATION, BRONISLAW CZECH UNIVERSITY OF PHYSICAL CULTURE IN CRACOW, CRACOW POLAND
[2]FACULTY OF SCIENCE AND TECHNOLOGY, INSTITUTE OF GEOGRAPHY AND ENVIRONMENTAL SCIENCES, JAN KOCHANOWSKI UNIVERSITY IN KIELCE, KIELCE, POLAND

ABSTRACT

Aim: The aim of the study was to assess the quality of services provided at the Wieliczka Salt Mine Health Resort from the perspective of patients and to identify key factors influencing their satisfaction.

Materials and Methods: The study was conducted using a diagnostic survey method among 250 patients participating in ten, two-week rehabilitation sessions. A proprietary questionnaire was utilised, and data were collected directly by the author and archived in digital form.

Results: The results indicate a very high level of overall patient satisfaction, particularly regarding the competence of physiotherapists. At the same time, a downward trend was observed in ratings among repeat users, which may indicate the need to personalise the services and implement quality monitoring mechanisms.

Conclusions: The conclusions from the study may contribute to the development of quality management in the health resort sector and support their strategic positioning in domestic and international health tourism.

KEYWORDS: Wieliczka Salt Mine Health Resort, services, quality

Acta Balneol. 2025;67(4):241-246. doi: 10.36740/ABAL202504101

INTRODUCTION

The Wieliczka Salt Mine, in continuous operation for over 700 years, is one of the most valuable monuments of mining technology and a key point on the Polish tourist map. In 1978, the mine was added to the UNESCO World Heritage List. Currently, the Wieliczka Salt Mine is primarily a flagship tourist attraction and also serves as a unique underground health resort [1].

Natural and cultural heritage play key roles in creating a competitive healthcare offer, which is the foundation of the Salt Mine's operations [2]. Rock salt, which has been mined in Wieliczka for centuries, is currently used to treat respiratory ailments and allergies. As the popularity of a healthy lifestyle and natural therapies grows, this health resort is gaining increasing importance as a place where tradition meets a modern approach to health [3].

The Wieliczka Salt Mine Health Resort offers a wide range of treatments based on natural healing methods. The microclimate of underground salt chambers is particularly beneficial for people suffering from respiratory ailments and allergies, and also supports the body's immune system. These treatments constitute a specific form of treatment called subterraneotherapy [4].

The resort offers, among others, halotherapy, inhalations, brine baths, and rehabilitation programmes, making it a popular choice among domestic and international visitors. A key factor attracting visitors is the high quality of services, which translates into satisfaction and loyalty to the health resort. However, in the face of changing expectations of modern patients, maintaining high quality standards poses a significant challenge. The quality of medical services and the professionalism of the staff play key roles in meeting patient expectations and the effectiveness of therapy [5]. A holistic approach to health is becoming standard in the spa and wellness industry. Meanwhile, the growing interest in wellness and the integration of modern technologies in the treatment process are opening up new opportunities for resorts such as Wieliczka. For medical resorts to maintain their market leadership, investment in innovative solutions and commitment to improving service quality are essential, which is a prerequisite for improving patient satisfaction and further development of the facility [6]. Modern health resort visitors seek not only effective therapy but also comprehensive support for their health and lifestyle [7].

In accordance with the literature on the subject, health tourism encompasses a number of specialised niches: medical, resort, thermal, wellness, senior and accessible tourism. Each of these forms meets different needs – from treatment and rehabilitation, through biological regeneration, to the social and recreational needs of the elderly and disabled. The growing interest in these segments is also confirmed by industry data and numerous strategies for the development of spa/health and wellness services in Europe and Poland [8]. The development of health tourism depends on the

degree to which the offer is tailored to actual market needs and the ability to respond to the challenges of growing competition – both domestically and internationally. Effective operation in this segment requires not only ongoing analysis of consumer motivations and preferences, but also their forecasting and systematic adaptation of the service structure to changing expectations. In an environement of dynamic competition, service providers who can flexibly respond to evolving customer needs have a better chance of retaining and increasing the number of visiting patients [9].

Currently, services constitute an increasingly dominant, broad and diverse economic sector [10]. At health resorts, in addition to accommodation, catering and recreational services, the most important are health services (also known as medical services), which include all therapeutic, rehabilitation and preventive measures [11].

In numerous studies, the growing demand for these services has been indicate. This demand results from two main factors: increasing health awareness among societies and the ongoing aging of the population [12, 13]. In Europe, the percentage of people above the age of 65 has increased from 16% in 2000 to over 21% in 2023, and forecasts predict it will reach 29% by 2050, which continues to significantly impact the demand for care and rehabilitation services [14].

Defining service quality is more complex than identifying the quality characteristics of goods. In the case of services, the customer is generally involved in the process of creating the service, which means that their perception shapes not only the final effect but also the form of service at each stage. The dimensions of service quality include responsibility, competence, courtesy, communication skills, credibility, safety and understanding [15]. At health resorts, it is important to provide high-quality health services, therefore, when assessing them, their significance in the «eyes» of customers should be considered [16].

In previous studies on the quality of services at the Wieliczka Salt Mine, the impact has been emphasized of factors such as staff professionalism, sanitary standards, infrastructure and unique natural resources on the overall level of patient satisfaction, which is a key indicator of health resort success. The quality of services at medical resorts is based on high service standards and appropriate quality management, which influences patient loyalty [17, 18].

Currently, in Poland, improving and maintaining the quality of treatment resort services is becoming increasingly important due to the growing share of commercial clients among the health resort clientele. Unlike patients referred through the public healthcare system, commercial clients typically have greater financial resources but also have less time for their stay. Therefore, they often expect not only effective health treatments but also high standards of service, modern infrastructure, a personalised approach, and an atmosphere conducive to both treatment as well as mental regeneration. Their needs differ from the expectations of system customers who, although also value quality, are often less demanding due to system limitations or lower awareness of commercial services [19].

AIM

The aim of this study is to assess the quality of services provided at the Wieliczka Salt Mine Health Resort, based on subjective patient opinions. Specifically, an attempt was made to answer the question of how often patients utilise health services at this facility, and how they evaluate their stay as well as the level of provided medical care. The performance of the medical staff - physiotherapists, physicians and nurses – was also analysed, as well as the relationship between the number of stays and the quality of services provided. This approach allows for the determination of patient satisfaction and the identification of areas requiring further improvement.

MATERIALS AND METHODS

The study was conducted using a diagnostic survey method in the form of a author-designed questionnaire. The original questionnaire was based on selected assumptions of the SERVQUAL model [15], adapted to the context of healthcare services [20]. Elements of tools used in measuring patient satisfaction, such as the Likert scale, were also included. The questionnaire contained single-choice questions and five-point rating scales. The variables examined in the survey included:

- frequency of health resorts service use – a categorical variable (first time, second time, etc.), allowing to determine whether the patient's experience influences his/her evaluation of the services;
- overall stay rating – a quantitative variable measured on a scale of 1 to 5 (1 – ' very poor', 5 – ' very good'), reflecting subjective satisfaction with the overall stay experience;
- service quality ratings for specific professional groups – quantitative variables: physiotherapists, nurses, physicians, reception staff;
- willingness to recommend – a quantitative variable also assessed on a scale of 1-5.

The questionnaire was designed in accordance with the principles of anonymity and voluntary participation. Surveys were obtained from 250 respondents. Measurements were always conducted on the final day of the stay, and the survey questions were posed directly by the author.

The analysed group of respondents was dominated by women (157), constituting over 62% of the total number of participants. The age range of the study participants was between 37 and 80. The largest age group comprised respondents age 60-69, representing approximately 44.8% of the total number of participants. The second largest group included those aged 70-80, and the smallest segment included participants below the age of 60. All respondents were residents of Poland.

RESULTS

Among the survey participants, 25% were first-time visitors, 32% were second-time visitors, constituting the largest group, while 16% were third-time visitors, and 10% were fourth-time visitors. Regulars comprised 17% - meaning those who have visited the resort five or more times,

Table 1. Assessment of services provided by physiotherapists, physicians and nurses at the Wieliczka Salt Mine Health Resort

Staff	Very poor	Poor	No opinion	Good	Very good
Physiotherapists	7	10	43	83	107
Physicians	12	20	38	88	92
Nurses	7	13	57	94	79
M	8.67	14.32	46	88.32	92.67
± SD	± 2.89	± 5.23	± 9.85	± 5.51	± 14.01

Source: compiled by the authors of this study

indicating varying levels of experience with the facility. In the conducted survey, 1.6% of respondents assessed the quality of the health resort services as 'very poor', 2% of respondents expressed a 'negative opinion', 19.6% had 'no opinion', while 31.6% and 45.2% of respondents assessed the services as 'good' and 'very good', respectively.

The questionnaire results regarding the evaluation of services provided by medical personnel at the Wieliczka Salt Mine Health Resort indicate high levels of patient satisfaction across all of the analysed professional groups: physiotherapists, physicians and nurses. Based on statistical analyses, positive responses dominated – 'good' and 'very good'.

Physiotherapists received the highest 'very good' rating among all groups (107 responses) and a relatively high 'good' rating (83 responses). This demonstrates the high level of patient appreciation for the quality of physiotherapy services (Table 1).

With regard to physicians, the distribution of ratings also indicates a high level of satisfaction with services. The mean values for positive ratings were 'good' (88 responses) and 'very good' (92 responses), respectively, indicating a generally positive perception of the received medical care. At the same time, this group demonstrated higher values for negative ratings compared to physiotherapists or nurses (20 responses) – 'poor' and 'very poor' (13 responses), however, this level remained relatively low. Nurses received the most varied opinions among the analysed groups. Although the mean ratings for the positive categories – 'good' (94 responses) and 'very good' (79 responses) indicate a high level of satisfaction, the greatest variability in opinions was noted in the 'no opinion' category (57 responses) (Table 1). This may indicate that some patients had limited contact with nursing staff or that their role was less visible to patients. Nonetheless, as in the case of other groups, negative ratings were rare.

Analysis of the mean values with corresponding standard deviations for each response category indicates a clear predominance of positive opinions in the assessment of medical staff at the Wieliczka Salt Mine Health Resort. The highest average frequency was recorded for the 'very good' category (M = 92.67, SD = 14.01), confirming it as the most frequently selected rating. However, the relatively high variability (SD) within this category suggests differentiation in how patients rated individual professional groups. For instance, physiotherapists received 107 'very good' ratings, while nurses received 79, indicating variation in perceived quality despite the overall positive trend.

In contrast, lower mean values were observed for negative ratings: 'poor' (M = 14.32, SD = 5.23) and 'very poor' (M = 8.67, SD = 2.89), which confirms their marginal share in the overall distribution of responses. The low standard deviations associated with these categories suggest a greater consistency among respondents in issuing low scores, likely reflecting a general agreement that serious dissatisfaction was rare.

This distribution indicates that while positive evaluations dominate, there is also noticeable variation in the intensity of these assessments across staff categories. The consistency of negative ratings, combined with their low frequency, reinforces the conclusion that poor service quality was not a common experience among patients.

The results of the study regarding willingness to recommend a stay at the resort indicate a clearly positive reception of the services provided. Based on statistical analysis, the dominant responses were positive – 'will recommend' and 'will definitely recommend', confirming the high level of satisfaction among respondents. The largest number of respondents responded 'will definitely recommend' (106 people, 42.4%), while another 82 individuals (32.8%) declared that they 'will recommend' a stay to others. In total, positive responses accounted for 75.2%, clearly demonstrating a high level of satisfaction with the health resort experience.

Neutral responses – 'no opinion' – were selected by 53 respondents (21.2%), which may reflect limited exposure to certain services or a lack of strong opinion. Negative responses ('will not recommend' – 6 respondents, 'definitely will not recommend' – 3 respondents) constituted only 3.6% of all answers, suggesting a low level of dissatisfaction. The arithmetic mean of the recommendation rating was M = 4.13, with a standard deviation of SD = 0.91, indicating both a predominance of positive evaluations and relatively low variability in responses. This result reflects a high degree of consistency in the patients' perceptions regarding their experience at the health resort. To verify whether the willingness to recommend differed significantly between

first-time and returning patients, an independent samples t-test was performed. The result showed no statistically significant difference ($t(248) = -1.56$, $p = 0.12$), suggesting that the likelihood of recommending the facility was comparable across both groups. The assumption of normality was verified using the Shapiro–Wilk test ($p > 0.05$), and equality of variances was confirmed using Levene's test ($p > 0.05$).

In summary, the analysis of responses ($M = 4.13$, $SD = 0.91$) confirms a generally high willingness to recommend the resort, which may serve as a proxy indicator of overall service quality and patient satisfaction with the therapeutic and recreational process.

One important area of evaluation of resort performance is the relationship between the frequency of using its services and the subjective perception of the quality of therapies and care provided. Identifying potential correlations between these two variables allows to better understand the mechanisms influencing patient satisfaction and assessing the sustainability of positive experiences associated with a stay at the facility.

Correlation analysis revealed a statistically significant negative relationship between the frequency of patient visits and their evaluation of key aspects of the resort's operation. The Pearson correlation coefficient for the number of visits and the overall stay rating was $r = -0.27$, $p < 0.01$, indicating a weak negative correlation. Similar negative correlations were observed for specific service categories: physiotherapy ($r = -0.22$, $p < 0.01$), medical services ($r = -0.20$, $p < 0.05$), and nursing care ($r = -0.18$, $p < 0.05$).

These results suggest that an increase in the number of visits was associated with slightly lower ratings of service quality. While the strength of the correlation is weak, it is statistically significant and consistent across multiple service areas. This may reflect growing expectations among repeat patients or a habituation effect, where familiarity with the environment leads to a diminished perception of novelty and satisfaction.

Experience at the treatment resort. This trend can be interpreted in several ways. First, it is possible that respondents returning to the resorts have higher expectations with regard to the provided services. This may lead to a more critical assessment of future stays. Second of all, the regularity of visits may lead to an adaptation effect – patients become accustomed to the conditions and procedures, resulting in a decreased sense of novelty and lower subjective value of the services. Finally, we cannot rule out the influence of variable factors, such as staff variability or differences in facility workload depending on the date of the stay.

The observed correlation is negative, meaning that along with an increase in the number of visits, service quality ratings tend to decline. This applies to both the overall stay at the resort and specific ratings related to medical and rehabilitation care. Of particular note, the decline in satisfaction affects various areas of the facility's operation, which may indicate a broader phenomenon not limited to a single group of service providers.

The study was conducted on a sample of $n = 250$ respondents. Assuming random sampling and a 95% confidence level, the confidence interval for a proportion of 50% is approximately 43.8%-56.2%. For proportions further from 50%, the interval becomes narrower. Therefore, results – particularly those below 10% – should be interpreted with caution due to relatively higher sampling variability at low frequencies.

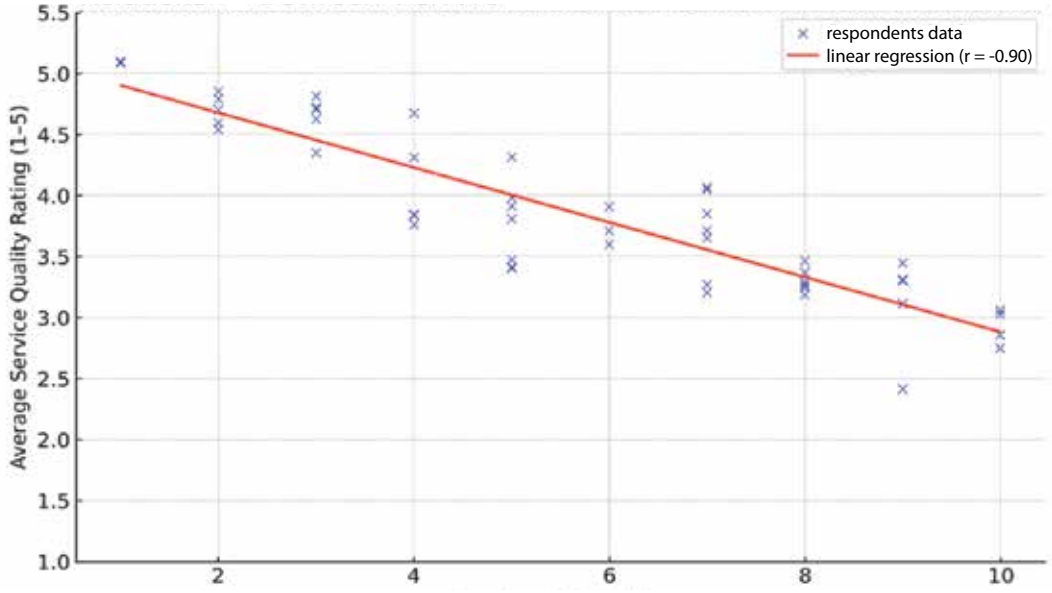


Fig. 1. Correlation between frequency of visits and assessment of health resort service quality (own elaboration)

Source: compiled by the authors of this study

DISCUSSION

The results of the conducted research allow to confirm the high level of satisfaction among patients using the services of the Wieliczka Salt Mine Health Resort. The quality of physiotherapists' work was particularly appreciated, indicating the high competence of the staff and the effectiveness of the therapeutic methods used. Similar observations are reflected in the literature [10, 12], which suggests that the professionalism of the medical staff is a key determinant of patient satisfaction.

The downward trend in service quality ratings among patients who repeatedly visited the resort, observed in the study, is a phenomenon worth further analysis. It may indicate the so-called "habituation effect" or the increasing expectations of repeat guests, which is confirmed in the literature on customer relationship management [6]. This indicates the need to develop a strategy to personalise the offer and systematically monitor the needs of returning patients to prevent potential discouragement.

The high level of willingness to recommend medical resort services (75.2% of positive responses) demonstrates the significant potential of word-of-mouth marketing and high patient trust in the offered services. This result aligns with Net Promoter Score (NPS), widely recognised as an effective measure of customer loyalty in the service sector [20]. A high NPS may also suggest the positive impact of the resort's atmosphere, infrastructure and unique microclimate, which distinguishes the Wieliczka Salt Mine from other facilities [1, 4].

Therefore, the study results allow to suggest that maintaining a high standard of service while adapting services to the changing demographic and health needs of patients – including commercial clients, who often have higher expectations for the quality of care provided, is of great significance [12]. Attention should be paid to the growing role of individualised therapy and the integration of wellness and preventive services, which should complement traditional treatment offers [21, 22].

CONCLUSIONS

The research conducted allowed for a comprehensive assessment of the quality of services provided at the Wieliczka Salt Mine Spa Resort from the patient perspective. The results indicate that patient experiences play a key role in shaping their opinions about medical services, which is consistent with service quality models.

High levels of satisfaction, willingness to recommend, and positive staff evaluations confirm that patients' basic expectations – both therapeutic and emotional – are met. The state of infrastructure and adherence to sanitary standards were also identified as significant factors influencing the overall quality assessment.

The identified correlation between the number of stays and lower service ratings indicates the need to develop a strategy for managing the experience of returning patients. Personalization of services and regular monitoring of satisfaction in this group can contribute to maintaining a high level of loyalty.

The data obtained suggest that the spa's further development should be based on a systematic analysis of patient expectations, the implementation of innovative solutions, and the utilization of natural resources and staff competencies. Although the study was local in nature and based on subjective assessments, its results provide a starting point for further comparative analyses involving other facilities and a broader understanding of the effectiveness of spa therapies.

In the future, it would worthwhile to broaden the analysis to include comparisons to other resorts, introduce a longer observation period and measure hard health indicators, which will allow for more comprehensive evaluation regarding the effectiveness of health resort services.

REFERENCES

1. Kruczek Z, Nowak K. The Wieliczka Salt Mine as a Flagship Attraction of Industrial Tourism and an Underground Health Resort; [w] Current Trends in Spa, Hotel and Tourism – Searching for a future direction in tourism, 12TH International Scientific Conference Proceedings. Belianum. Publishing house of the Matej Bela University in Banská Bystrica. 2024:40-47.
2. Czerwiński T., Skorupa M.Turystyka zdrowotna i uzdrowiskowa [Health and treatment tourism].Wydawnictwo Naukowe PWN, Warszawa 2018. (Polish)
3. Kowalczyk A. Turystyka zrównoważona [Sustainable Tourism]. Wydawnictwo Naukowe PWN, Warszawa 2014. (Polish)
4. Ponikowska I, Kochański J.W.: (red). Wielka Księga Balneologii, Medycyny Fizykalnej i Uzdrowiskowej. Część ogólna [The Great Book of Balneology, Physical and Thermal Medicine. General Part]. Wyd. Aluna. Konstancin-Jeziorna. 2017, t.1. (Polish)
5. Pawłowska B. Emotions of Medical Personnel versus the Status and Power at Work in Hospital Wards. Przeg Soc Jak. 2021;17(4):68-87. doi:10.18778/1733-8069.17.4.
6. Porter ME., Teisberg EO. Redefining Health Care: Creating Value-Based Competition on Results, Boston: Harvard Business School Press, 2006.
7. Găman G. Changes of tourists' motivations and preferences towards health tourism services. Case study: the potential tourism cluster Moineşti-târgu Ocnaslănic Moldova. Cactus Tourism Journal. 2016;14(2):33-44.
8. Chojnacka-Ożga L, Ożga A, Ożga W. Turystyka uzdrowiskowa w Polsce i jej znaczenie w rozwoju lokalnym [Treatment tourism in Poland and its importance in local development]. Tur Roz Reg. 2024;22:31-42. doi:10.22630/TIRR.2024.22.15. [Polish]
9. Kútvölgyi V, Szabó Z. Consumer expectations when visiting a spa. Regional Possibilities Of Spa Towns. 2023;12:155-173.
10. Panasiuk A. Jakość usług turystycznych [Quality of Tourism Services]. Wydawnictwo Naukowe PWN. Warszawa 2007. (Polish)

11. Hadzik A. Turystyka i rekreacja uzdrowiskowa [Treatment Tourism and Recreation]. Wydawnictwo AWF Katowice. Katowice 2011. (Polish)
12. Hadzik A, Szromek A, Sadowska-Krępa E. Determinants of participation in sport and tourism of visitors to Polish health resorts. A case study. Studies in Physical Culture and Tourism. 2012;19(1):42-49.
13. Smith M, Puczków L. More than a special interest: Defining and determining the demand for health tourism. Tourism Recreation Research. 2015;40(2):205-219. doi:10.1080/02508281.2015.1045364.
14. Health at a Glance: Europe 2024. State of Health in the EU Cycle. Paris: OECD Publishing. doi: 10.1787/health-glance-eu-2024-en.
15. Hadzik A, Kantyka J. Ocena poziomu usług rekreacyjno-sportowych uzdrowiska Ustroń w świetle współczesnych badań, [w]: (red.) A. Szromek: Uzdrowiska i ich funkcja turystyczno-lecznicza. [Assessment of the level of recreational and sports services in the Ustroń health resort in the light of contemporary research, [in:] Ed. A. Szromek: Health resorts and their tourist and therapeutic function.] Wydawnictwo Proksenia 2014. (Polish)
16. Krzyżanowska K. Turystyka uzdrowiskowa i jej postrzeganie przez kuracjuszy [Treatment Tourism and Its Perception by Patient]. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Krakowie. 2016;956:65-76. (Polish).
17. Oleszczyk N, Dominiak N. Analiza turystyki uzdrowiskowej na przykładzie Kołobrzegu. [An Analysis of Treatment Tourism Using Kołobrzeg as an Example]. Tourism. 2021;31(1):45-60. (Polish)
18. Przybyło-Kisieleska K, Kruczek Z. Recreational activity of health resort guests as a factor increasing the attractiveness of a stay. Acta Balneol. 2025;67(2):102-107. doi:10.36740/Abal202502104
19. Zeithaml VA, Bitner MJ, Gremler DD. Services marketing: Integrating customer focus across the firm (7th ed.). McGraw-Hill Education, 2018.
20. Hadzik A, Tomik R. Znaczenie rekreacji we współczesnej turystyce uzdrowiskowej na przykładzie badań gości górnośląskich kurortów. [The importance of recreation in contemporary treatment tourism as exemplified by research on guests of Upper Silesian spas]. EkonoProb Turyst. 2014;2(26):151-166. (Polish)
21. Puczków L. Health, Wellness and Tourism: healthy tourists, healthy business? Proceedings of the Travel and Tourism Research Association Europe Annual Conference. Dalarna, Sweden 2010.

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
Karolina Nowak: 0000-0002-7251-0638 A B C D
Karina Dominika Przybyło-Kisielewska: 0009-0007-2729-4941 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: 20.03.2025
ACCEPTED: 09.07.2025

ORIGINAL ARTICLE

Management of burn convalescents medical treatment in health tourism system using sanatorium facilities

Volodymyr Kulivnuk[1], Oleksandr Hladkyi[2], Alexander Gertsiy[3], Rostislav Semeniuk[1]

[1]VINNYTSIA NATIONAL PIROGOV MEMORIAL MEDICAL UNIVERSITY, VINNYTSIA, UKRAINE
[2]STATE UNIVERSITY OF TRADE AND ECONOMICS, KYIV, UKRAINE
[3]STATE UNIVERSITY OF INFRASTRUCTURE AND TECHNOLOGIES, KYIV, UKRAINE

ABSTRACT

Aim: To determine the scientifically based tactics of rehabilitation of victims with burns and their consequences in sanatorium conditions.

Materials and Methods: The methodological basis of the research is the basis of scientific dialectics. The main methods of research are bibliographic, informational, monitoring as well as watch and wait, diacrisis, clinical-functional, laboratory, instrumental and thermographic methods. An analysis of almost 30 years of own experience in medical rehabilitation of burn convalescents in clinical sanatorium «Avangard» was conducted. In total, about 8000 people aged 6 to 72 years completed rehabilitation treatment with good results. This positive clinical sanatorium «Avangard» experience results were shown in received data and different calculations described in this paper.

Results: The different procedures of burn convalescents' medical rehabilitation using experience and equipment of sanatorium and health tourism institutes is explored. The scientifically based tactics of rehabilitation of victims with burns and their consequences in sanatorium conditions are determined. The main health injuries of burn convalescents as well as methods of their treatment are systemized. The periods of medical rehabilitation of post-burn patients are clearly divided. The main indications and contraindications for rehabilitation of burn convalescents in sanatorium and health tourism are investigated. The main mandatory services for burn convalescents pathology treatment are systemized.

Conclusions: The results obtained by applying rehabilitation measures at different stages in patients with thermal injuries indicate their effectiveness and feasibility of using them to optimize the course of the wound process, reduce the possibility of scar formation and early stabilization, and reduce the time of reconstructive surgery. The system of medical examination and surgical rehabilitation of patients with thermal injuries and their consequences allows solving the urgent problem of restoring various types of tissue defects, as well as deformities and contractures of joints, reducing the number of unsatisfactory results, improving the functional and cosmetic effect of treatment and improving the quality of life of the victims.

KEYWORDS: thermal injuries, burns, scars, post-burn patients, treatment methods

Acta Balneol. 2025;67(4):247-255. doi: 10.36740/ABAL202504102

INTRODUCTION

Thermal injuries are a serious medical, social and economic problem [1]. Its relevance is due to the high proportion of contractures, hypertrophic and keloid scars, and internal organ damage [2]. Almost 4/5% of burn survivors are people of working age. Therefore, the medical rehabilitation of post-burn patients is an important problem in the treatment consequences of burns.

Their rehabilitation process is complicated not only by the fact that it is necessary to restore the skin, musculoskeletal system functions, internal organs and systems, but also by the fact that many of these patients subsequently need surgical removal of contractures and deformities.

Today, there is a clear limit to the possibilities of conservative therapy for post-burn patients. This is due, on the one side, to the insufficient effectiveness of many means and methods of conservative therapy, and on the other – to the insufficient number of institutions that would have the entire arsenal of rehabilitation tools and methods.

Rehabilitation of patients after burns in health tourism system using sanatorium facilities is focused on physical and psychological recovery and return of the victims to work and social life. The authors' long-term experience in developing and improving of algorithms for burn convalescents' conservative rehabilitation that were implemented in clinical sanatorium "Avangard" (Nemyriv city, Vinnitska region, Ukraine) indicates their feasibility and effectiveness.

AIM

The main aim of this paper is to scientifically substantiate of rehabilitation tactics for burn convalescents in health tourism system using sanatorium facilities.

MATERIALS AND METHODS

The methodological basis of the research is the basis of scientific dialectics. The main methods of research are bibliographic, informational, monitoring as well as watch and wait, diacrisis, clinical-functional, laboratory, instrumental and thermographic

methods. An analysis of almost 30 years of own experience in medical rehabilitation of burn convalescents in clinical sanatorium «Avangard» was conducted. In total, about 8000 people aged 6 to 72 years completed rehabilitation treatment with good results. This positive clinical sanatorium «Avangard» experience results were shown in received data and different calculations described in this paper.

RESULTS

The rehabilitation tactics, which consists in the phasing of care depending on the stage and timing of scar tissue development, have been determined and substantiated. It has been shown that active rehabilitation measures lead to early stabilization of scars. The results obtained indicate the effectiveness of the conservative medical rehabilitation of burn convalescents in health tourism system using sanatorium facilities. The applied therapeutic effects made it possible to restore tissue defects, deformities and joint contractures, reduce the number of unsatisfactory results, improve the functional and cosmetic effect of treatment and improve the quality of life of the victims.

In 40-45% of adults who have suffered deep burns of more than 10% of the body surface, and in 70-80% who have had deep burns of more than 20% of the body surface, various disorders of the internal organs develop. Their frequency and nature depend on the timing of plastic closure of burn wounds and complications that occurred during the treatment of burn disease. Early surgical treatment – excision of burn wounds in the period from 2-3 to 10-11 days with simultaneous skin plastic surgery leads to a 2-3-fold reduction in the incidence of complications and disorders of internal organs and systems.

In adults, during the first year after burns, 40-45% have proteinuria, hematuria, and nocturia. In 55-60% of patients, glomerular filtration rate, renal plasma flow, and renal circulatory disorders are reduced. In 2-3% of patients, pyelitis, pyelonephritis, nephritis, nephrosis, renal stone disease, and renal amyloidosis are detected.

In children, as a rule, renal dysfunction is noted in deep lesions of more than 15% of the body surface. They are found in almost all children in the first and subsequent 3-4 years after large deep burns and have the same character as in adults.

In 70-80% of victims who have suffered the above burns, there are disorders of protein-forming, detoxification function of the liver. This manifests itself within 2-3 years.

In 30-40% of patients after deep burns of 10 % of the body surface and in 60-80 % of victims after deep burns of more than 15 % of the body surface, cardiovascular and respiratory system disorders are observed [3, 4].

Adult patients with superficial and deep burns covering more than 10% of the body surface and children with identical burns covering more than 7% develop intoxication. It accompanies the burn disease until the burn wounds heal (from the 25th to the 30th to the 50th to the 55th day) [5].

Toxic substances of various origins act on the systemic, organ, cellular and subcellular levels of the body, causing many pathological changes in the patient – impaired blood circulation, oxygen transport, myocardial depression, impaired excretory and secretory function of the kidneys, inhibition of excretory and absorptive, protein synthesizing and detoxification functions of the liver, blockade of the RES (reticulo-endothelial system), tissue breakdown, disruption of the blood-brain barrier, etc. [6].

As for the respiratory system, chronic bronchitis, interstitial pneumonia, chronic and focal pneumonia are noted. At the same time, even without residual inflammatory phenomena, restrictive disorders of the bronchopulmonary system are noted. Patients experience shortness of breath, increased minute respiratory volume, decreased lung capacity and reserve capacity of the respiratory system, oxygen utilization rate, and decreased blood oxygen saturation.

Here, along with the processes observed in the course of burn disease (pneumonia, bronchitis, respiratory tract burns, etc.), persistent disorders of bronchial patency, permeability of the blood-alveolar barrier, and the localization of scars, especially in children in the chest area, which limit its mobility, are important.

During the first year after the injury, post-burn patients have subcompensated functional and bactericidal activity of neutrophilic granulocytes, as well as reduced phagocytic activity. At the same time, the toxin-binding capacity of serum proteins is reduced.

During 1.5-2 years after deep burns covering 10-15% of the body surface, secondary immunodeficiency is determined, accompanied by a 2-3-fold increase in the level of circulating immune complexes, a decrease in the functional and suppressive activity of T-lymphocytes.

To clarify the nature and volume of the existing disorders, rheography, spirography, polycardiography, ultrasound, tomography, biochemical, immunological and other examinations are performed.

25-30% of adults and children have dysfunction of one or more joints. They are manifested in the form of contractures, trophic ulcers, dermatitis, stiffness and deforming arthrosis, fibrous, extraarticular and bone ankylosis, subluxations and dislocations, impaired venous and lymphatic outflow, and pathological scars.

Each of the major joints is characterized by clearly defined types of contractures. As a rule, adductor contractures and elbow contractures are formed in the shoulder joint, back or palmar flexion contractures in the wrist joint, knee flexion contractures, hip flexion or adductor contractures, ankle flexion or plantar flexion, plantar flexion or back flexion, back extensor contractures of the fingers, and adductor contractures of the neck. On the part of the hand, posterior extensor contractures of the I-V fingers are most often formed; somewhat less often – palmar flexor contractures of the II-V fingers, often – flexor-adductor contractures of the I finger.

In case of deep burns of any localization in adults and children, a certain number of scars always forms on 3-4% of the body surface during plastic surgery of granulating wounds. This is due to both the independent healing of some deep burns (III B stage) and the presence of dermal lesions around deep burns (III A stage), which can cause the formation of various scars.

Very old scars (more than 10-12 years), which are often inflamed, or trophic post-burn ulcers often cause the formation of squamous cell or, less often, basal cell skin cancer.

Pathological scars, which are formed most often after superficial burns of the III A stage, treated with ointment dressings, are usually accompanied by severe vegetative and allergic phenomena (sensitization): itching, paresthesias, heat, pain in the scarred areas. These phenomena can be so pronounced that they deprive patients of sleep, peace of mind and can lead to mental disorders.

The scars that form have to mature. In the process of maturation, the scar goes through 4 stages of development (formation).

1. Epithelialization stage. From the moment of complete epithelialization of the granulating wound, scar formation begins. Subsequently, the scar becomes coarser, the epithelium from pale pink becomes white, denser, and closer in color to the surrounding skin.
2. The stage of swelling. The scar begins to slightly thicken, rise above the skin level, redden and become sensitive to palpation ("groping"). Within a few weeks (3-4), the redness acquires a cyanotic tint and the pain decreases.
3. The stage of compaction. The scar becomes evenly dense, stands out sharply above the skin surface, and in some places dense plaques with a cyanotic tint appear. Sometimes this character of the scar remains forever or it goes into the fourth stage.
4. The stage of softening. The scar settles, becomes soft, mobile, flatter, somewhat pigmented, whitish in places and differs little from the surrounding skin.

Each of these stages of scar formation lasts at least 1.2-2 months [7; 8].

The main tasks of medical rehabilitation of post-burn patients are to return to work by restoring the functions of the musculoskeletal system and improving the functions of vital organs and systems (liver, kidneys, cardiovascular and respiratory systems).

MEDICAL REHABILITATION OF SUCH PATIENTS IS CLEARLY DIVIDED INTO 3 PERIODS [8].

The first, or early, period begins with the restoration of lost skin by autodermoplasty or self-healing of burn wounds. For part of this period (2-2.5 weeks), the victim stays in a burn unit (center), then is transferred to outpatient treatment at the place of residence or in specialized sanatoriums.

The goal of this period is to maximize the restoration of joint function, as well as to increase the degree of compensation and restore the functions of internal organs and systems through conservative treatment aimed at accelerating scarring, stabilizing the autodermografts that have taken root, and eliminating disorders of internal organs and systems.

The first rehabilitation period lasts from 2-3 to 12 months or more. One of the most important places in this period is occupied by comprehensive rehabilitation in health tourism system using sanatorium facilities.

The second and third periods are for patients with post-burn contractures, deformities, pathological scars, and other cosmetic defects.

The objective of the second rehabilitation period is to eliminate the contracture or deformity, reduce the degree of cosmetic and functional disorders associated with them [9].

The third rehabilitation period begins 2-3 weeks after the surgical elimination of contractures and deformities, and the engraftment of the displaced and transplanted skin pieces. Its task is to restore and develop the preserved functions of joints and organs through the use of conservative therapy identical to that used in the first period.

The third period is carried out only in relation to the operated joint. Since post-burn patients often have contractures and deformities of several localizations, and no more than two joints are mobilized at the same time, interventions should be performed on other joints in the future, which again requires the third stage of rehabilitation. A significant role in the successful completion of the third stage of rehabilitation belongs to comprehensive sanatorium rehabilitation.

The following post-burn patients are subject to medical rehabilitation in health tourism system using sanatorium facilities:

- adult patients who had deep burns of more than 4-5% of the body surface in the area of joints or near them or large deep burns (20-30% of the body surface) even without deformities;
- all children over 3 years of age who had deep burns of more than 3-4% of the body surface, even if they had no burn deformities when discharged from the hospital;
- patients (adults and children) who had various complications in the course of burn disease (pneumonia, bronchopneumonia, endocarditis, myocarditis, gastrointestinal bleeding, Kurling's ulcers, nephritis, pyelitis, toxic hepatitis, acute thrombophlebitis, arthritis of large joints, osteomyelitis, sepsis, etc;)
- adults and children who had limited and deep burns (1-2% of the body surface) in the areas of the hands and face, even if no deformities were observed at discharge;
- all patients with large superficial burns (III A grade): children over 10-15% of the body surface, adults over 15-20% of the body surface, and in case of burns of the face and hands – regardless of the total area of burns;
- all adults and children who have suffered deep burns of more than 10% of the body surface, who even without burn contractures and deformities have compensated or subcompensated dysfunctions of internal organs;
- all patients who have pathological scars (keloid and hypertrophic) regardless of the area of burns;
- all patients who have suffered burns with exposure or damage to deep structures (tendons, ligaments, bones, joints);
- patients who have suffered combined injuries (burn + mechanical injury, or burn + thermal injury of the respiratory tract).

Children over 3 years old and adults can be subject to rehabilitation in health tourism system using sanatorium facilities. The most favorable period for rehabilitation is 3 months after the restoration of lost skin.

INDICATIONS FOR REHABILITATION ARE
- burn contractures and deformities of any localization that spread within 1.5 years after burns;
- post-burn scars that mature and heal on their own, burns of III A degree not in the joint area (within 1 year of healing of burn wounds);
- ripening areas of free skin grafting, not in the joint area (within 1 year after skin grafting);
- hypertrophic and keloid scars after surgical treatment or self-healing of burn wounds (within 1.5 years after wound healing);
- thermal damage to the respiratory tract (inhalation damage) – within 1 year after the burn;
- burn pneumonia (within 1 year after the injury);
- toxic hepatitis, enteritis;
- post-burn pyelitis (within 1 year);
- post-burn myocarditis (within 1 year) [9].

CONTRAINDICATIONS
- persons with coronary heart disease or other subcompensated chronic comorbidities;
- persons with uncompensated disorders of various organs and systems;
- persons with mental illnesses;
- general contraindications for sanatorium treatment.

A major role in rehabilitation is played by regional burn units and centers, which are organizational and methodological centers for the rehabilitation of post-burn patients. All severe burn patients are treated at these units. Here, the necessary examinations, contingents and terms of referral for rehabilitation are determined.

The most effective comprehensive rehabilitation of post-burn patients (within 24 days) can be carried out in specialized sanatoriums and resorts. For example, in the health tourism system of Ukrprofozdorovnytsia CJSC, the sanatorium stage of rehabilitation is carried out in the Avangard (Nemyriv city, Vinnytska Oblast, Ukraine), Dniprovskiy (Kam'yanske city, Dnipropetrovska Oblast, Ukraine), and Berdiansk (Berdiansk city, Zaporizhska Oblast, Ukraine) sanatoriums.

DISCUSSION

Discussion of above-mentioned result was held in former "Avangard" and related "Dniprovskiy" Clinical Sanatoriums where diagnosis and treatment of burn patients had been founded and organized using the following items.

In the structure of pathology, burn patients accounted for 5.2% of the total number of patients undergoing health tourism treatment in the sanatorium. Patients with this pathology were admitted for treatment in the absence of contraindications.

Burn patients were selected for sanatorium treatment in accordance with the guidelines approved by the Ministry of Health of Ukraine [10-12]. Among them: adult convalescents who had deep burns of more than 4-5% of the body surface (BS) in the joints, or deep burns of 20-30% of the BS in other areas; all children over 3 years old who had deep burns of more than 3-4% of the BS; all convalescents with complications; all convalescents who had third-degree burns of more than 15% of the BS, and in case of burns of the face and hands, regardless of the burn area all convalescents who have suffered deep burns of more than 10% of the body surface area with impaired function of internal organs; all convalescents who have pathological scars regardless of the burn area; all convalescents who have suffered burns with damage to tendons, ligaments, bones, joints; patients with combined injuries. The list of services included in the cost of a sanatorium voucher is shown in Table 1.

Thus, burn patients were optimally provided with the necessary living conditions, dietary nutrition, diagnostic tools and sanatorium treatment.

It should be borne in mind that medical rehabilitation after burn patients is a long and continuous process, and it should be carried out on a regular basis, on the basis of other sanatorium and health tourism resort facilities, using the general principles and methods of comprehensive rehabilitation. To accelerate the maturation and stabilization of the engrafted skin, improve the function of the musculoskeletal system, treatment can be carried out in physiotherapy, balneotherapy, and mud therapy facilities and departments [13].

However, under all conditions, the most effective and comprehensive rehabilitation is in specialized sanatorium and health tourism resort departments [14].

Rehabilitation measures are aimed at:
- Identification of the peculiarities of the course of burn disease, depending on the time that has passed since the burn, its area, depth, the presence of internal organ damage and concomitant pathology
- identification of clinical variants of the course of burn disease based on clinical and functional, instrumental, laboratory, thermographic and other indicators. Patients are prescribed 5 meals a day, aimed at strengthening the body's resistance capabilities. The diet is enriched with complete proteins, mineral salts, trace elements, and vitamins.

BALNEOLOGICAL PROCEDURES

Balneological procedures are especially effective, and they are advisable at any time of rehabilitation. These procedures are necessary both for lesions of the musculoskeletal system and for dysfunctions of internal organs. For this purpose, carbon dioxide-radon or radon baths of low and medium concentration, hydrogen sulfide (sulfide) baths of low and medium concentration are used (as effective), iodine-bromine baths with a concentration of at least 10 mg/l of iodine and 20 mg/l of bromine, nonspecific general baths, as well as sea and brine baths, sea bathing, coniferous, soda, alum, herbal baths (with rouge, thyme, oak bark, St. John's wort, etc.), which have an overall positive effect on the body of post-burn patients.

The use of baths improves peripheral blood flow in the skin and tissues, improves amino acid metabolism, increases immunological reactivity and natural resistance, etc.

BALNEOTHERAPY PROCEDURES

Balneotherapy procedures are of particular importance in improving the function of internal organs: they provide a sedative effect on the body, improve skin metabolism,

Table 1. Mandatory services for burn convalescents pathology

Name of services	Services included in the package price
1. Residence services	
Number of persons in the room	2
Typical equipment of rooms with furniture and household appliances	The rooms are equipped with beds, a table, a wardrobe with hangers, chairs, bedside tables, individual lighting devices (according to the number of beds in the room), a decanter with glasses, bed mats, bed linen, household equipment, a TV, a refrigerator
Location of the sanitary unit in relation to the living room	Sanitary unit in the room
Availability of cold/hot water and its supply mode	Cold and hot water around the clock
2. Food services	
Availability of dietary nutrition according to the treatment profile for the lot	Diet No. 12a, all types of diets are available
Diet (frequency of meals)	6 meals a day
3. Treatment services	
3.1 Diagnostics at the sanatorium stage	
Laboratory tests	Complete blood count, clinical; general urine analysis
Instrumental research	Ultrasound diagnostics, thermography, electrocardiography
Consultations with doctors	Physical and rehabilitation medicine (PRM), combustiologist, physiotherapist, other members of the multidisciplinary team
3.2 Sanatorium and thermal treatment	
Drinking mineral waters	"Zbruchanskaya"
Hydrotherapy procedures (optional)	Sage, bischofite, turpentine, hydrogen sulfide, radon, oxygen, brine, sodium chloride, hydrokinesitherapy in the pool
Heat treatment procedures (selectively)	Mud, or paraffin, or ozokerite applications, galvanic mud therapy
Procedures of hardware physiotherapy (selective)	Medicinal electrophoresis, sinusoidal modulated currents, laser therapy, magnetolaser therapy, galvanization, cryotherapy, magnetotherapy, phonophoresis, ultraviolet light, inductothermy, electrical stimulation
Exercise therapy procedures (optional)	Exercise therapy (individual or small group), mechanotherapy according to an individual approach, morning hygienic gymnastics, kinesitherapy, traction therapy
Massage procedures (selective)	Dry traction or underwater traction, manual segmental massage or underwater massage, or electromassage

Source: compiled by the authors of this study

peripheral blood flow in the limbs and skin. For post-burn patients, indifferent temperatures (33-35°C) or warm baths (36-38°C) with an average duration (10-20 minutes) are usually used. The time of procedures in children is reduced by 1.5-2 times depending on age. The frequency of baths depends on the adaptive capacity of the body, its reaction to the procedure and the patient's age.

It is very effective to do various types of massage when taking general baths: underwater shower massage with a water jet pressure of 2026-4052 hPa (2-4 atmospheres), vortex (flow, rotary or turbine), vibration with a vibration frequency of 4 to 20 Hz and a sound pressure of 1 to 10000 bar.

HARDWARE PHYSIOTHERAPY

Hardware physiotherapy is used as a local remedy in the form of electrophoresis of potassium iodide, lidase; phonophoresis of hydrocortisone ointment, lidase; magnetotherapy on the area of keloid scars; local darsonvalization of hypertrophic scars.

After wound healing (first 3-4 weeks), ultrasound is used daily – 12-15 procedures per course of treatment. The effect is based on tissue micromassage and physicochemical effects on cellular formations with increased permeability, increased protein dispersion, diffusion, redox processes, and activation of connective tissue functions. The use of ultrasound stimulates the regeneration processes in the graft, promotes the correct positioning of collagen fibers and reduces their excessive growth [15].

LIGHT THERAPY

Light therapy is performed using Bionic and Bioptron lamps. It is believed that light therapy improves tissue trophism, healing of small wounds, and reduces itching. However, this requires convincing evidence.

In the presence of contractures and concomitant pathology of the musculoskeletal system and peripheral nervous system, heat treatment is prescribed: applications of various therapeutic muds, paraffin or ozokerite. The use of thermal procedures in the first 2-3 months after wound healing (at the stage of scar swelling and retraction of skin pieces) is contraindicated, it is advisable to use them at the stage of resorption of scar formations, deretraction of skin pieces that have taken root (3-4 months and later).

COMPRESSION THERAPY REQUIRES

Compression therapy requires prolonged wearing (from 6 to 9-12 months) of special elastic bandages, suits, masks, gloves, stockings that exert a pressure of 25 mm Hg on the underlying tissues. Such bandages and suits are made of elastic materials (including silicone) and are poorly breathable, so they are difficult for patients to tolerate and need to be changed after 3-4 months. At the same time, under the influence of such therapy, together with resorptive therapy, the number of fibroblasts decreases, scars become flatter, become mobile, and their growth stops.

MAGNETOTHERAPY

Magnetotherapy changes enzymatic and metabolic processes in cells, stimulates redox processes, improves microcirculation, and normalizes immunological processes. All this makes it possible to use PMP or PEMP for scar deformities.

LASER THERAPY

Laser therapy using helium-neon radiation quickly eliminates pain, itching, and increases joint mobility. Scar resorption is accelerated and metabolic processes are improved. The clinical effect is expressed in scarring of scars (epidermis layering), elasticity and extensibility of scar tissue increases.

BIOENERGY THERAPY

Bioenergy therapy is carried out using the Vita 01 apparatus in the form of lidase biophoresis and biogalvanic baths.

PSYCHOTHERAPY

Psychotherapy is carried out in the form of individual sessions. It normalizes the patient's general condition, emotional state, emotional reactions, improves mood, provides a positive attitude to the possibility of recovery, strengthens faith in the possibility of a full recovery.

ELECTROSLEEP

Electrosleep helps to normalize the psycho-emotional state of patients, reduce subjective sensations, paresthesias, and itching in the scar area.

Electrophoresis and ionophoresis of drugs in scar areas and scar fields are widely used, providing both physical action and the introduction of resorbable drugs into scar tissue.

The most commonly used local resorptive therapy agents in any rehabilitation period are, in order of decreasing effectiveness, such drugs as contractubex, collisin, corticosteroids, potassium iodide, teralithin, enzyme preparations, pyrogenal, biohalation and biophoresis, trypsin, aloe, etc.

The creation of a drug depot in scarred areas for the purpose of resorption is possible both by phonophoresis and by iontophoresis (electrophoresis) of various drugs. In this case, both the above-mentioned drugs and preparations are used, as well as traditional and non-traditional resorptive drugs: proteolytic enzymes (lecosyme, papain, lecopain), various salts (potassium iodide, sodium chloride, bee venom, apifor, etc.).

Local absorbing therapy can also be carried out by means of biogalvanization, in which the directed transfer of free charge carriers close to the membrane potentials of cells in human biological systems occurs under the influence of the contact difference in electrode potentials when two electrodes of different materials are applied. Using biogalvanization, it is also possible to carry out targeted injection of absorbable drugs into scar tissue and transplanted skin, i.e., biophoresis.

The creation of a drug depot in scar tissue for the purpose of resorption is possible both by phonophoresis and ionophoresis (electrophoresis), using galvanic currents and external current sources. In this case, the course of treatment in adults is 15-20, and in children 10-15 procedures.

In the presence of keloid scars with a statute of limitations of at least 5-6 months from the date of injury, abnormal laboratory parameters a) immunological (serum toxicity more than 30, presence of cryoglobulins); b) clinical (lymphocytosis, anemia); c) biochemical (hyperkalemia), in the absence of a keloid scar, itching, pain, hyperemia, large area and depth of the burn, general discomfort, symptoms of intoxication, plasmapheresis is prescribed.

For topical treatment, if necessary, calendula ointments, solcoseril, iruksol, actovegin, etc. are used.

The use of targeted comprehensive rehabilitation in sanatoriums and health tourism resorts can significantly improve rehabilitation outcomes. In particular, when the recommended rehabilitation system is carried out within 2 to 4-5 months after the healing of burn wounds, almost half of post-burn patients achieve good cosmetic and functional results, i.e., joint function is fully restored, stabilization of engrafted skin grafts occurs, contractures of the I-II degree are eliminated, and the maturation of scars and scar fields is significantly accelerated. Almost 40% of post-burn patients achieve satisfactory rehabilitation results, which significantly increase the range of motion in the joints and halve the need for subsequent surgical interventions.

As a result of comprehensive rehabilitation, there is a significant improvement in the functional state of the cardiovascular and respiratory systems.

The above-mentioned positive effects of conservative rehabilitation are confirmed by laboratory tests in Dniprovskiy snatorium (Ukraine) in table 2. Thus, with good rehabilitation results, the levels of circulating immune complexes decrease by 50-60%, and with satisfactory results, they decrease by 30-40% of the initial state [16-19].

The decrease in the absolute and relative content of lymphocytes approaches the indicators of healthy individuals. There is a tendency to restore normal immunological reactivity.

Table 2. Criteria for the medical and social rehabilitation of post-burn patients in the sanatorium "Dniprovskiy"

Criteria	Points
1. Severity of post-burn contractures (range of motion, angle of flexion, extension)	
decreased	3 points
former	2 points
increased (minus)	1 point
2. Frequency of exacerbations of concomitant diseases within 6 months after rehabilitation	
less than before rehabilitation	3 points
at the same level	2 points
more (minus)	1 point
3. Dynamics of the results of additional examination methods (ECG, FVC, respiratory function, etc.)	
positive	3 points
without dynamics	2 points
negative (minus)	1 point
4. Dynamics of laboratory parameters (indicators of the immune system, leukocytes, etc.)	
improvement and approximation to the indicators of healthy individuals	3 points
without dynamics	2 points
negative dynamics (minus)	1 point
5. Staying on sick leave 3 months after rehabilitation	
less than before rehabilitation	3 points
likewise	2 points
more than before rehabilitation (minus)	1 point
6. Establishment or strengthening of disability groups after rehabilitation	
the group is removed or reduced	3 points
unchanged	2 points
first established after rehabilitation or strengthened after rehabilitation (minus)	1 point
7. The need for constant outside help or supervision after rehabilitation	
is no longer necessary	3 points
at the same level	2 points
has become necessary (minus)	1 point
8. Improved social adaptation as a result of improved communication, orientation, behavioral control, and self-care	
is the improvement of social adaptation	3 points
social adaptation at the same level	2 points
no improvement in social adaptation (minus)	1 point
9. Terms of return to work and active lifestyle	
immediately after rehabilitation	3 points
6 months after rehabilitation	2 points
inability to return to work and an active lifestyle (minus)	1 point
10. Possibility to perform the same labor activity	
restored	3 points
limited (night shifts, overtime, etc. are excluded)	2 points
inability to perform the previous labor activity and the need for retraining (minus)	1 point
	If the sum of points: 10 to 15 points – rehabilitation is assessed as unsatisfactory; From 16 to 20 – satisfactory; From 21 to 30 – good.

Source: compiled by the authors based on [1]

CONCLUSIONS

The received results of burn convalescents' rehabilitation indicate their effectiveness and feasibility of usage for optimizing the course of the wound process, reducing the possibility of scars formation based on their early stabilization, as well as reducing the timing of reconstructive operations start.

The determined and substantiated rehabilitation algorithms in accordance with the stage-by-stage approach of providing care, that depended from the stage and timing of scar tissue development, ensure the restoration of various types of tissue defects, deformations and contractures.

Preventive rehabilitation (the first stage) is carried out in the acute period of injury in the process of restoring the lost skin.

After wound closure, conservative measures are aimed at flattening, softening scars as well asl at preventing deformations and contractures.

Rehabilitation assistance of any scope is provided in forms of scarring management, restoration of self-care functions as well as in forms of selection, adjustment, ancillary rehabilitation aids usage training and provision etc. according to individual needs.

Thus, medical rehabilitation of burn convalescents is consistently carried out in all periods of burn disease.

REFERENCES

1. Zharsky O. Pry opikakh vazhlyvo svoiechasno ta hramotno nadaty pershu domedychnu dopomohu [In case of burns, it is important to provide first aid in a timely and competent manner]. Bezpeka zhyttiediialnosti: vseukrainskyi naukovo-populiarnyi zhurnal. 2020;12:24. (Ukrainian)
2. Lukyantseva HV, Pastukhova VA, Kovalchuk OI. Submikroskopichni zminy hemokapiliariv velykykh pivkul holovnoho mozku, sprychynenykh termichnym opikom [Submicroscopic changes in the hemocapillaries of the cerebral hemiscle causes caused by thermal burn]. Bull Prob Biol Med. 2021;3(161):268-271 doi: 10.29254/2077-4214-2021-3-161-268-271. (Ukrainian)
3. Povstyanyi MY, Kylivnyk VS, Hikavchuk SV. Osnovni printsipy medichnoi reabilitatsii na etapi sanatorno-kurortnogo likuvanya. Pislyaopikivi zakhvoruvaniya: kolektivna monografia. Medichna reabilitatsiya v sanatorno-kurortnikh zakladakh ZAT "Ukrprofozdorovnytsia" [Basic principles of medical rehabilitation at the stage of sanatorium treatment. Post-burn diseases: a collective monograph. Medical rehabilitation in sanatorium-resort institutions of CJSC "Ukrprofozdorovnytsia"]. Kyiv: FOP Kupriyanova, 2005:154-171. (Ukrainian)
4. Kulivnuk VS, Hladkyi OV et al. Kurortolohiia: istorychni,orhanizatsiini ta klinichni aspekty: monohrafiia [Balneology: historical, organizational and clinical aspects: monograph]. Kyiv: Publishing House "Center of Educational Literature", 2021: 232. (Ukrainian)
5. Nazarchuk OA. Mikrobiolohichne obhruntuvannia vykorystannia antyseptykiv u opikovykh khvorykh dlia profilaktyky mikrobnykh uskladnen: avtoreferat disertatsii doctora medichnykh nauk [Microbiological justification for antiseptics usage by burn patients in reason of microbial complications prevention: abstract of the dissertation dr. of Medical Sciences]. Kyiv: National Medical University, 2020:26. (Ukrainian)
6. Kovalchuk OI, Gunas IV. Strukturna perebudova orhaniv neiroimunoendokrynnoi systemy za umov opikovoi khvoroby [Structural Restructuring of Neuroimmune Endocrine System in Conditions of Burn Disease]. Klinichna anatomiia ta operatyvna khirurhiia: naukovo-praktychnyi medychnyi zhurnal. 2020;3(73):27-34. (Ukrainian)
7. Povstyanyi MY, Kozynets GP, Loboda MV et al. Medichna reabilitatsiya opikovykh reconvalescentiv u sanatorno-kurortnikh ustanovakh: metodichni recomendatsii [Medical rehabilitation of burn convalescents in sanatorium-resort institutions: methodological recommendations]. Kyiv: FPU Editon, 2000:28. (Ukrainian)
8. Kozynets GP, Vasylchuk YM, Pinchuk VD. et al. Metody konservativnoi ta khirurgichnoi reabilitatsii u postrazhdalykh z naslidkami opikiv: navchalniy posibnik [Methods of conservative and surgical rehabilitation in victims with burns: a textbook]. Kyiv: JVC «Interdruk-Poligraphservis», 2010:100. (Ukrainian)
9. Papuga OE. Rozrobka dermalnykh ekvivalentiv shkiry z vykorystanniam klityn liudyny i novykh biomaterialiv dlia likuvannia masyvnykh opikiv: avtoreferat disertatsii kadydata biolohichnykh nauk [Development of dermal skin equivalents using human cells and new biomaterials for the treatment of massive burns: abstract of the dissertation candidate of biological sciences]. Kyiv: Institute of Molecular Biology and Genetics, 2021:26. (Ukrainian)
10. Loboda MV et al. Standarty (klinichni protokoly) sanatorno-kurortnogo likuvanya [Standards (clinical protocols) of sanatorium treatment]. Kyiv: KIM, 2008:417. (Ukrainian)
11. Kolesnik EO. Medichna reabilitatsiya v sanatorno-kurortnikh zakladakh ZAT "Ukrprofozdorovnytsia" (metodichniy posibnik) [Medical rehabilitation in sanatorium-resort institutions of CJSC "Ukrprofozdorovnytsia" (methodological guide)]. Kyiv: Kupriyanova, 1994:304. (Ukrainian)
12. Pashkov V, Trotska M, Leiba L. Factor of Natural Curative Resources in Context of Legal Regulation of Medical Rehabilitation. Acta Balneol. 2019;1(155);2019:49-54. doi:10.36740/ABal201901109.
13. Zhernov OA, Osadcha OI, Trach RI, Guz OA. Konservatyvna reabilitatsiia opikovykh rekonvalestsentiv pry rekonstruktsii rubtsevykh deformatsii [Conservative rehabilitation of burn convalescents in the reconstruction of scar deformities]. Sportyvna medytsyna i fizychna reabilitatsiia. 2020;1:100-104 doi: 10.32652/spmed.2020.1.100-104. (Ukrainian)
14. Kulivnuk VS, Hladkyi OV. Stan ta perspektyvy rozvytku rynku sanatorno-kurortnykh posluh v Ukraini [Current situation and development prospects of sanatorium and resort market services in Ukraine]. "Svitova medytsyna: suchasni tendentsii ta faktory rozvytku": zbirnyk tez naukovykh robit uchasnykiv mizhnarodnoi naukovo-praktychnoi konferentsii. Lviv: NGO "Lviv Medical Community". 2020:108. (Ukrainian)
15. Kravtsov OV. Diagnostyka ta kombinovane likuvannya paranekrotychnikh zon opikovykh urazhen: avtoreferat disertatsii doctora medichnykh nauk 14.01.03 [Diagnostics and combined treatment of paranecrotic zones of burn lesions: abstract of the dissertation dr. of Medical Sciences: 14.01.03]. Kharkiv: National Medical University. 2020:42. (Ukrainian)

16. Raetska Y. Morfofunktsionalni kharakterystyky stravokhodu za umov luzhnoho opiku stravokhodu 2 stupenia ta pry vvedenni ekstaktu struchkiv phaseolus vulgaris [Morphofunctional characteristics of esophagus under conditions of alkaline 2nd degree burn of esophagus as well as using Phaseolus vulgaris pod extract]. Bulletin of Taras Shevchenko National University of Kyiv: Series Problems of regulation of physiological functions. 2019;1(26):6-12. (Ukrainian)
17. Raietska Y. Riven prozapalnykh tsytokiniv za umov luzhnoho opiku stravokhodu 2-ho stupenia ta pry vvedenni ekstraktu struchkiv Phaseolus vulgaris [The content of proinflammatory cytokines in blood serum in rats with alkali burns esophagus under the treatment with Phaseolus vulgaris extract]. Bulletin of Taras Shevchenko National University of Kyiv: Series Biology. 2019;1(77):90-94. doi:10.17721/1728_2748.2019.77.90-94. (Ukrainian)
18. Raietska Y. Biokhimichni mekhanizmy za khimichnoho opiku stravokhodu: disertatsiya doctora biolohichnykh nauk 03.00.04 [Biochemical mechanisms in chemical burns of the esophagus: dissertation Dr. of Biol. Sciences: 03.00.04]. Kyiv: Taras Shevchenko National University of Kyiv. 2019:327. (Ukrainian)
19. Tytarenko VM. Strukturni zminy mozkovoi rechovyny nadnyrkovykh zaloz shchuriv pry eksperymentalnii opikovii travmi shkiry ta za umov zastosuvannia infuziinykh rozchyniv [Structural changes in medulla of rats' adrenal glands during experimental skin burn injury and under conditions of infusion solutions usage: abstract of diss. Cand. of Med. Sciences: 14.03.01]. Kharkiv: National Medical University. 2021:23. (Ukrainian)

CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Oleksandr Hladkyi
State University of Trade and Economics
19 Kyoto St., 02156, Kyiv, Ukraine
e-mail: o.gladkey@knute.edu.ua

ORCID AND CONTRIBUTIONSHIP
Volodymyr Kulivnuk: 0000-0001-6965-8204 A E
Oleksandr Hladkyi: 0000-0002-0600-0832 B C
Alexander Gertsiy: 0000-0002-8634-5880 D F
Rostislav Semeniuk: 0000-0001-7283-9284 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: 17.03.2025
ACCEPTED: 06.06.2025

ORIGINAL ARTICLE

Cannabis therapy for pain management in degenerative diseases – implementation of R&D results in health resort. A case study and best practices

Monika Anna Knefel

DEPARTMENT OF LABOR RESOURCE MANAGEMENT, CRACOW UNIVERSITY OF ECONOMICS, CRACOW, POLAND

ABSTRACT

Aim: The aim of this article is to present the completed research and development work on the use of cannabis in health resort dedicated to reducing the perception of pain in degenerative diseases of the spine and peripheral joints. The study serves as a case study and an example of best practice in setting new directions for treatment and the development of health tourism in Busko-Zdrój.

Materials and Methods: The research was conducted as part of project no. RPSW.01.02.00-26-0025/18 titled "Improving quality of life by reducing pain perception in degenerative diseases of the spine and peripheral joints", implemented at TERMA Słowacki Resort Medical Thermal in Busko-Zdrój. The project was co-financed by the European Union under the European Regional Development Fund within the Regional Operational Programme of the Świętokrzyskie Voivodeship for 2014-2020. The research utilized a comparative study method to assess traditional therapies against cannabis-based treatments. In the initial phase, new therapeutic procedures were developed, followed by a clinical study involving 200 patients. The research was conducted under the supervision of the Medical Bioethics Committee in Kielce.

Results: The findings indicate a positive impact of cannabis-based products used in thermal treatments. Outcomes were evaluated both objectively – through blood and urine analysis – and subjectively – by assessing patients' perceived pain levels. As a result of the study, an innovative commercial pain therapy for degenerative diseases was developed and implemented.

Conclusions: In conclusion, the study confirmed that treatments involving cannabis products had a positive effect on reducing pain symptoms in the research group, as well as on the final laboratory test results.

KEYWORDS: Busko-Zdrój, therapeutic sulphide water, industrial hemp, musculoskeletal pain

Acta Balneol. 2025;67(4):256-262. doi: 10.36740/ABAL202504103

INTRODUCTION

The therapeutic properties of sulphide-hydrogen sulphide, chloride-sodium, iodine, and bromine waters have long been known and widely used in thermal medicine. The Świętokrzyskie health tourism region is renowned for its medicinal waters with a particularly high concentration of sulfur compounds. A comparison of the mineral composition of Solec and Busko waters with international thermal stations reveals that waters from the Świętokrzyskie region significantly surpass those from places like Baden or Trenčín in mineral content [1]. Medicinal waters are distinguished by the form in which minerals occur, which positively influences their absorption by the human body [2, 3]. Among the most common treatments are balneological baths, although these are often associated with the unpleasant smell of hydrogen sulfide during bathing, as well as the sulfuric odor released from the body afterward – especially during physical exertion [4-6].

The first documented uses of cannabis for medicinal purposes, including for muscle pain, date back over 5,000 years. Tetrahydrocannabinol (THC) exhibits strong anti-inflammatory, analgesic, and smooth muscle relaxant effects. The cannabinoid CBD (Cannabidiol) is also known for its anti-inflammatory and pain-relieving properties [7, 8]. Although the use of cannabis has long been controversial [9], particularly around 2018 when this study was being prepared, its therapeutic potential became a source of inspiration [10, 11] for supplementing and expanding traditional medical resort treatments with cannabidiol-based mechanisms.

AIM

The aim of this article is to present the completed research and development work on the use of cannabis in health resort dedicated to reducing the perception of pain in degenerative diseases of the spine and peripheral joints. The study serves as a case study and an example of best practice in setting new directions for treatment and the development of health tourism in Busko-Zdrój.

On the one hand, the aim was to address the issue of odor – eliminating the unpleasant sensory experience during baths – so as to align the therapy with modern Thermal & Wellness trends. This also involved modifying other procedures to incorporate cannabis-based products.

On the other hand, it was essential to improve the effectiveness of the treatments in order to achieve the desired therapeutic outcomes in alleviating degenerative pain. The research problem involved developing a treatment protocol aimed at reducing perceived pain by 50%.

MATERIALS AND METHODS

Based on an original model for creating innovation in health tourism [12, 13], the study analyzes the problem of hydrogen sulfide release into the air during balneological baths. In collaboration with a team of experts, a solution was developed to reduce hydrogen sulfide emissions by using hemp oil and plant-based glycerin. This solution was patented as Patent No. 234306 – Method for Reducing Hydrogen Sulfide Emissions from Sulphide Baths, and served as an inspiration for further research into the use of cannabis in thermal treatments aimed at reducing the perception of pain in degenerative diseases of the spine and peripheral joints.

The study was conducted as part of project no. RPSW.01.02.00-26-0025/18 titled "Improving quality of life by reducing the perception of pain in degenerative diseases of the spine and peripheral joints," implemented from April 1, 2019, to December 30, 2021, at the TERMA Słowacki Resort Medical Thermal in Busko-Zdrój. The project was financed by the Regional Operational Programme of the Świętokrzyskie Voivodeship for 2014-2020 and co-financed by the European Union under the European Regional Development Fund.

In the first phase of the study, a method was developed to reduce the emission of hydrogen sulfide into the air during balneological baths. This involved applying a mixture of plant-based glycerin and hemp oil to the surface of the water, forming a thin oil microfilm barrier. This solution significantly improved the olfactory experience during the bath and enhanced the therapeutic effect of hydrogen sulfide in the water. It also allowed more H_2S to remain on the skin post-bath, which is less wiped off, thus intensifying its effects. Additionally, the residual oil layer improved skin hydration and left a pleasant scent. This solution was patented as Patent No. 234306 – Method for Reducing Hydrogen Sulfide Emissions from Sulphide Baths. It inspired further research into using hemp in medical treatments aimed at reducing pain in musculoskeletal disorders. As a result, the following procedures were developed:

- Sulphide-hydrogen sulphide baths with a hemp oil surface film
- Baths in a mini therapeutic pool with an extract from hemp inflorescences
- Drinking hemp infusion (crenotherapy) three times a day
- Classical massages using hemp oil and CBD oil

Subsequently, the author applied to the Medical Bioethics Committee in Kielce for approval to conduct a clinical trial. The research used a comparative methodology to evaluate traditional thermal treatments against cannabis-based therapy. The study assessed the effectiveness of two therapeutic programs:

1. Standard treatment program – traditional sulphide--hydrogen sulphide baths and other rehabilitation methods (kinesiotherapy, physiotherapy, hydrotherapy, peloid therapy, classical and mechanical massages)
2. Innovative treatment program – sulphide-hydrogen sulphide baths using a hemp oil film to limit H_2S release and intensify therapeutic effect, mini-pool hemp extract baths, drinking hemp infusion, classical massages with CBD and hemp oil, and other individually selected rehabilitation methods depending on the type and stage of the disease [4, 14, 15].

The study included 200 patients participating in the clinical experiment, divided into two groups of 100 (male and female), all diagnosed with degenerative diseases of the spine and peripheral joints at varying stages. The age range was 40 to 75 years (mean age: 60.45 years). Therapy for both the test and control groups lasted at least two weeks. Both groups received therapeutic treatments; however, the test group received therapies incorporating hemp-based procedures, while the control group followed conventional treatment protocols.

To assess the outcomes of the hemp-based therapy [15], the following evaluation tools were used:

1. Laboratory tests: CRP, orosomucoid, lipid profile, uric acid.
2. Visual Analogue Scale (VAS) – a 10 cm graphical-descriptive scale (0-10) used for assessing pain intensity; patients marked their current pain level on the scale.
3. Laitinen Scale – a subjective, point-based scale assessing four indicators: pain intensity, frequency of pain, limitation of physical activity, and frequency of analgesic use. Each is rated 0-4, where 0 indicates no problem and 4 indicates the most severe.
4. WOMAC Scale – evaluates pain, stiffness, and physical function based on 24 indicators scored from 0 to 4, as in the Laitinen Scale.

The assessments were conducted at the beginning and end of the treatment cycle, and follow-up surveys using the VAS, Laitinen, and WOMAC scales were completed three months after therapy.

The study was challenged by the global COVID-19 crisis, which limited the normal functioning of the facility. To mitigate this, corrective measures were taken, including the inclusion of outpatient participants, particularly local residents, to ensure the continuity of the research.

RESULTS

ANALYSIS OF LABORATORY RESULTS
(BLOOD AND URINE)

The gender, age, and body weight structure of both the test and control groups is similar, allowing for an objective comparison of the results obtained (Table 1).

In the lipid profile analysis, the test group achieved significantly better results: a decrease in total cholesterol (by 1.21%), non-HDL cholesterol (2.04%), LDL cholesterol (4.76%), and triglycerides (4.94%), along with an increase in HDL (so-called "good cholesterol") by 0.82%, which is a positive change. In contrast, the control group recorded a decrease in HDL by 1.85% (Table 2).

The average CRP level in the test group decreased by

27.1%, compared to 16.06% in the control group, confirming the stronger anti-inflammatory effect of the experimental therapy (Table 3).

The average decrease in orosomucoid levels was 5.28% in the test group versus 3.32% in the control group, further supporting the greater effectiveness of the new pain treatment method (Table 4).

Uric acid levels decreased by 2.17% in the test group compared to 1.39% in the control group, confirming the higher therapeutic efficacy of the studied approach (Table 5).

ANALYSIS OF PAIN PERCEPTION RESULTS

VAS SCALE

Participants assessed their pain levels three times using a 10-point Visual Analogue Scale (VAS), indicating their perceived pain level before and after the therapy, as well as three months later. The analysis of average changes in pain perception shows that although the initial pain level in the test group was 0.55 points higher than in the control group, by the end of the therapy the average pain level in the test group decreased by 2.37 points (37.01%), while in the control group it decreased by only 1.35 points (23.12%). After three months, the pain level in the test group decreased by an additional 0.28 points (7.14%), whereas in the control group, it increased by 0.36 points (7.19%). Considering the entire measurement process, the pain level in the test group decreased by a total of 2.65 points (41.5%), while in the control group by only 0.99 points (17.04%). These data are presented in tabular form (Table 6). It is worth noting that the therapeutic effect in the test group is more sustained than in the control group.

Table 1. Group Structure

Group description	Test group	Control group
Sample Size	100	100
- Women	69	61
- Men	31	39
Average Age [years]	60.5	60.4
Average Body Weight [kg]	78.3	80.2
Average Height [cm]	166.3	165.8
Average BMI [kg/m^2]	28.3	30.2

Source: compiled by the authors of this study

Table 2. Lipid Profile – Average Results

Lipid Tests	Before Therapy (Test / Control)	After Therapy (Test / Control)	Average Change	Change (%)
Total Cholesterol	207.71 / 195.06	205.19 / 194.48	-2.52 / -0.58	-1.21 / -0.30
HDL Cholesterol	59.01 / 60.79	59.49 / 59.66	0.49 / -1.13	+0.82 / -1.85
Non-HDL Cholesterol	148.73 / 134.55	145.70 / 134.82	-3.04 / 0.27	-2.04 / +0.20
LDL Cholesterol	129.03 / 107.32	122.88 / 116.38	-6.14 / 9.06	-4.76 / +8.44
Triglycerides	131.35 / 134.78	124.87 / 137.58	-6.48 / 2.81	-4.94 / +2.08

Source: compiled by the authors of this study

Table 3. C-Reactive Protein (CRP) – Average Results

CRP (mg/L)	Before Therapy (Test / Control)	After Therapy (Test / Control)	Average Change	Change (%)
CRP	2.739 / 2.731	1.997 / 2.293	-0.742 / -0.439	-27.10 / -16.06

Source: compiled by the authors of this study

Table 4. Alpha-1-Acid Glycoprotein (Orosomucoid) – Average Results

Orosomucoid (mg/dL)	Before Therapy (Test / Control)	After Therapy (Test / Control)	Average Change	Change (%)
Orosomucoid	76.318 / 73.807	72.289 / 71.359	-4.029 / -2.448	-5.28 / -3.32

Source: compiled by the authors of this study

Table 5. Uric Acid – Average Results

Uric Acid (mg/dL)	Before Therapy (Test / Control)	After Therapy (Test / Control)	Average Change	Change (%)
Uric Acid	5.416 / 5.445	5.298 / 5.369	-0.118 / -0.076	-2.17 / -1.39

Source: compiled by the authors of this study

Table 6. Reduction of Pain Perception According to Different Scales – Test and Control Groups

Pain level analysis	Average scores	Percentage change
	Test Group	Control Group
VAS SCALE		
Before Treatment	6.39	5.84
After 2 Weeks	4.02	4.49
After 3 Months	3.74	4.85
LAITINEN SCALE		
Before Treatment	6.93	5.84
After 2 Weeks	4.34	4.42
After 3 Months	4.12	4.71
WOMAC SCALE		
Before Treatment	47.21	44.65
After 2 Weeks	31.34	30.31
After 3 Months	31.26	32.68

Source: compiled by the authors of this study

LAITINEN SCALE

Participants assessed their pain three times: before and after therapy, and three months later. The assessment included pain intensity, frequency, intake of painkillers, and limitation of physical activity, each scored on a 0-4 scale. Although the baseline pain score in the test group was 0.39 points higher, by the end of therapy the score had decreased by 2.59 points (37.42%) and was 0.08 points lower than in the control group, where the decrease was 2.12 points (32.44%). Three months after therapy, the test group showed an additional decrease of 0.22 points, while the control group reported an increase of 0.29 points. Overall, from baseline, pain perception in the test group decreased by 2.81 points (40.53%), while in the control group the reduction was 1.83 points (27.98%).

WOMAC SCALE

Participants assessed pain, stiffness, and physical function three times: before and after therapy, and three months later, across 24 parameters scored on a 0-4 scale. The scores were then converted to a percentage scale, with 100% indicating the maximum severity for all parameters. At baseline, the test group showed a higher WOMAC index by 2.46 percentage points. After therapy, the index decreased by 15.23 percentage points (33.61%) in the test group and by 13.76 percentage points (32.1%) in the control group. After three months, the test group recorded a further slight decrease of 0.08 percentage points, while the control group showed an increase of 2.36 percentage points. In total, the WOMAC score in the test group decreased by 15.95 percentage points (33.78%) and in the control group by 11.97 percentage points (26.8%). These results indicate a more favorable outcome for the test group and further support the observation of a more sustained therapeutic effect in this group.

The obtained results confirm the effectiveness of the studied therapy using industrial hemp (Cannabis sativa L.).

DISCUSSION

In both groups, the characteristics of pain related to degenerative musculoskeletal diseases were similar, in accordance with the study's sampling methodology. More than half of the participants had been suffering from osteoarthritis or spinal degeneration for over 10 years, and approximately one-quarter had experienced symptoms for between 5 and 10 years. Nearly all participants reported spinal and joint pain, while more than 75% experienced joint stiffness. These indicators were identical in both the test and control groups. Joint swelling was reported by 2 out of 5 individuals, with half of these cases affecting both joints.

Pain most commonly occurred spontaneously and during simple daily activities, as well as after prolonged exertion or physical exercise. Other pain-inducing situations mentioned included sedentary work, computer use, standing up from a chair, nighttime or early-morning activity, cycling, leaning

forward, writing, and lifting. One-third of participants experienced pain several times a day, and a significant number reported constant pain. One-fifth experienced pain several times per week. The symptoms of degenerative joint disease are a natural part of the aging process [16-18], though thermal treatments and new therapies can help delay these processes and alleviate symptoms.

Two-thirds of participants used pain relief medications, most commonly ointments and creams, followed by tablets. Other methods included patches, cold compresses, and herbal remedies [16, 19]. Nearly one-third of respondents stated that their pain often subsided on its own, and more than one-fifth reported relief when they ceased movement. When asked about the nature of their pain, most described it as recurring or chronic. One-fifth had difficulty characterizing it, while 15% in the test group and 7.4% in the control group described it as acute.

The most frequently reported difficulties in daily activities were lifting, kneeling, and climbing stairs. Other problematic activities included maintaining the same position for long periods, getting dressed (especially putting on socks), bending, squatting, vacuuming, cooking, and manual labor. When asked to self-assess their physical activity level, over 80% rated it as average or good, though many noted it could be improved. Regarding limitations in physical activity caused by degenerative disease, over 80% reported partial restrictions. In terms of occupational limitations, over 50% were affected, while 40% of the test group and 32% of the control group reported no such limitations.

When asked about their health and well-being before the study, 62% of the test group rated their condition as poor, compared to 49% in the control group. A positive self-assessment was reported by 28% in the test group and 42% in the control group.

After completing the therapy, participants were asked to evaluate the treatment and its effects subjectively. When comparing their health before and after the program, 40% in the test group and 31% in the control group noticed a clear improvement, while 51% and 61%, respectively, noticed slight improvement. Thus, over 90% reported some form of improvement.

Most participants rated their post-treatment physical activity as good: 41% in the test group and 47% in the control group; very good: 35% and 36%, respectively; and average: 22% in the test group and 16% in the control group. It should be noted that the initial pain level in the test group was higher.

Mobility improved significantly for 38% of participants in the test group and 35% in the control group; slight improvement was observed in 50% and 54%, respectively; and 10% in both groups reported no change [20].

Quality of life after the treatment improved significantly for 42% of the test group and 35% of the control group, while slight improvement was noted in 48% and 52%, respectively. In total, quality of life improved for 90% of the test group and 87% of the control group [21, 22].

It should be considered that, due to the widespread limitations resulting from the COVID-19 pandemic during the study period, only outpatient participants could be qualified for the study. Had the therapy been conducted as part of inpatient medical stays, the effectiveness of the treatment might have been even greater [23].

Nonetheless, especially among the test group, patients declared their intention to continue making lifestyle changes [24], such as increasing physical activity (e.g., walking) to maintain the therapy's benefits. It is worth emphasizing that most patients experienced mobility issues and limited their movement to only essential daily tasks.

CONCLUSIONS

The study aimed to gain new knowledge and skills in developing a novel therapeutic program (service) and treatment process by creating new elements of therapy and verifying their effectiveness. Effective innovation management within an interdisciplinary expert team enabled the integration of knowledge and experience, leading to the development of innovative treatments, including the patenting of an invention. The treatments designed as part of the therapeutic program using Cannabis sativa enabled the achievement of the primary goal: reducing pain levels in patients undergoing 2- to 3-week treatment.

An analysis of both objective results (laboratory tests of blood and urine) and subjective pain assessments (VAS, Laitinen, and WOMAC scales) demonstrated greater effectiveness of the cannabis-based therapy in treating pain associated with degenerative joint diseases compared to traditional methods.

Based on the analysis of the effectiveness of the developed treatments – through medical staff consultations and patient evaluations – the most effective procedures were selected, and the pain management process was optimized in preparation for implementing a new therapy. The results obtained allowed for the development of recommendations for the implementation of this new therapy, and marketing efforts were undertaken to support its commercial introduction to the market. The implementation of this proprietary therapy strengthened the competitive position and distinguished the offering on the market, making it one of the flagship products of health tourism offered by the facility.

This case study of cooperation within an innovation ecosystem serves as an example of best practices in identifying new directions in treatment and the development of health tourism. The creation of an effective cannabis-based therapy as an alternative and complementary method for managing pain in degenerative diseases contributes to improved patient quality of life and reduced strain on the healthcare system. The conducted research and development work confirmed the effectiveness of cannabis-based pain therapy. The planned milestones were achieved, and a longer-lasting therapeutic effect was observed in the test group.

However, due to the limitations resulting from pandemic-related regulations and formal restrictions associated with project implementation, the study focused only on the most essential aspects. Future challenges include the continued development of research and the adaptation of legal frameworks to enable broader use of cannabis in

medicine. The observations made during the study serve as a starting point for further research and the expansion of cannabis-based therapy with new treatments aimed at improving patient quality of life.

Another key aspect is the advancement of thermal medicine and the identification of new treatment directions that address the evolving needs of patients – particularly in the area of lifestyle diseases such as obesity [25]. Treatments based on natural resources used in thermal medicine, enhanced by the action of herbs such as cannabis plants, hold significant potential for strengthening the effects of traditional therapies and advancing the development of thermal-based healthcare.

REFERENCES

1. Szromek A, Brożyna M, Letka-Paralusz E. Działalność uzdrowiskowa i zasoby lecznicze w uzdrowiskach ziemi świętokrzyskiej [Health resort activities and therapeutic resources in the health resorts of the Świętokrzyskie region]. Kraków. Proksenia. 2014. (Polish)
2. Bąk E, Bruczyńska J, Lipiec I. Warunki hydrogeochemiczne występowania wód siarczkowych w południowej części niecki miechowskiej [Hydrogeochemical conditions of sulphide water occurrence in the southern part of the Miechów trough]. Prz Geol. 2021;69(10):687-696. doi. 10.7306/2021.37. (Polish)
3. Korczak M, Owczarek J. Właściwości lecznicze wód siarczkowych [Medicinal properties of sulphide waters]. Acta Balneol. 2014;2(136):106-8. (Polish)
4. Ponikowska I, Kochański JW. Wielka Księga Balneologii Medycyny Fizykalnej i Uzdrowiskowej [The Big Book of Balneology, Physical Medicine and Health Great Resort]. Aluna Publishing House. Konstancin-Jeziorna. 2018:190-200. (Polish)
5. Ponikowska I, Adamczyk P, Placek K. Hydrogen sulphide and sulphide waters in the light of latest research reports. Acta Balneol. 2024;66:400-403. doi:10.36740/ABAL202406105.
6. Puszczyłowska-Lizis E, Łuczyszyn P. Propozycja nowoczesnej balneorehabilitacji pacjentów z dyskopatią lędźwiową [Proposal for modern balneorehabilitation of patients with lumbar discopathy]. Acta Balneol. 2011;4(126):282-7. (Polish)
7. Strzelczyk M, Kaniewski R. Konopie siewne Cannabis sativa L. – jeden z najstarszych gatunków roślin użytkowych [Hemp Cannabis sativa L. – one of the oldest species of useful plants]. Post Fitoter. 2021;22(1):53-60. doi:10.25121/PF.2021.22.1.53. (Polish)
8. Świechowska I. Konopie roślina przeklęta czy zapomniana [Hemp: cursed or forgotten plant]. Brwinów: Centrum Doradztwa Rolniczego W Brwinowie Oddział w Poznaniu. 2019. (Polish)
9. Wieczorek Ł, Dąbrowska K, Sierosławski J. Raport z badania pt. Używanie kannabinoidów w celach medycznych [Research report: Use of cannabinoids for medical purposes]. Ministrstwo Zdrowia. 2022. (Polish)
10. Kaniewski R, Pniewska I, Kubacki A i wsp. Konopie siewne (Cannabis sativa L.) – wartościowa roślina użytkowa i lecznicza [Hemp (Cannabis sativa L.) – a valuable utility and medicinal plant]. Post Fitoter. 2017;18(2):139-144. doi: 10.25121/PF.2017.16.2.139. (Polish)
11. Kaczmarczyk-Sedlak I, Wojnar W, Zych M, Dudek S. Lecznicze właściwości konopi i możliwości ich zastosowania w medycynie [Medicinal properties of hemp and possibilities of its application in medicine]. Katowice: Śląski Uniwersytet Medyczny w Katowicach. 2017:26-35. (Polish)
12. Knefel M, Przybylo-Kisielewska K, Wrzochal A, Kalska A. SDR – Sulfide Reduction Diet from idea to implementation – the process of carrying out research and development work and implementation of an innovative health tourism product. Folia Turistica. 2024;62:91-2. doi:10.5604/01.3001.0054.6888.
13. Knefel M, Korczak P. Sto lat tradycji uzdrowiskowej – Sanatorium „SŁOWACKI" w Busku-Zdroju [One hundred years of health resort tradition – Sanatorium "SŁOWACKI" in Busko-Zdrój]. Kraków. Wydawnictwo Proksenia. 2016:175-86. (Polish)
14. Główczewska J, Kędziora-Kornatowska K. Balneoterapia i fizykoterapia w wybranych chorobach wieku podeszłego [Balneotherapy and physiotherapy in selected diseases of old age]. In: The Big Book of Balneology, Physical Medicine and Health Great Resort]. Aluna Publishing House. Konstancin-Jeziorna. 2018;T 2:406-407. (Polish)
15. Ponikowska I. Encyklopedia balneologii i medycyny fizykalnej oraz bioklimatologii, balneochemii i geologii uzdrowiskowej [Encyclopedia of balneology and physical medicine and bioclimatology, balneochemistry and health resort geology]. Aluna Publishing House. Konstancin-Jeziorna. 2015, p.349. (Polish)
16. Malec-Milewska M. Leczenie bólu u chorych w wieku podeszłym [Pain treatment in elderly patients]. Post Nauk Med. 2015;28(7):493-4. (Polish)
17. Kuliński W, Siołek A. Analysis of physical Therapy in Knee Osteoarthritis. Acta Balneol. 2020;62(4):203-8. doi:10.36740/ABAL202004101.
18. Zduńska A, Zduński S, Nowicka K, Rudnicka A. Balneoterapia i fizykoterapia w przewlekłych zespołach bólowych kręgosłupa lędźwiowo-krzyżowego. Przegląd aktualnego piśmiennictwa [Balneotherapy and physiotherapy in chronic lumbosacral spine pain syndromes. Review of current literature]. Acta Balneol. 2020;62(2):119-226. doi: 10.36740/ABAL202002109. (Polish)
19. Citko A. Choroba zwyrodnieniowa stawów – postępowanie terapeutyczne [Osteoarthritis – therapeutic management]. Lek w Polsce. 2024;34(403):36-43. doi: 10.57591/ Lek.202412.04. (Polish)
20. Nitera-Kowalik A, Olszewska E, Nowakowska K, Solecki B. Wpływ leczenia uzdrowiskowego na zapobieganie upadkom u osób starszych [The influence of health resort treatment on fall prevention in the elderly]. Acta Balneol. 2018;60(3):169-75. (Polish)
21. Romay-Barrero H, Herrero-López J, Llorente-González J et al. Balneotherapy and Health-related Quality of Life in Adults with Knee Osteoarthritis: a Prospective Observational Study Into a Real Clinical Practice Condition. Acta Balneol. 2022;64(6):507-16. doi:10.36740/ABAL202206103.
22. Kostro AM, Dakowicz A, Moskal-Jasińska D, Kuryliszyn-Moskal A. Ocena wpływu laseroterapii i magnetoterapii na funkcjonowanie i jakość życia pacjentów z zajęciem rąk w przebiegu reumatoidalnego zapalenia stawów [Assessment of the impact of laser therapy and magnetotherapy on the functioning and quality of life of patients with hand involvement in rheumatoid arthritis]. Acta Balneol. 2020;62(3):149-53. doi: 10.36740/ABAL202003103. (Polish)
23. Kuciel-Lewandowska J, Paprocka-Borowicz M. Wpływ terapii uzdrowiskowej na obniżenie natężenia odczuwania bólu u pacjentów z chorobą zwyrodnieniową stawów i kręgosłupa [The influence of health resort therapy on reducing the intensity of pain in patients with degenerative joint and spine disease]. Pom J Life Sci. 2015;61(3):257-62. (Polish)

24. Niezgoda A, Knefel M. Wykorzystanie oferty turystyki zdrowotnej w kontekście zmian stylu życia (przykład województwa świętokrzyskiego) [Utilisation of health tourism offer in the context of lifestyle changes (example of the Świętokrzyskie Voivodeship)]. Folia Turistica. 2019;(53):285-98. doi: 10.5604/01.3001.0013.7528. (Polish)
25. Wrzochal A, Kalska A, Knefel M, Tworek D. Crenotherapy with therapeutic sulfide water as a new direction of health resort treatment on the example of the Sulfide Reduction Diet. Acta Balneol. 2024;66(3):158-62. doi: 10.36740/ABAL202403102.

CONFLICT OF INTEREST
The Author declare no conflict of interest

CORRESPONDING AUTHOR
Monika Anna Knefel
Department of Labor Resource Management,
Cracow University of Economics, Cracow, Poland
e-mail: knefelm@uek.krakow.pl

ORCID AND CONTRIBUTIONSHIP
Monika Anna Knefel: 0009-0003-9429-8986 A B C D 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: 01.02.2025
ACCEPTED: 30.06.2025

ORIGINAL ARTICLE

Effect of foam rolling on induced DOMS of quadriceps muscle on range of motion, lower body power and pain among young adults: An experimental study

Ashfak Ahamed S[1], Muthukumaran Jothilingam[2]

[1]SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCES, CHENNAI, INDIA
[2]SRI BALAJI VIDYAPEETH DEEMED TO BE UNIVERSITY CHENNAI, CHENNAI, INDIA

ABSTRACT

Aim: To find the effect of foam rolling on induced Delayed Onset Muscle Soreness (DOMS) of quadriceps muscle on range of motion, lower body power and pain among young adults.

Materials and Methods: In this study, a total of thirty subjects were allocated. The pre- and post-test findings were computed using the pain algometer, vertical jump test and knee ROM. 4-5 reps withhold seconds on 15 for each repetition per day for 3 days. After tabulating and statistical analysis, the tables were assessed.

Results: The results revealed statistically significant differences between the two groups. Group A (foam rolling) showed significantly higher mean pain algometry scores (3.100 *vs*. 2.733, $p<0.0001$) and greater range of motion (112.67° vs. 107.33°, $p<0.0001$) compared to Group B (static stretching) in the post-test.

Conclusions: This study concluded that the foam rolling group shows the significant effect on induced DOMS of quadriceps muscle on range of motion, lower body power and pain among young adults compared to static stretching group.

KEYWORDS: ROM, DOMS, lover body power, pain algometer, static streatching

Acta Balneol. 2025;67(4):263-268. doi: 10.36740/ABAL202504104

INTRODUCTION

The largest muscle in the human body is the quadriceps femoris, which is an incredibly vital muscle from an athletic perspective, but prone to injury due to the stress it experiences [1, 2]. The quadriceps femoris contracts, affecting the hip and knee joints. Its proper mobility is essential for tasks like getting out of a chair or ascending stairs, and it plays a crucial role in maintaining postural balance and facilitating autonomous walking [2, 3].

The quadriceps muscle receives its nourishment from the femoral artery, which is a continuation of the external iliac artery. The superficial and deep femoral arteries are considered some of its most important branches [4]. Muscular fatigue can result from various causes, such as the accumulation of metabolites within muscle fibers or insufficient motor command in the motor cortex, leading to a decrease in the muscle's maximal force or power output [5].

Delayed-onset muscular soreness (DOMS) is a common side effect of unusually intense exercise, particularly involving eccentric contraction, where the muscle is contracted while being stretched. [6] Regular physical activity often leads to fatigue in the musculoskeletal, neurological, and metabolic systems, potentially causing discomfort, inflammation, and pain. Vigorous workouts can disrupt the extracellular matrix, sarcolemma, and intracellular muscle structure, resulting in prolonged discomfort and DOMS [7].

Improving resistance training (RT)-induced muscle adaptations requires careful modulation of RT factors, and range of motion (ROM) may be crucial for muscle adaptations [8,9]. Studies suggest that strength adaptations are specific to the joint angle exercised, and training should encompass the entire joint excursion to gain strength throughout the whole range of motion [10]. Alternative stretching tools like foam rollers and roller massagers have been shown to increase ROM [11, 12].

Power, or speed strength, is essential for various sports activities like jumps, accelerations, and direction changes. The development of lower-body power generation is a main priority in many training regimens due to its relevance to sport performance. Unconventional training approaches like contrast and complex training, which combine heavy resistance exercises with explosive movements, can elicit higher power output levels than traditional methods by leveraging post-activation potentiation (PAP) [13-20].

Sports medicine frequently uses the bilateral strength asymmetry of the knee extensors and flexors to assess the functional deficit resulting from knee injury and or surgery, track the efficacy of sport rehabilitation programs, and determine when an athlete is ready to resume competition [21, 22]. Moreover, asymmetry in bilateral strength may increase the incidence of musculoskeletal problems, according to certain research. The nature of its open-chain

movement and isokinetic muscle action makes it unsuited to most sports activities, which are typified by closed-chain movements and quick muscular actions involving the stretch-shortening cycle. Additionally, it requires highly expensive equipment.

Research suggests that employing the foam rolling technique may make DOMS (delayed onset muscular soreness) feel less intense due to thixotropic, which may result in locally changed tissue stiffness or no neural tone [23, 24]. According to the authors, foam rolling does not appear to be particularly helpful for lowering muscular discomfort beyond what can be accomplished with a dynamic warm-up during the recovery process following exercise-induced muscle injury brought on by running.

Stretching is frequently used to broaden a joint's range of motion (ROM), which is thought to enhance athletic performance [25-27]. Except for an increased range of motion, recent research has not provided compelling evidence to support the use of stretching to improve performance. According to several studies, acute and prolonged stretching may potentially have a negative impact on human performance by reducing force and power. In comparison to standard static stretching, using a foam roller to apply myofascial release after vigorous exercise may aid to preserve muscular force the day after exercise [28-33].

AIM

To find the effect of foam rolling on induced DOMS of quadriceps muscle on range of motion, lower body power and pain among young adults.

MATERIALS AND METHODS

Study design: Experimental study

Subjects: People aged between 18 to 25 with induced DOMS of quadriceps muscles

Sampling technique: Convenient sampling

Sample size: 15+15 = 30 subjects

INCLUSION CRITERIA

- Young adults aged between 18 and 25 years of both genders.
- Subjects display signs of DOMS like pain, tenderness, and restricted knee ROM due to pain.

EXCLUSION CRITERIA

- Subjects with recent musculoskeletal lesions in lower extremity.
- History of recent surgery in spine and lower extremity.

STUDY PROCEDURE

Total of 30 subjects was selected based on the selection criteria. The study procedure was explained to all the participants and informed consent was obtained. Selected participants were divided into Foam Roller group and Static stretching group. Participants in both the groups were induced DOMS by doing eccentric quadriceps muscle training in single bout. Foam roller group underwent foam rolling on quadriceps muscle for 4-5 reps withhold seconds on 15 for each repetition per day for 3 days. static stretching group underwent static stretching for quadriceps muscle for 4-5 reps withhold seconds on 15 for each repetition per day for 3 days. Outcomes were assessed for pain, ROM and lower body power.

GROUP A. FOAM ROLLING (N=15)

Foam roller group will be doing foam rolling on quadriceps muscle for 4-5 reps withhold seconds on 15 for each repetition per day for 3 days.

A foam roller is a cylindrical foam tool used for self-massage to target tight muscles and trigger points through self-myofascial release.

In the described study, Group A participants will perform foam rolling on their quadriceps for 4-5 repetitions per session Each repetition involves foam roller along the quadriceps for 15 seconds. This routine will be done once daily for three consecutive days to assess its effects on quadriceps muscle function.

GROUP B. STATIC STRETCHING (N=15)

Static stretching group will be doing static stretching for quadriceps muscle for 4-5 reps withhold seconds on 15 for each repetition per day for 3 days. All the participants Pain, ROM and lower body power will be measured.

1. Stand upright and hold onto something for balance if needed.
2. Bend one knee and bring your heel toward your buttocks, grabbing your ankle with the same-side hand.
3. Gently pull your ankle toward your body until you feel a stretch in the front of your thigh and hip.
4. Keep your knees together and your body upright.
5. Hold the stretch for 15-30 seconds, breathing deeply.
6. Release and repeat 2-3 times per leg.

HUMAN PARTICIPANTS

This study was approved by the Institutional Scientific Review Board (07/012/2024/ISRB/SR/SCPT), and all participants provided written informed consent.

ETHICAL CLEARANCE

Approved by Institutional Scientific Review Board. ISRB number: 07/012/2024/ISRB/SR/SCPT.

RESULTS

The post-assessment demonstrates a notable improvement over the pre-assessment in effect of Foam Rolling on induced DOMS of quadriceps muscle on range of motion, lower body power and pain among young adults. A statistically analysed of quantitative data indicated a statistically significant difference in both the groups.

PAIN ALGOMETER RESULTS

Group A (foam rolling) showed a significant increase in pain algometry scores from pre-test (mean = 0.967, SD = 0.176) to post-test (mean = 3.100, SD = 0.085) with $t = 64.0$, $p < 0.0001$. See Table 1 for detailed data.

Similarly, Group B (static stretching) demonstrated improvement from pre-test (mean = 0.933, SD = 0.176)

Table 1. Pre and Post-test for values of group A (foam rolling) for pain algometer

Outcome measure	Group-A	Mean	SD	t Value	P Value
PAIN ALGOMETER	Pre- test	0.967	0.176	64.0	<0.0001
	Post- test	3.100	0.085		

Source: compiled by the authors of this study

Table 2. Pre and Post-test for values of group B (static stretching) for pain algometer

Outcome measure	Group-B	Mean	SD	t Value	P Value
PAIN ALGOMETER	Pre- test	0.933	0.176	82.4864	<0.0001
	Post- test	2.733	0.213		

Source: compiled by the authors of this study

Table 3. Post-test values for both Group A (foam rolling) and Group – B (static stretching) for pain algometer

Outcome measure	Pain algometry	Mean	SD	t- Value	p-Value
Group A	Post-test	3.100	0.085	8.0718	<0.0001
Group B	Post-test	2.733	0.213		

Source: compiled by the authors of this study

to post-test (mean = 2.733, SD = 0.213) with t = 82.4864, p < 0.0001. See Table 2 for complete results.

When comparing post-test results between groups, Group A showed significantly higher pain algometry scores (mean = 3.100, SD = 0.085) compared to Group B (mean = 2.733, SD = 0.213) with t = 8.0718, p < 0.0001. See Table 3 for comparison data.

RANGE OF MOTION RESULTS

Post-test comparison revealed Group A had significantly greater ROM (mean = 112.67°, SD = 2.13) compared to Group B (mean = 107.33°, SD = 2.13) with t = 6.8672, p < 0.0001. See Table 4 for details.

VERTICAL JUMP TEST RESULTS

Group A showed significant improvement in vertical jump test scores from pre-test (mean = 35.00, SD = 1.69) to post-test (mean = 65.33, SD = 1.29) with t = 91.00, p < 0.0001. See Table 5 for complete data.

Group B also improved from pre-test (mean = 34.00, SD = 1.69) to post-test (mean = 60.00, SD = 0.85) with t = 68.7895, p < 0.0001. See Table 6 for details.

In post-test comparison, Group A demonstrated significantly higher vertical jump performance (mean = 65.33, SD = 1.29) compared to Group B (mean = 60.00, SD = 0.85) with t = 13.3866, p < 0.0001. See Table 7 for comparative analysis.

DISCUSSION

The present study aimed to investigate the effects of foam rolling on delayed onset muscle soreness (DOMS) induced in the quadriceps muscle, specifically focusing on range of motion, lower body power, and pain perception among young adults. The study's findings complement the body of information already available about successful recovery techniques for reducing symptoms of DOMS and improving general physical performance.

Recent studies continue to support the role of foam rolling in reducing symptoms of DOMS and improving recovery outcomes. Vaidya et al. (2021) compared neurodynamic therapy and foam rolling in healthy individuals and found both interventions significantly reduced DOMS symptoms, corroborating our results that foam rolling enhances pain modulation. Michalak et al. (2024) explored different types of foam rollers and emphasized that the physical properties

Table 4. Post-test values for both Group A (foam rolling) and Group – B (static stretching) for Range of motion

Outcome measure	Rom	Mean	SD	t- Value	p-Value
Group A	Post-test	112.67	2.13	6.8672	<0.0001
Group B	Post-test	107.33	2.13		

Source: compiled by the authors of this study

Table 5. Pre and Post-test for values of group A (foam rolling) for Vertical jump test

Outcome measure	Group-A	Mean	SD	t Value	P Value
VERTICAL JUMP TEST	Pre- test	35.00	1.69	91.00	<0.0001
	Post- test	65.33	1.29		

Source: compiled by the authors of this study

Table 6. Pre and Post-test for values of group B (static stretching) for Vertical Jump Test

Outcome measure	Group-B	Mean	SD	t Value	P Value
VERTICAL JUMP TEST	Pre- test	34.00	1.69	68.7895	<0.0001
	Post- test	60.00	0.85		

Source: compiled by the authors of this study

Table 7. Post-test values for both Group A (foam rolling) and Group – B (static stretching) for Vertical Jump Test

Outcome measure	Vertical jump test	Mean	SD	t- Value	p-Value
Group A	Post-test	65.33	1.29	13.3866	<0.0001
Group B	Post-test	60.00	0.85		

Source: compiled by the authors of this study

of rollers influence effectiveness, highlighting the relevance of consistent roller characteristics in our study. Similarly, Hendricks et al. (2020), in their systematic review, reported that foam rolling improves flexibility and reduces muscle soreness, aligning with our findings on range of motion and pain reduction.

Furthermore, Zhang et al. (2024) found that foam rolling in elite volleyball athletes reduced lactate levels and DOMS symptoms, suggesting physiological benefits at a cellular level, which may explain the improvements observed in our vertical jump outcomes. Lastly, Lu et al. (2024) demonstrated that foam rollers with varied shore hardness yielded different results in DOMS alleviation, pointing to biomechanical and neurophysiological variables that could further optimize future intervention strategies. These studies reinforce our conclusions and suggest that foam rolling may offer superior recovery benefits compared to static stretching when appropriately implemented.

A self-myofascial release method called foam rolling has drawn a lot of interest lately as a possible intervention for lowering DOMS and accelerating muscle repair [23-25]. The application of pressure through the foam roller is believed to target muscle adhesions, release myofascial restrictions, and improve blood flow to the affected area. Several studies have explored the potential benefits of foam rolling in mitigating DOMS symptoms, although findings have been mixed. Regarding range of motion, the present study's findings align with previous research suggesting that foam rolling can effectively improve joint mobility and flexibility [11, 12, 26, 27].

Furthermore, the potential benefits of improved range of motion extend beyond athletic performance. Individuals with limited flexibility due to sedentary lifestyles, occupational demands, or age-related changes may also benefit from incorporating foam rolling into their regular routines [30, 31]. By promoting increased mobility and reducing muscle tightness, foam rolling could contribute to improved posture, reduced risk of musculoskeletal injuries, and enhanced functional capacity in daily activities.

With respect to lower body power, the study's findings add to the body of current literature on the potential impact of foam rolling on explosive strength and power production [13-16]. While some studies have reported no significant effects of foam rolling on power output others have suggested that foam rolling may enhance power performance by improving muscle function and neuromuscular efficiency. Future research should aim to investigate these potential moderating factors to provide more specific guidelines for practitioners and athletes. The study's findings on pain perception align with previous research demonstrating the potential of foam rolling to alleviate muscle soreness associated with DOMS [17-20, 23-25].

The findings of the present study may provide further insights into this area, enabling more informed decisions regarding the incorporation of foam rolling into training and recovery protocols for power-based activities. For athletes and individuals involved in sports or activities that require explosive movements, such as sprinting, jumping, or weightlifting, the ability to maintain or enhance lower body power output is crucial for optimal performance. However, it is essential to acknowledge that the relationship between foam rolling and power production may be impacted by a number of variables, including the specific muscle groups

targeted, the intensity and duration of the foam rolling intervention, and the timing of power assessments relative to the foam rolling session [13-16, 28-29].

The potential mechanisms underlying the pain-relieving effects of foam rolling have been explored in several studies. It has been suggested that the application of pressure during foam rolling can stimulate the release of endogenous opioids, which have analgesic properties and can modulate pain perception [23-33].

Additionally, the study's results should be interpreted in the context of the specific population (young adults) and the targeted muscle group (quadriceps). Furthermore, the timing of the foam rolling intervention relative to the exercise bout and the subsequent assessments of pain, range of motion, and power output may also play a role in the observed effects [29-31].

CONCLUSIONS

This experimental study demonstrates that foam rolling is significantly more effective than static stretching in managing induced DOMS of the quadriceps muscle among young adults. The foam rolling intervention produced superior outcomes in all measured parameters: pain tolerance (as measured by algometry), range of motion, and lower body power (as measured by vertical jump performance).

The findings clearly indicate that foam rolling can be recommended as a preferred recovery technique following exercise-induced muscle soreness, particularly for the quadriceps muscle group. The significant improvements in functional performance metrics suggest that foam rolling not only alleviates pain but also enhances muscle function during the recovery period.

These results have important practical implications for athletes, fitness enthusiasts, and rehabilitation professionals seeking effective strategies to manage DOMS and maintain physical performance levels. Future research should explore the optimal duration, frequency, and techniques of foam rolling to maximize its benefits for different muscle groups and various athletic and rehabilitative contexts.

REFERENCES

1. Deleget A. Overview of thigh injuries in dance. J Dance Med Sci. 2010;14(3):97-102. doi:10.1177/1089313X1001400304.
2. Murdock CJ, Mudreac A, Agyeman K. Anatomy, abdomen and pelvis, rectus femoris muscle. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025.
3. O'Sullivan ST, Harty JA. Patellar stabilization surgeries in cases of recurrent patellar instability: a retrospective clinical and radiological audit. Ir J Med Sci. 2021 May;190(2):647-652. doi:10.1007/s11845-020-02344-x.
4. Williams M, Caterson J, Cogswell L, Gibbons C, Cosker T. A cadaveric analysis of the blood supply to rectus femoris. J Plast Reconstr Aesthet Surg. 2019 Apr;72(4):616-621. doi:10.1016/j.bjps.2018.12.045
5. Enoka RM, Duchateau J. Muscle fatigue: what, why and how it influences muscle function. J Physiol. 2008 Jan 1;586(1):11-23. doi:10.1113/jphysiol.2007.139477.
6. Asmussen E. Observations on experimental muscular soreness. Acta Rheumatol Scand. 1956;2(2):109-16. doi:10.3109/rhe1.1956.2.issue-1-4.12.
7. Byrne C, Twist C, Eston R. Neuromuscular function after exercise-induced muscle damage: theoretical and applied implications. Sports Med. 2004;34(1):49-69. doi:10.2165/00007256-200434010-00005.
8. Kraemer WJ, Adams K, Cafarelli E et al. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. Med Sci Sports Exerc. 2002;34(2):364-80. doi:10.1097/00005768-200202000-00027.
9. Haff GG, Triplett NT. Essentials of strength training and conditioning. Champaign, IL. Human Kinetics, 2016 p. 735.
10. Thépaut-Mathieu C, Van Hoecke J, Maton B. Myoelectrical and mechanical changes linked to length specificity during isometric training. J Appl Physiol. 1988;64(4):1500-5. doi:10.1152/jappl.1988.64.4.1500.
11. Kay AD, Blazevich AJ. Effect of acute static stretch on maximal muscle performance: a systematic review. Med Sci Sports Exerc. 2012 ;44(1):154-64. doi:10.1249/MSS.0b013e318225cb27.
12. MacDonald GZ, Penney MD, Mullaley ME et al. An acute bout of self-myofascial release increases range of motion without a subsequent decrease in muscle activation or force. J Strength Cond Res. 2013;27(3):812-21. doi:10.1519/JSC.0b013e31825c2bc1.
13. Newton RU, Murphy AJ, Humphries BJ. Influence of load and stretch shortening cycle on the kinematics, kinetics and muscle activation that occurs during explosive upper-body movements. Eur J Appl Physiol Occup Physiol. 1997;75(4):333-42. doi:10.1007/s004210050169.
14. Canavan PK, Garrett GE, Armstrong LE. Kinematic and kinetic relationships between an olympic-style lift and the vertical jump. J Strength Cond Res. 1996 1;10(2):127-30. doi:10.1519/1533-4287(1996)010<0127.
15. Kaneko M. Training effect of different load on the force-velocity relationship and mechanical power output in human muscle. Scand J Sports Sci. 1983;5:50-5. doi:10.1519/13933.1.
16. Knuttgen HG, Kraemer WJ. Terminology and measurement. J Appl Sport Science Res. 1987;1(1):1-0. doi:10.1519/00124278-198702000-00001.
17. Cormie P, McGuigan MR, Newton RU. Developing maximal neuromuscular power: part 2 - training considerations for improving maximal power production. Sports Med. 2011;41(2):125-46. doi:10.2165/11538500-000000000-00000.
18. Docherty D, Robbins D, Hodgson M. Complex training revisited: A review of its current status as a viable training approach. Strength Cond J. 2004;26(6):52-7. doi:10.1519/1533-4295.

19. Duthie GM, Young WB, Aitken DA. The acute effects of heavy loads on jump squat performance: an evaluation of the complex and contrast methods of power development. J Strength Cond Res. 2002;16(4):530-8.
20. Tillin NA, Bishop D. Factors modulating post-activation potentiation and its effect on performance of subsequent explosive activities. Sports Med. 2009;39(2):147-66. doi:10.2165/00007256-200939020-00004.
21. Klein CS, Rice CL, Marsh GD. Normalized force, activation, and coactivation in the arm muscles of young and old men. J Appl Physiol. 2001;91(3):1341-9. doi:10.1152/jappl.2001.91.3.1341.
22. Macaluso A, De Vito G. Muscle strength, power and adaptations to resistance training in older people. Eur J Appl Physiol. 2004;91(4):450-72. doi:10.1007/s00421-003-0991-3.
23. Edmunds R, Dettelbach A, Dito J et al. Effects of foam rolling versus static stretching on recovery of quadriceps and hamstrings force. J Bodyw Mov Ther. 2016;20(1):146. doi:10.1016/j.jbmt.2015.07.022.
24. Pearcey GE, Bradbury-Squires DJ, Kawamoto JE et al. Foam rolling for delayed-onset muscle soreness and recovery of dynamic performance measures. J Athl Train. 2015;50(1):5-13. doi:10.4085/1062-6050-50.1.01.
25. Cheatham SW, Kolber MJ, Cain M, Lee M. The effects of self-myofascial release using a foam roll or roller massager on joint range of motion, muscle recovery, and performance: a systematic review. Int J Sports Phys Ther. 2015;10(6):827-38.
26. Junker DH, Stöggl TL. The foam roll as a tool to improve hamstring flexibility. J Strength Cond Res. 2015;29(12):3480-5. doi:10.1519/JSC.0000000000001007.
27. Bradbury-Squires DJ, Noftall JC, Sullivan KM et al. Roller-massager application to the quadriceps and knee-joint range of motion and neuromuscular efficiency during a lunge. J Athl Train. 2015;50(2):133-40. doi:10.4085/1062-6050-49.5.03.
28. Peacock CA, Krein DD, Silver TA et al. An Acute Bout of Self-Myofascial Release in the Form of Foam Rolling Improves Performance Testing. Int J Exerc Sci. 2014 1;7(3):202-211. doi:10.70252/DTPM9041.
29. Krause F, Wilke J, Niederer D et al. Acute effects of foam rolling on passive tissue stiffness and fascial sliding: study protocol for a randomized controlled trial. Trials. 2017;18(1):114. doi:10.1186/s13063-017-1866-y.
30. Couture G, Karlik D, Glass SC, Hatzel BM. The Effect of Foam Rolling Duration on Hamstring Range of Motion. Open Orthop J. 2015;9:450-5. doi:10.2174/1874325001509010450.
31. Su H, Chang NJ, Wu WL et al. Acute Effects of Foam Rolling, Static Stretching, and Dynamic Stretching During Warm-ups on Muscular Flexibility and Strength in Young Adults. J Sport Rehabil. 2017;26(6):469-477. doi:10.1123/jsr.2016-0102.
32. Aboodarda SJ, Spence AJ, Button DC. Pain pressure threshold of a muscle tender spot increases following local and non-local rolling massage. BMC Musculoskelet Disord. 2015;16:265. doi:10.1186/s12891-015-0729-5.
33. Beardsley C, Škarabot J. Effects of self-myofascial release: A systematic review. J Bodyw Mov Ther. 2015;19(4):747-58. doi:10.1016/j.jbmt.2015.08.007.

Thanks to the members of the private sports clubs at Chennai for assisting us in data collection and organization. I would also like to express my gratitude to the statistician for helping us with data analysis.

The data supporting the results of the study are available by contacting the corresponding author.

CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Ashfak Ahamed S
SIMATS
162 Poonamallee High Rd, Chennai, India
e-mail: ashfakahamed68@gmail.com

ORCID AND CONTRIBUTIONSHIP

Ashfak Ahamed S: 0009-0009-9815-1918 A B C D
Muthukumaran Jothilingam: 0000-0002-2868-1093 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: 29.03.2025
Accepted: 04.06.2025

ORIGINAL ARTICLE

Assessment of the impact of vibration massage on pain symptoms and functional status in patients with spinal pain syndrome

Aleksandra Milewska, Agnieszka Przedborska, Grzegorz Musialski, Robert Irzmański

MEDICAL UNIVERSITY OF LODZ, LODZ, POLAND

ABSTRACT

Aim: The aim of the study was to assess the effect of vibrotherapy on the functional status and pain of patients with spinal pain syndrome.

Materials and Methods: The study included 75 patients aged 40-85 (72,48±9,88), who underwent a series of 10 vibration massage treatments using the Vitberg RS2 mattress in the Neuro program. The study was conducted on the basis of the author's questionnaire containing Thomayer and Schober functional tests, the Revised Oswestry Low Back Pain Disability Scale for the assessment of daily activities, and the Laitinen scale and Visual Analogue Scale (VAS) to assess the severity of pain. The questionnaire was completed before and after a series of treatments.

Results: After a series of treatments, pain was significantly reduced ($p<0,0001$), thus the amount of painkillers taken by patients decreased. In addition, functional tests showed a significant improvement in spinal mobility. The Revised Oswestry Low Back Pain Disability Scale showed an improvement in the ability to perform daily activities (IQR: 22,5-32,5 points before therapy, IQR: 12-21,5 points after therapy).

Conclusions: Vibration massage effectively reduces pain and improves the psychophysical condition of patients with lumbar spine pain syndrome.

KEYWORDS: low back pain, vibration therapy, Oswestry Disbility Index

Acta Balneol. 2025;67(4):269-274. doi: 10.36740/ABAL202504105

INTRODUCTION

Spinal pain syndromes (SPS) are currently one of the most common diseases of the musculoskeletal system in the adult population. Many authors classify SPS as a disease of affluence, as in highly developed countries it affects up to 85% of the population [1-4]. If left untreated, it leads to gradually progressive disability and, consequently, to a significant deterioration in the quality of life of patients.

When examining the etiology of SPS, it is difficult to indicate a clear cause, many factors can overlap over time. It can occur as a result of rheumatoid diseases, degeneration of the spine joints, long-term overload or a sedentary lifestyle [5, 6].

Effective methods of preventing and treating back pain are constantly being sought. Studies indicate the high effectiveness of physical training selected according to the problem and the patient's functional capabilities [7]. Manual therapeutic methods play an important role in the treatment of patients [8]. Individual or group exercises are supplemented by various types of physical stimuli, including vibrotherapy [5, 9]. The subject of this study was whole-body vibration massage, which is a method commonly used in outpatient and sanatorium conditions in various diseases [10, 11].

Whole Body Vibration (WBV) is based on controlled therapeutic oscillation, which allows for the generation of mechanical waves propagating in different directions [12]. The effect of the stimulus on the body is based on a neurophysiological mechanism in form of the tonic vibration reflex, which involves the reflexive contraction of the stimulated muscle through tonic activation of muscle spindles [13]. Some studies report a positive effect of this mechanism on muscle relaxation or acceleration of post-workout regeneration [14, 15]. However, it has been shown that the procedure should not be performed in the case of, among others, metastatic malignant tumors, thromboembolic disease, acute inflammation or infection [16].

AIM

The aim of the study was to assess the effect of vibrotherapy on the functional status and pain of patients with spinal pain syndrome.

MATERIALS AND METHODS

The study was conducted on the basis of the interpretation of medical records of 75 patients of the Orthopaedic and Post-Traumatic Rehabilitation Clinic of the University Clinical Hospital No. 2 in Lodz who were hospitalized in 2024. The study was approved by the Bioethics Committee at the Medical University of Lodz No. RNN/134/25/KE.

The inclusion criteria for the study included individuals aged 40 to 85 years (72,48±9,88), with a diagnosed lumbar spine pain syndrome due to degenerative changes. The exclusion criteria assumed the use of other forms of massage in the spine area within the last six months.

During hospitalization patients underwent a series of 10 vibration massage treatments on the lumbosacral area, five days a week with a weekend break . For the therapy

the Vitberg RS2 mattress in the Neuro program was used in accordance with the manufacturer's recommendations. Additionally, patients performed exercises dedicated to spinal pain syndromes, the level of advancement of which was individually adjusted.

The study was conducted on the basis of the author's questionnaire in order to systematize data from medical records. It included subjective assessment and functional evaluation using the Thomayer and Schober tests to assess spinal mobility. The Revised Oswestry Low Back Pain Disability Scale was used to analyze the performance of daily activities. Whereas, the Visual Analogue Scale (VAS) and the four-stage Laitinen questionnaire were used to assess the degree of pain [1-3]. Tests were performed before and after therapy.

STATISTICAL ANALYSIS

To describe the quantitative variables, the arithmetic mean and standard deviation (in the case of normality of the distribution) or positional measures: median (Me), interquartile range (IQR) and minimum and maximum (Min-Max) – in the case of the absence of normality or ordinal variables, were used. The normality of the variables was determined using the Shapiro-Wilk normality test. For qualitative variables , the number of observations with a given trait variant (N) and the corresponding percentage (%) are given. To compare the condition of patients before and after a series of procedures, in the absence of normality of the distribution of variable sets, and to compare ordinal variables, the Wilcoxon pair order test was used. To assess the size of the obtained effect, the measure of Cohen's d-value was used. The effect is interpreted as large when d ∈0,80, medium when d is in the range of <0,5-0,8) and small when d ∈<0,2-0,5).

The Spearman monotonic relationship test was used to analyze the correlation. Of the correlations that turned out to be statistically significant, those whose absolute value of the calculated rho correlation factor was greater than 0,5 were specified. Results above 0,7 should be assessed as a strong correlation.

The level of statistical significance was p<0,05. Calculations were performed using the statistical software PQStat v. 1.8.6.

RESULTS

Table 1 presents the assessment of pain intensity according to the VAS scale before and after the series of treatments. After therapy, a statistically significant reduction in pain symptoms was observed (p<0,0001). Half of the participants rated the intensity of their pain before therapy at a maximum of 7 points (IQR:5-8), and after therapy at 3 points (IQR:2-4). The effect obtained was assessed as high.

Table 2 presents the assessment of pain using the Laitinen scale (total score) before and after the series of treatments. After therapy, a statistically significant reduction in pain-related symptoms was observed (p<0,0001). Half of the participants rated the intensity of symptoms before therapy at a maximum of 9 points (IQR:7-11), and after therapy at 5 points (IQR:3-7). The obtained effect was considered large.

Fig. 1 presents the scores for the individual subscales of the Revised Oswestry Low Back Pain Disability Scale questionnaire before and after a series of treatments.

Analyzing the results presented in Fig. 1, the following phenomena can be noted:

- in terms of care – before the therapy, most of the respondents felt an increase in pain (35%) or an increase in pain with the need to change the way they performed certain activities (33%), after a series of treatments, most people felt only slight pain (39%),
- ability to lift heavy objects – before the treatments, the majority of participants were those who could lift only light and moderately heavy objects (35%), after the treatments, most participants declared that they were able to lift heavy objects, but not from the floor (33%),
- before the therapy, pain predominantly preventing walking for a distance longer than 800 m (33%) or walking possible only with the help of a cane or crutch (32%), after therapy, patients were able to walk distances of up to 1500 meters (40%),

Table 1. Pain assessment according to the VAS scale before and after a series of treatments

Variable	Pain assessment according to VAS		Level p	Effect value
	Before therapy	After therapy		
Me (IQR)	7 (5-8)	3 (2-4)	<0.0001	3.3253
Min-Max	2-10	0-9		

Source: compiled by the authors of this study

Table 2. Pain assessment using the Latinena scale (sum of points) before and after a series of treatments

Variable	Total number of points in the questionnaire		Level p	Effect value
	Before therapy	After therapy		
Me (IQR)	9 (7-11)	5 (3-7)	<0.000001	3.1434
Min-Max	3-15	0-12		

Source: compiled by the authors of this study

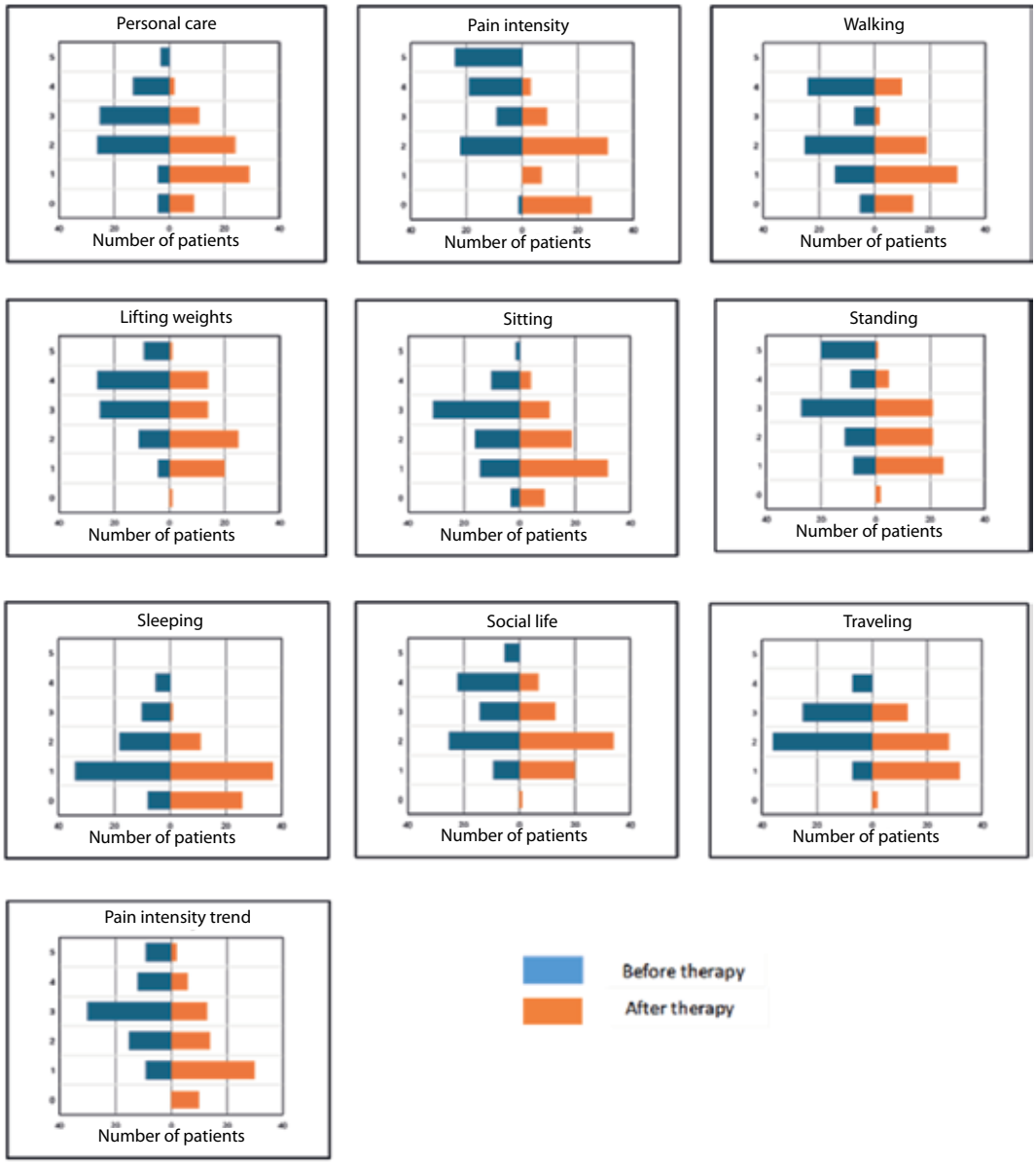


Fig. 1. Assessment of the ability to perform daily activities according to the Revised Oswestry Low Back Pain Disability Scale before and after a series of treatments

Picture taken by the authors

- vibrotherapy resulted in a significant improvement in the duration of sitting on a chair. Before the treatments, 41% of participants were unable to maintain the sitting position for more than 30 minutes, after the treatments, 43% of patients (an increase from 19%) were able to sit for an unlimited amount of time,
- before the treatments, the majority of participants reported being unable to stand for more than half an hour without increasing pain (36%) or avoiding standing altogether (27%), after the series of treatments, in most cases (33%), a slight pain when standing without increasing,has been reported,
- the most frequently given response regarding sleep comfort both before (45%) and after (49%) therapy was the presence of pain that did not interfere with sleep. After the treatments, the number of patients who did not experience pain at night increased from 11% to 35%,
- in the area of social life, the most common response both before (33%) and after (45%) the treatments remained the same: pain did not significantly affect this activity but required avoiding activities such as dancing. After therapy, the number of participants whose social life remained normal despite experiencing pain increased (from 12% before treatment to 27% after treatment),
- before the treatments, most of the respondents felt additional pain when traveling, which did not force them to look for other ways of traveling (48%) or one that forced them to look for other forms of travel (33%). After a series of treatments, the percentage of people who felt

pain while traveling, but did not increase over time (an increase from 9% to 43%), increased significantly,
- before the therapy, most patients did not experience significant changes in pain intensity (40%). After the therapy, the majority of participants reported a reduction in pain symptoms (40%).

Table 3 summarizes the scores obtained on the Revised Oswestry Low Back Pain Disability Scale before and after a series of treatments. After therapy, a statistically significant (p<0,0001) overall improvement in the ability to perform daily activities was observed. Half of the respondents scored no more than 26 points before the therapy (IQR:22,5-32,5 points), and no more than 16 points after the therapy (IQR:12-21,5 points). The effect obtained is assessed as large.

Table 4 presents the results of the Thomayer test in the study group of patients before and after a series of treatments. After therapy, a statistically significant (p<0,0001) improvement in parameters was observed. Before the procedures, half of the patients had a test result of less than 13 cm (IQR:6-21,5 cm), while after a series of treatments, half of the patients had a result of 0 cm (IQR:0-9,5 cm). The effect obtained should be assessed as large.

Table 5 shows the results of the Schober test before and after a series of treatments. As can be seen, a statistically significant (p<0,0001) improvement in results was found after the therapy. Before the procedures, half of the patients had a test result of less than 4 cm (IQR:3-5 cm), and after a series of treatments – 6 cm (IQR:4,5-6 cm). The effect obtained should be assessed as large.

DISCUSSION

WBV as a therapeutic method is gaining more and more popularity, and its effectiveness in various disease entities is the subject of numerous studies. This study focused on the use of vibrotherapy in the case of lumbar spine pain, which significantly affected the daily functioning and quality of life of patients. Similarly to Pasterczyk-Szczurek et al. a significant reduction in pain was observed after a series of vibrionics therapy treatments [17]. Thus, the need for patients to take painkillers chronically was reduced. This effect can be explained on the basis of the gate control theory by increasing the pain threshold of the tissues subjected to the procedure [18].

Minimizing the pain that accompanies patients in their daily activities translates directly into an improvement in their quality of life. Functional tests and scales used to assess fitness showed an increase in mobility within the spine and flexibility of the posterior superficial band muscles. The phenomenon is also reflected in other studies [19].

Table 3. Assessment of the ability to perform daily activities according to the Revised Oswestry Low Back Pain Disability Scale before and after a series of treatments

Variable	Total number of points in the questionnaire		Level p	Effect value
	Before therapy	After therapy		
Me (IQR)	26 (22.5-32.5)	16 (12-21.5)	<0.000001	3.3174
Min-Max	12-43	4-35		

Source: compiled by the authors of this study

Table 4. Thomayer test results before and after a series of treatments

Variable	Thomayer test results		Level p	Effect value
	Before therapy	After therapy		
Me (IQR)	13 (6-21.5)	0 (0-9.5)	<0.0001	2.1855
Min-Max	0-68	0-33		

Source: compiled by the authors of this study

Table 5. Schober test results before and after a series of treatments

Variable	Schober test results		Level p	Effect value
	Before therapy	After therapy		
Me (IQR)	4 (3-5)	6 (4.5-6)	<0.0001	2.7483
Min-Max	1-7	1-8		

Source: compiled by the authors of this study

This fact can be used as an element supporting the regeneration of musculoskeletal structures after intensive training [15]. As a result of vibrations, microcirculation in the treated tissues changes, which may improve the properties of the skin by faster removal of unnecessary tissue metabolites [20]. Additionally, researchers report a positive effect of the discussed stimulus on the process of angiogenesis, which opens new possibilities for treating hard-to-heal wounds and ulcers located in the distal parts of the musculoskeletal system [21].

Chronic pain in the spine effectively reduces the quality of sleep, which contributes to chronic fatigue. In addition, the limitation of social activities causes deterioration of the mental state of patients [22]. Systemic and local vibrations, reducing pain, have a positive effect on the psychophysical sphere of patients. For better results, treatments can be combined with classic manual techniques or appropriately selected physical training [23-25].

The literature on spinal pain syndromes does not indicate a single effective method of treatment for this condition [26]. Therefore, it is so important to conduct research into the creation of an early therapeutic strategy that will prevent the symptoms from getting worse and thus allow for maintaining the optimal quality of life of patients for a long time. Apart from numerous benefits, the study conducted has limitations. These include the lack of a large comparative group and a long-term follow-up, which makes it impossible to determine long-term effects. It is definitely necessary to conduct further research on this topic on larger groups of patients with an appropriately long follow-up period.

CONCLUSIONS

Vibration massage effectively contributes to reducing symptoms in patients with lumbar spine pain syndrome, thereby improving the quality of their daily life in many aspects, including both functional capacity and overall well-being.

REFERENCES

1. Weber-Rajek M, Czerniachowska I, Radzimińska A, Strojek K. Assessment of the Effectiveness Peat Packs in the Treatment of Low Back Pain – a Pilot Study. Acta Balneol. 2016;145(3):178-184.
2. Sobański G, Mańko G, Sitkiewicz A et al. Effectiveness Evaluation of the Rehabilitation program Containing Tai-Chi Techniques in the Treatment of Lumbar spine pain syndrome in Comparison to the standard Rehabilitation program. Acta Balneol. 2019;155(1):29-33.
3. Radzimińska A, Strączyńska A, Weber-Rajek M et al. Oswestry Disability Index (ODI) – a method for Assessing the Effectiveness of physical Therapy in patients with Low Back pain. Acta Balneol. 2017;150(4):310-316.
4. Koszela K, Krukowska S, Woldańska-Okońska M. Ból pleców jako choroba cywilizacyjna [Back pain as a lifestyle disease]. Pediatr Med Rodz 2017; 13: 344-351. doi: 10.15557/PiMR.2017.0036. (Polish).
5. Wójcik G, Skalska-Izdebska R, Kolbuszewska A, Szulc A. The effect of comprehensive therapy Spa for the treatment of pain syndrome the spine lumbosacral. J Educ Health Sport. 2016;6(12):71-83. doi:10.5281/zenodo.192324.
6. Łubkowska W, Mroczek B. Current trends in the rehabilitation of low back pain – a systematic review. Pomeranian J. Life Sci, 2018;64(3):152-160. doi:10.21164/pomjlifesci.460.
7. Szczepaniak-Kucharska E. An Analysis of the Effectiveness of Strengthening or Stretching Exercises in Patients Performing Prolonged Sedentary Work with Non-Specific Lower Back Pain. Ortop Traumatol Rehabil. 2024;26(3):57-68. doi:10.5604/01.3001.0054.7266.
8. Wyszyński S, Stiler-Wyszyńska S, Winkler S. Analiza progu bólu uciskowego u pacjentów z bólem kręgosłupa lędźwiowego [Analysis of the pressure pain threshold in patients with pain in the lumbar spine]. Zeszyty Naukowe AG. 2024;15(3):134-143. (Polish).
9. Ponikowska I. Encyklopedia balneologii i medycyny fizykalnej [Encyclopedia of balneology and physical medicine]. Aluna Publishing House. Warsaw. 2015:114-115. (Polish).
10. Ponikowska I, Kochański JW. Wielka Księga Balneologii, Medycyny Fizykalnej i Uzdrowiskowej [The Big Book of Balneology, Physical Medicine and Thermal Medicine]. Aluna Publishing House, Konstancin-Jeziorna, 2017. (Polish).
11. Qiu CG, Chui CS, Chow SKH et al. Effects of whole-body vibration therapy on knee osteoarthritis: a systematic review and meta-analysis of randomized controlled trials. J Rehabil Med. 2022;54:2032. doi:10.2340/jrm.v54.2032.
12. Kabata–Piżuch A, Suder A, Jagielski P et al. Effect of Vibrotherapy on Body Fatness, Blood Parameters and Fibrinogen Concentration in Elderly Men. J Clin Med. 2021;10(15):3259. doi:10.3390/jcm10153259.
13. Germann D, El Bouse A, Shnier J et al. Effects of local vibration therapy on various performance parameters: a narrative literature review. J Can Chiropr Assoc. 2018;62(3):170-181.
14. Hausswirth C, Le Meur Y. Physiological and nutritional aspects of post-exercise recovery: specific recommendations for female athletes. Sports Med. 2011;41(10):861-82. doi:10.2165/11593180-000000000-00000.
15. Chwała W, Pogwizd P, Rydzik Ł, Ambroży T. Effect of Vibration Massage and Passive Rest on Recovery of Muscle Strength after Short-Term Exercise. Int J Environ Res Public Health. 2021;18(21):11680. doi:10.3390/ijerph182111680.
16. Piotrowska A, Czerwińska-Ledwig O. Analysis of the effect of a one-time vibrotherapy treatment on selected skin characteristics, body composition and body circumferences of women with lipodystrophy. Aesth Cosmetol Med. 2021;10(2):79-85. doi: 10.52336/acm.2021.10.2.07.
17. Pasterczyk-Szczurek A, Golec J, Golec E. Effect of low-magnitude, variable-frequency vibration therapy on pain threshold levels and mobility in adults with moderate knee osteoarthritis-randomized controlled trial. BMC Musculoskelet Disord. 2023;24(1):287. doi:10.1186/s12891-023-06334-9.

18. Shahinpour S, Refahi F, Ali Nazemian N. Effect of Vibration on Acute and Chronic Back Pain After Spinal Anesthesia: A Randomized Clinical Trial. Anesth Pain Med. 2024;14(2):e143528. doi:10.5812/aapm-143528.
19. Pogwizd P, Pasterczyk-Szczurek A, Bigosińska M. Effect of vibrational therapy on muscle tissue. Med Rehabil. 2018;22(3):11-19. doi:10.5604/01.3001.0012.6898.
20. Piotrowska A, Czerwińska-Ledwig O, Stefańska M et al. Changes in Skin Microcirculation Resulting from Vibration Therapy in Women with Cellulite. Int J Environ Res Public Health. 2022;19(6):3385. doi:10.3390/ijerph19063385.
21. Saragih ID, Susanto H, Lin HC, Lee BO. Vibration therapy for patients with hard-to-heal wounds: A systematic review and meta-analysis of experimental studies. J Tissue Viability. 2025;34(1):100852. doi:10.1016/j.jtv.2024.100852.
22. Tomaszek L, Cepuch G, Piórko B. Level of pain intensity vs sleep quality and functioning of patients with cervical and lumbar disc disease. BÓL. 2016;17(3):19-25. doi:10.5604/01.3001.0009.5269.
23. Chochowska, M, Marcinkowski JT, Rąglewska P, Babiak J. Masaż klasyczny i masaż wibracyjny punktów spustowych bólu w leczeniu zespołu bólowego kręgosłupa z towarzyszącym mu obniżeniem nastroju – u osób starszych [Swedish Massage Therapy and Vibration Massage of Trigger Points in Elderly Patients With Low Back Pain and Depression]. Probl Hig Epidemiol. 2011;92(3):428-435. (Polish).
24. Rodrigues FTM, Ferreira APL, Alves KFP et al. Whole-Body Vibration Associated with Strength Training on the Lower-Limb Blood Flow and Mobility in Older Adults with Type 2 Diabetes: A Study Protocol for a Randomized Controlled Trial. Diagnostics (Basel). 2022;12(7):1550. doi:10.3390/diagnostics12071550.
25. Sitjà-Rabert M, Martínez-Zapata MJ, Fort Vanmeerhaeghe A et al. Effects of a whole body vibration (WBV) exercise intervention for institutionalized older people: a randomized, multicentre, parallel, clinical trial. J Am Med Dir Assoc. 2015;16(2):125-31. doi:10.1016/j.jamda.2014.07.018.
26. Cabak A, Kamiński D. Physioprophylaxis of spinal pain syndromes – systematic review. Pol. J. Sports Med. 2022;38(3): 131-143. doi:10.5604/01.3001.0016.0257.

CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Aleksandra Milewska
Medical University of Lodz
1 Plac Hallera, 91-647, Lodz, Poland
e-mail: aleksandra.milewska@umed.lodz.pl

ORCID AND CONTRIBUTIONSHIP
Aleksandra Milewska: 0009-0007-6777-1079 C D
Agnieszka Przedborska: 0000-0002-2107-6157 A B E
Grzegorz Musialski: 0009-0001-2118-6129 C E
Robert Irzmański: 0000-0001-9276-7273 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: 30.03.2025
ACCEPTED: 06.06.2025

ORIGINAL ARTICLE

Preservation and restoration of students' mental health during the war through the use of rationally organized motor activity

Nataliia Liakhova[1], Oleksandr I. Orlov[2], Valeriia V. Masol[2], Liliia M. Rudenko[2], Mykola I. Lukjanchenko[3], Vasyl M. Maksymiak[3], Olha A. Atamas[4]

[1]POLTAVA STATE MEDICAL UNIVERSITY, POLTAVA, UKRAINE
[2]UKRAINIAN STATE DRAGOMANOV UNIVERSITY, KYIV, UKRAINE
[3]DROHOBYCH IVAN FRANKO STATE PEDAGOGICAL UNIVERSITY, DROHOBYCH, UKRAINE
[4]BOHDAN KHMELNYTSKYI CHERKASY NATIONAL UNIVERSITY, CHERKASY, UKRAINE

ABSTRACT

Aim: To investigate the effect of rationally organized martial arts training sessions on preserving and restoring students' mental health during the war.

Materials and Methods: The research involved 60 male students aged 18-19, of whom the experimental and control groups were formed. The experimental group students, in addition to their compulsory physical education training sessions, attended optional martial arts training sessions 3 times a week; the students of the control group were engaged in physical exercises scheduled only 2 times a week. The students' mental health was studied by indicators of stress and anxiety.

Results: The research of the baseline level of the students' mental health has found that about 50 % of the students have high levels of anxiety, and more than 80 % experience signs of stress. It has been found that rationally organized martial arts training sessions contribute to the preservation and restoration of the mental health of students during the war. It has been found that the level of students' stress in the experimental group significantly decreased by 61.8 %. The levels of personal and reactive anxiety decreased by 7.0 % and 10.5 %, respectively. The control group had no significant changes.

Conclusions: The effect of rationally organized martial arts training sessions on the preservation and restoration of students' mental health during the war has been proven by a significant reduction in stress levels, as well as a decrease in the indicators of personal and reactive anxiety and their approximation to the optimal level.

KEYWORDS: mental health, stress level, students, motor activity, martial arts, war

Acta Balneol. 2025;67(4):275-281. doi: 10.36740/ABAL202504106

INTRODUCTION

At the current stage of society's development, the deterioration of the health of the adult population, including the younger generation, has become a national problem. The vast majority of the Ukrainian population experiences increased psycho-emotional stress and is in a permanent state of stress, including due to long-term pandemic restrictions and the full-scale war [1]. The situation is further complicated by the fact that most students have not formed the need to take care of their health, which is expressed in the neglect of basic norms of its preservation and leads to an increase in somatic and mental diseases, functional and cognitive disorders [2, 3].

Since human health is not limited to optimal physical condition but also involves psycho-emotional balance, universal types of motor activity should be introduced into the physical education process. This would positively impact not only the physical but also the mental health of students.

Different types of motor activity provide a comprehensive solution to the educational, health, and awareness-raising tasks of physical education, in particular, contribute to forming necessary motor experience, developing motor abilities, and fostering moral and volitional qualities [4, 5]. However, the introduction of martial arts training sessions contributes to the development of not only the patriotic spirit of young people, the formation of the need for physical self-improvement, but also a careful attitude to health, which, in turn, leads to a healthy lifestyle and ensures the improvement of the mental health of future professionals, especially during the war in Ukraine [6, 7].

AIM

The aim is to investigate the effect of rationally organized martial arts training sessions on preserving and restoring students' mental health during the war.

MATERIALS AND METHODS

PARTICIPANTS

The research involved 60 male students aged 18-19 (1-2 academic years) studying at the Ukrainian State Dragomanov University (Kyiv, Ukraine), Faculty of Physical Education, Sports and Health. The experimental (EG) and the control (CG) groups of 30 were formed. In addition to compulsory

physical education training sessions scheduled 2 times a week (4 hours), the EG students attended optional martial arts training sessions (boxing, kickboxing, combat sambo; 6 hours) 3 times a week, and the CG students exercised 2 times a week (4 hours of compulsory training sessions) and did not attend any of the sports clubs. Training sessions in martial arts clubs with the EG students were conducted under the guidance of experienced coaches, had a clearly defined structure and focus, were accompanied by a balanced combination of means, methods, and types of training, dosage of physical loads, pedagogical, psychological, and medical control. The experiment lasted 8 months during the 2023-2024 academic year (October-May).

RESEARCH METHODS

Analysis and generalization of scientific literature, pedagogical observation, testing of mental health indicators, and statistical methods. The analysis and generalization of scientific literature contributed to the study of the problem of mental health of students during the war in Ukraine at the theoretical level and to substantiate the effectiveness of martial arts training in its preservation and restoration (26 sources from scientometric databases Index Copernicus, Scopus, Web of Science were analyzed). Pedagogical observation was carried out on the volume and intensity of physical activity during physical education training sessions in the EG and the CG, and sports club training sessions in the EG. The level and dynamics of students' mental health were studied by indicators of stress and anxiety. The level of stress was determined by the test of V. Yu. Shcherbatykh, which allows the study of various signs of stress – intellectual, behavioral, emotional and physiological according to the answers to the questionnaire consisting of four groups of questions [8]. The total maximum score for the entire list can theoretically reach 66. A score of 0 to 5 points is considered good, meaning there is no significant stress at this point in life. A score of 6 to 12 points means that a person is experiencing moderate stress, which can be compensated for by rational use of time, periodic rest, and finding the best way out of the situation. A score of 13 to 24 points indicates a fairly pronounced tension of the emotional and physiological systems of the body, which arose in response to severe stress that could not be compensated for. In this case, unique methods of coping with stress are required. A score of 25 to 40 points indicates a state of severe stress, which requires the help of a psychologist or psychotherapist to overcome it successfully. This stress level suggests that the body is already close to the limit of its ability to resist stress. A score of more than 40 points indicates that the body is moving to the third, most dangerous stage of stress – the depletion of adaptive energy reserves.

To determine the level of reactive and personal anxiety of students, the Spielberg-Khanin psychological test was used [9]. The scale consists of two questionnaires that assess reactive (RA, statements 1-20) and personal (PA, statements 21-40) anxiety separately. Personal anxiety is relatively stable and not related to the situation, as it is a personality trait. Reactive anxiety, on the other hand, can be caused by a specific problem. RA and PA indicators are calculated using the following formulas:

RA = Σ1 – Σ2 + 50, where Σ1 is the sum of the crossed-out numbers on the form for items 3, 4, 6, 7, 9, 13, 14, 17, 18; Σ2 is the sum of the remaining crossed-out numbers (items 1, 2, 5, 8, 10, 11, 15, 16, 19, 20);

PA = Σ1 – Σ2 + 35, where Σ1 is the sum of crossed-out numbers on the form for items 22, 23, 24, 25, 28, 31, 32, 34, 35, 37, 38, 40; Σ2 is the sum of other crossed-out numbers (items 21, 26, 27, 30, 33, 36, 39).

For the general interpretation of the indicators, we used the following anxiety scores: up to 30 points – low; 31-44 points – moderate; 45 and more – high.

STATISTICAL METHODS

At the beginning and the end of the academic year, the diagnostics of the initial and control levels of mental health of students were carried out in terms of stress, personal, and reactive anxiety indicators. At the beginning of the pedagogical experiment, the homogeneity of all indicators of the EG and the CG students was determined, i.e., the absence of a significant difference in the studied indicators ($p > 0.05$), and it was found that the distributions of the EG and the CG are normal, which allowed us to assess the reliability of the results using Student's t-test. The reliability of the difference between the indicators, expressed as a percentage, was determined using Pearson's χ^2 test.

The research implementation process was built in accordance with scientific ethics. The Academic Ethics Commission of the Ukrainian State Dragomanov University approved the research. The pedagogical experiment was open; participants were informed about the research's aim and tasks, and voluntarily participated in it.

RESULTS

The results of the preliminary study of the mental health of the EG and the CG students showed that students of both groups often experience stress and psycho-emotional discomfort, tension and anxiety, which can be explained by the unfavorable military-political and economic situation in the country and the patterns of mental development of the age period of youth. Thus, it turned out that the overwhelming majority of the EG and the CG students experience stress to varying degrees. Moreover, 6.7 % of the EG students and 10.0 % of the CG students experience severe stress, 36.7 % of the EG students and 33.3 % of the CG students experience a fairly pronounced stress of emotional and physiological systems of the body, 38.3 % of the EG students and 36.7 % of the CG students experience moderate stress, 18.3 % of the EG students and 20.0 % of the CG students have no stress (Table 1). It is important to note that no significant difference exists between the stress levels in the EG and the CG students ($p > 0.05$).

The study of initial levels of anxiety showed that a high level of personal anxiety was recorded in 53.3 % of the EG and 50.0 % of the CG students, a moderate level of personal anxiety was found in 26.7 % of the EG and 30.0 %

Table 1. Level of mental health of the EG and the CG students at the beginning of the research, %

Stress and anxiety levels	Study groups		Reliability of the difference	
	EG	CG	χ^2	p
Stress				
High	6.7	10.0	0.7711	>0.05
Significant	36.7	33.3		
Moderate	38.3	36.7		
None	18.3	20.0		
Personal anxiety				
High	53.3	50.0	0.2975	>0.05
Moderate	26.7	30.0		
Low	20.0	20.0		
Reactive anxiety				
High	46.6	43.3	1.1363	>0.05
Moderate	30.0	36.7		
Low	23.4	20.0		

Legend: χ^2 – value of Pearson's criterion, p – statistical significance indicator
Source: compiled by the authors of this study

of the CG students, a low level of personal anxiety – in 20.0 % of the EG and 20.0 % of the CG students; 46.6 % of the EG and 43.3 % of the CG students have a high level of reactive anxiety, 30.0 % of the EG and 36.7 % of the CG students have a moderate level of reactive anxiety, 23.4 % of the EG and 20.0 % of the CG students have a low level of reactive anxiety. There was no significant difference between the anxiety levels of the EG and the CG students at the beginning of the research. Thus, it was found that about half of the young men have high levels of personal and reactive anxiety, and more than 80.0 % of the students experience signs of stress to varying degrees.

To improve the mental health of the EG students during martial arts training sessions, we proposed a methodology of training that involves the training of technical actions, which is closely related to the process of developing motor skills and fostering volitional qualities. When planning motor loads, we were guided by the provision that the attack strategy requires a higher manifestation of psycho-emotional stability than the defense strategy, and therefore, to develop stress resilience for students, we planned motor tasks in attack and defense in a ratio of 2:1. The content of motor actions in martial arts is characterized by reactivity, that is irregularity and variability; techniques in the activity of a fight are performed without a specific sequence of elements, in variable conditions, without stereotypicality of the performed movements and depend on the plans of the opponent. The success of competitive activity in martial arts is influenced mainly by speed and strength qualities, as well as the ability to perform short-term power actions and maintain a high level of performance for a long time. The motor training of students in the process of martial arts training is aimed at developing strength (maximum, dynamic, static and explosive), speed (speed of sensorimotor reactions – simple reaction and choice reaction, frequency of movements, speed of single movement), and endurance (strength, speed and strength, coordination and general endurance). The structure and physiological mechanisms of movements in martial arts require a complex manifestation of psychomotor, sensorimotor abilities and features of neuropsychic processes that determine strength and speed abilities, properties of the psyche involved in their manifestation (thinking, imagination, attention, memory, strength, mobility and balanced state of nervous processes), as well as moral and volitional qualities during the performance of techniques in training and competitive activities.

The preservation and restoration of students' mental health in the process of martial arts training sessions was carried out through the purposeful fostering of volitional qualities, which is the content of awareness-raising tasks. The strong-willed training of students contributes to forming a worthy young link in society, the younger generation of citizens. Martial arts is a special kind of sport that requires a high level of volitional qualities: purposefulness, courage, determination, perseverance, nervous and emotional stability, self-control and endurance, the ability to overcome internal and external obstacles on the way to the goal, as well as the manifestation of crucial individual personality traits positioned as soft skills: respect for the opponent, discipline, responsibility, sociability, independence, initiative, flexibility, adaptability, leadership qualities. In addition, martial arts training sessions develop cognitive skills: analyzing, comparing, generalizing, and drawing conclusions, which are the key to a successful young person. The rivalry factor in a fight creates an extraordinary emotional and physiological background that enhances the effect of physical exercise and can contribute to the maximum manifestation of

Table 2. Dynamics of mental health indicators of the EG and the CG students during the academic year (X ± m), points

Mental health indicators	Groups	Research stages		The difference,%	Reliability of the difference	
		Beginning	End		t	p
Stress level	EG	12.5 ± 0.31	6.6 ± 0.29**	61.8	13.9	≤0.001
	CG	12.1 ± 0.40	11.9 ± 0.38	1.7	0.36	>0.05
Personal anxiety	EG	35.6 ± 0.65	33.2 ± 0.58*	7.0	2.75	≤0.05
	CG	35.3 ± 0.71	35.0 ± 0.66	0.4	0.31	>0.05
Reactive anxiety	EG	38.1 ± 0.62	34.3 ± 0.55*	10.5	4.58	≤0.001
	CG	37.2 ± 0.69	36.6 ± 0.68	0.8	0.62	>0.05

*Legend: X – arithmetic mean, m – error of the arithmetic mean, t – Student's t-test, p – statistical significance indicator, *, ** – reliability of the difference between the EG and the CG at the end of the research at the level of p ≤ 0.05, p ≤ 0.001*
Source: compiled by the authors of this study

the body's functional and mental capabilities. Due to the factor of confrontation in the activity of the fight, mental tension requires the ability to mobilize one's will and self-control in difficult situations. At the same time, the factor of rivalry can contribute to the manifestation of negative character traits (egoism, short temper, excessive ambition, arrogance, aggressiveness, etc.), so we were careful to use the competitive method, taking into account the individual characteristics of students.

To test the effectiveness of martial arts training sessions for preserving students' mental health, rationally organized optional martial arts training sessions were introduced into the physical education process during the eight months of the academic year. At the end of the research, a final screening of the level of stress and anxiety in the EG and the CG young men was performed, and a comparison with the initial data was made. The dynamics of students' mental health indicators during the academic year were studied (Table 2).

It was found that the EG students' stress level significantly decreased by 61.8 % at p ≤ 0.001, while in the CG students, the stress level decreased by 1.7 %, which was determined to be unreliable (p > 0.05). At the same time, the levels of personal and reactive anxiety of the EG students who additionally practiced martial arts decreased by 7.0 % and 10.5 %, respectively, at p ≤ 0.05-0.001. In contrast, changes among the CG students were not statistically significant (p > 0.05). It is important to note that at the end of the research, all mental health indicators of the EG students were significantly better than those of the CG students (p ≤ 0.05-0.001). All this shows that rationally organized martial arts training sessions contribute to preserving and restoring students' mental health during the war.

DISCUSSION

According to scientists [10, 11], mental health is a relatively stable state of the body and personality that allows a person to consciously, taking into account their physical and mental capabilities, as well as the surrounding natural and social conditions, fulfill and ensure their individual and communal (collective) biological and social needs based on the normal functioning of psychophysical systems, healthy psychosomatic and somatopsychic relations in the body. Experts [12] associate mental health with the psyche's ability to self-organize (self-regulation, self-renewal, self-healing). According to other scientists [13], mental health is a state of mental well-being characterized by the absence of painful mental manifestations, which ensures adequate regulation of behavior and activity. The stability of the human psyche depends on the strength of these mechanisms. Awareness of the problem and active volitional control of one's psyche are crucial. According to scientists, one of the leading indicators of mental health is the optimal level of anxiety and neuropsychological stability (stress resilience) [14].

Mental health is closely related to the presence and maintenance of psychological resilience in stressful situations. The problems of psychological resilience are of great practical importance, since resilience protects the individual from disintegration and personality disorders, creates the basis for inner harmony, and ensures the realization of physical and spiritual abilities. Students' daily activities in the conditions of study and everyday life during the war are accompanied by various situations associated with psychological tension [16]. The nervous and emotional stability is successfully fostered in practicing multiple types of motor activity, particularly during martial arts training [16].

Educational and professional activity requires endurance, prudence, and adequate response to adverse environmental manifestations from a modern young person. It has been proven that human anxiety affects physical and mental health, development of the emotional sphere and communication, educational activities, as it leads to a decrease in mental and physical performance, productivity, communication difficulties, and is often the cause of pathological phenomena and a component of the clinical picture of various psychosomatic and cognitive disorders [17]. Anxiety as a normal response to a signal of danger

focuses attention on possible difficulties and obstacles to achieving a goal, allows you to mobilize your strength and thus achieve the best result [18]. An excessive level of anxiety is a maladaptive response to a situation and manifests itself in the general disorganization of behavior and activities. In psychological practice, there is a complete absence of anxiety, which interferes with regular adaptation. Therefore, a standard (optimal) level of anxiety is perceived as a necessary indicator of effective adaptation to reality and a component of mental health [19].

Scientists [18, 20] distinguish two types of anxiety. Reactive anxiety is caused by a specific situation, in anticipation of possible troubles and life complications that objectively cause discomfort. This condition is not only expected but also plays a positive role, as it acts as a kind of mobilizing mechanism that allows a person to take a serious and responsible approach to solving problems. A low level of reactive anxiety is abnormal, when a person in severe circumstances demonstrates negligence and irresponsibility, which most often indicates an infantile life position, insufficiently formulated self-awareness [20]. Personal anxiety is a personality trait that manifests itself in a constant tendency to experience disturbance in a variety of life situations, including those that do not objectively require it. It is characterized by the emergence of unconscious fear, an uncertain sense of threat, and a willingness to perceive any event as unfavorable and dangerous [18].

In our research, the process of forming students' psycho-emotional stability, preserving and restoring their mental health, was carried out during rationally organized martial arts training sessions at sports clubs. Solving the goal during martial arts training sessions, we relied on the fundamental rules – general, didactic, and some specific principles of physical education. The peculiarity of martial arts training sessions is a vigorous emotional intensity, so in the process of teaching martial arts techniques and tactics, they naturally contribute to reducing anxiety, stress levels, improving subjective indicators of psycho-emotional state, overcoming negative feelings of fear, confusion, embarrassment, etc. In martial arts training sessions, the students were introduced to the concepts of mental health and the impact of pandemic restrictions, war and its consequences; the concept of stress, its physiological, psycho-emotional, somatic, and behavioral manifestations; the possibilities of maintaining mental and somatic health in war conditions; the peculiarities of recovery after mental and physical exertion, stress; the basics of self-control during physical and psychological pressure based on subjective signs of the body's reaction. The results of our research confirm the conclusions of other scientists [21-26] about the effectiveness of motor activity in restoring students' mental health during the war, supplementing and expanding them.

CONCLUSIONS

At the current stage of social development in Ukraine, the deterioration of the health of the adult population, including the younger generation, has become a national problem. The vast majority of the Ukrainian population experiences increased psycho-emotional pressure and is in a permanent state of stress, including due to long-term pandemic restrictions and the full-scale war. The study of mental health indicators of male students showed that about half of the students have high levels of personal and reactive anxiety, and more than 80 % of students experience signs of stress to varying degrees.

It has been found that rationally organized martial arts training sessions contribute to the preservation and restoration of the mental health of students during the war. It has been found that the stress level of students in the experimental group significantly decreased by 61.8 % ($p \leq 0.001$). In comparison, the levels of their personal and reactive anxiety decreased by 7.0 % and 10.5 %, respectively ($p \leq 0.05$-0.001). The control group had no significant changes ($p > 0.05$). At the same time, at the end of the research, all mental health indicators of the EG students were significantly better than those of the CG students ($p \leq 0.05$-0.001).

The effect of rationally organized martial arts training sessions on the preservation and restoration of students' mental health during the war has been proven by a significant reduction in stress, as well as a decrease in personal and reactive anxiety indicators and their approach to the optimal level.

PROSPECTS FOR FURTHER RESEARCH

Prospects for further research will be aimed at assessing the impact of martial arts training sessions on the restoration of mental and physical health of students of different genders during the war.

REFERENCES

1. Zasiekina L, Duchyminska T, Bifulco A, Bignardi G. War trauma impacts in Ukrainian combat and civilian populations: Moral injury and associated mental health symptoms. Mil Psychol. 2024;36(5):555-566. doi:10.1080/08995605.2023.2235256.
2. Taghavi K, Isaacs D, McLeod L et al. The ethics of war-time data in paediatric trauma: Attitudes, angles and impacts. BMJ Glob Health. 2023;7(Suppl 8): e013071. doi:10.1136/bmjgh-2023-013071
3. Harb GC, Schultz JH. The nature of posttraumatic nightmares and school functioning in war-affected youth. PLoS One. 2020;15(11):e0242414. doi:10.1371/journal.pone.0242414.
4. Holovanova IA, Prontenko KV, Lyakhova NA et al. Dynamics of indicators of cadets' morphological and functional development in the process of their physical exercises of different orientation. World of Medicine and Biology. 2024;87(1):47-52. doi:10.26724/2079-8334-2024-1-87-47-52.

5. Griban G, Okhrimenko I, Lyakhova N et al. Influence of the amount of students' motor activity on their health status and psychophysical readiness for future life. Acta Balneol. 2022;64(2): 150-154. doi:10.36740/ABAL202202109.
6. Riad A, Drobov A, Krobot M et al. Mental Health Burden of the Russian-Ukrainian War 2022 (RUW-22): Anxiety and Depression Levels among Young Adults in Central Europe. Int J Environ Res Public Health. 2022;19(14):8418. doi:10.3390/ijerph19148418.
7. Holovanova IA, Gorbenko DA, Ostapovich VP et al. Dynamics of the psychophysical state of future law enforcement officers in the course of their professional training. World of Medicine and Biology. 2023;86(4):35-39. doi:10.26724/2079 -8334-2023-4-86-35-39.
8. Prontenko KV, Okhrimenko IM, Rohovenko MM et al. Correction of physical health and psycho-emotional state of student youth under martial law. Acta Balneol. 2024;66(5):345-350. doi:10.36740/ABAL202405108.
9. Palamar B, Palamar S, Miyer T et al. Studying anxiety as a predictor in students to predict the development of burnout. Wiad Lek. 2023;76(5 pt 1):1054-1061. doi:10.36740/WLek202305125.
10. Walsh S, Cassidy M, Priebe S. The application of positive psychotherapy in mental health care: A systematic review. J Clin Psychol. 2017;73(6):638-651. doi:10.1002/jclp.22368.
11. Okhrimenko IM, Bilevych NO, Drozdova LV et al. Restoration of the psycho-physical state of future law enforcement officers during recreational and health--improving training sessions. Acta Balneol. 2024;66(4):262-267. doi:10.36740/ABAL202404108.
12. Carleton RN, Sauer-Zavala S, Teckchandani TA et al. Mental health disorder symptom changes among public safety personnel after emotional resilience skills training. Compr Psychiatry. 2025;138:152580. doi:10.1016/j.comppsych.2025.152580.
13. van Agteren J, Iasiello M, Lo L et al. A systematic review and meta-analysis of psychological interventions to improve mental wellbeing. Nat Hum Behav. 2021;5(5):631-652. doi:10.1038/s41562-021-01093-w.
14. Yevdokimova O, Okhrimenko I. Coping strategies for overcoming stress in atypical situations. BRAIN. Broad Research in Artificial Intelligence and Neuroscience. 2020;11(2Sup1):56-63. doi: 10.18662/brain/11.2Sup1/94.
15. Seshadri A, Orth SS, Adaji A et al. Mindfulness-based cognitive therapy, acceptance and commitment therapy, and positive psychotherapy for major depression. Am J Psychother. 2021;74(1):4-12. doi:10.1176/appi.psychotherapy.20200006.
16. Holovanova IA, Okhrimenko IM, Sharapova JV et al. The influence of motor activity on the formation of stress resistance in servicemen while performing special service and combat missions. World of Medicine and Biology. 2024;89(3):39-44. doi:10.267224/2079-8334-2024-3-89-39-44.
17. Prontenko K, Griban G, Okhrimenko I et al. Academic performance and mental capacity of cadets engaged in sports during studies. Dilemas Contemporaneos-Educacion Politica y Valores. 2019;7(SI): Art. no 23. doi: 10.46377/dilemas.v29i1.1896.
18. Crocq MA. A history of anxiety: from Hippocrates to DSM. Dialogues Clin Neurosci. 2015;17(3):319-325. doi:10.31887/DCNS.2015.17.3/macrocq.
19. Wolgensinger L. Cognitive behavioral group therapy for anxiety: recent developments. Dialogues Clin Neurosci. 2015;17(3):347-351. doi:10.31887/DCNS.2015.17.3/lwolgensinger.
20. Tymoshenko O, Domina Zh, Masenko L et al. Dependence of stress level on the strength of nervous processes and development of special types of endurance in 16-17-year-old men. Acta Balneol. 2024; 66(5), 330-334. doi:10.36740/ABAL202405106.
21. Nechita D, Nechita F, Motorga R. A review of the influence the anxiety exerts on human life. Rom J Morphol Embryol. 2018;59(4):1045-1051.
22. Bloshchynskyi I, Okhrimenko I, Dekhtiarenko I et al. Cadets' cognitive independence as a leading factor of their successful training. Revista Romaneasca Pentru Educatie Multidimensionala. 2023;15(4):34-49. doi: 10.18662/rrem/15.4/778.
23. Domina ZhH, Tymoshenko OV, Markus IS et al. Improving high school students' somatic and mental health through interactive methods of physical education. Acta Balneol. 2024; 66(4), 256-261. doi:10.36740/ABAL202404107.
24. Zhamardiy V, Shkola O, Ulianova V et al. Influence of fitness technologies on the student youth's physical qualities development. Dilemas Contemporaneos-Educacion Politica y Valores. 2019;7(SI): Art. no 49. doi: 10.46377/dilemas.v29i1.1947.
25. Griban G, Moskalenko N, Adyrkhaiev S et al. Dependence of students' health on the organization of their motor activity in higher educational institutions. Acta Balneol. 2022;5(171): 445-450. doi:10.36740/ABAL202205112.
26. Bondarenko V, Prontenko K, Donets I et al. Comparative analysis of the levels of cadets' physical activity at different stages of their professional training. Acta Balneol. 2024;66(4): 236-241. doi:10.36740/ABAL202404104.

CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Nataliia Liakhova
Poltava State Medical University
24 Shevchenko St., 36000 Poltava, Ukraine
e-mail: NataNew2017@ukr.net

ORCID AND CONTRIBUTIONSHIP
Nataliia Liakhova: 0000-0003-0503-9935 A
Oleksandr I. Orlov: 0009-0003-3965-2620 B D
Valeriia V. Masol: 0000-0002-5214-073X B
Liliia M. Rudenko: 0000-0003-1655-5708 B D
Mykola I. Lukjanchenko: 0000-0002-0253-858X C D
Vasyl M. Maksymiak: 0009-0000-4141-8823 E
Olha A. Atamas: 0000-0003-4711-5211 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: 29.03.2025
ACCEPTED: 04.06.2025

ORIGINAL ARTICLE

The impact of Femi Therapy on body weight, symptom occurrence in perimenopausal women, and long-term changes in dietary habits and lifestyle

Anna Wrzochal[1], Anna Kalska[2], Monika Knefel[3], Dorota Tworek[4]

[1]GDANSK UNIVERSITY OF PHYSICAL EDUCATION AND SPORT, GDANSK, POLAND
[2]HIGHER SCHOOL OF VOCATIONAL SKILLS IN PINCZOW, PINCZOW, POLAND
[3]CRACOW UNIVERSITY OF ECONOMICS, CRACOW, POLAND
[4]FONTIA LLC, POLAND

ABSTRACT

Aim: The aim of this study was to assess the impact of Femi Therapy, an important element of which is sulphur water crenotherapy, on body weight, the alleviation of menopausal symptoms, and the regulation of hormone levels in perimenopausal women, as well as to define new directions for treatment and development in Busko-Zdrój.

Materials and Methods: The research was carried out as part of project no. RPSW.01.02.00-26-0020/21 titled: «Use of crenotherapy with therapeutic sulphide water in alleviating menopausal symptoms», implemented under the Regional Operational Programme of the Świętokrzyskie Voivodeship for 2014-2020 and co-financed by the European Union from the European Regional Development Fund. A comparative study was conducted on a group of 100 menopausal women aged 45-60. Study group, which underwent crenotherapy, consisted of 70 women, while the control group, which did not drink sulphide water, included 30 women. Additionally,Femi Therapy included diet and physical activity. The main research tool was a diary in which participants noted their symptoms, physical activity, and the products and drinks they consumed.

Results: Statistically significant differences were found between the study group and the control group with normal body mass when comparing differences in body mass, body fat mass, and waist and hip circumference. Statistically significant differences were also observed between the overweight groups when comparing the percentage of body fat after the therapy.

Conclusions: The results of the analyses are promising and show that Femi Therapy can help improve body mass and composition, as well as lifestyle. However, further studies are needed to confirm the effectiveness of Femi Therapy.

KEYWORDS: diet, menopause, health resort tourism, Busko-Zdrój, crenotherapy

Acta Balneol. 2025;67(4):282-287. doi: 10.36740/ABAL202504107

INTRODUCTION

Menopause is a period in a woman's life marked by a decline in ovarian hormonal function and the permanent cessation of menstruation. This stage typically occurs around the age of 50 [1]. Hormonal changes, combined with improper nutrition and lifestyle habits, result in a range of physiological alterations that can lead to various ailments and diseases, thereby reducing quality of life. The symptoms experienced during menopause can vary greatly among women in both intensity and frequency. The most common symptoms include: fatigue, exhaustion, hot flashes, increased sweating, sleep disorders, reduced physical performance, weight gain, increased fat mass and changes in its distribution, lipid metabolism disorders, atherosclerosis, hypertension, ischemic heart disease, insulin resistance, type 2 diabetes, metabolic syndrome, osteoporosis, urinary incontinence, mood swings, depressive episodes, and mental health disorders [2-4].

In today's world, perimenopausal women are actively engaged in professional, family, and social life. Therefore, the symptoms and illnesses associated with menopause can significantly impact their functioning and quality of life. This life stage thus requires special attention to health. Research findings indicate that lifestyle modifications – including dietary habit changes, increased physical activity, and the elimination of stimulants – can alleviate menopausal symptoms and reduce the risk of diseases associated with this period [2,3,4]. For this reason, nutritional education for menopausal women and the promotion of a healthy lifestyle appear to be essential. At the same time, the search for new methods to minimize the negative effects of menopause remains a current challenge and an important need for contemporary women.

The research problem addressed in this study was to investigate the impact of crenotherapy on the occurrence of symptoms in perimenopausal women, and subsequently, as

part of development work, to create a therapeutic program which, in its final stage, was implemented as a commercial health tourism product.

The main objective of the first stage of the industrial research was to acquire new knowledge on the effects of sulphide water in alleviating menopausal symptoms, which was confirmed by the positive verification of the primary hypothesis:

H.0. Sulphide water crenotherapy contributes to the reduction of menopausal symptoms, as well as the supplementary hypothesis:

H.1. Sulphide water crenotherapy regulates hormonal changes during menopause. The second stage of the study included verification of the additional hypothesis:

H.2. Weight reduction positively correlates with the frequency of vasomotor symptoms. An additional objective was to submit a patent application for the invention regarding the use of crenotherapy in alleviating menopausal symptoms.

AIM

The aim of this study was to assess the impact of Femi Therapy, an important element of which is sulphur water crenotherapy, on body weight, the alleviation of menopausal symptoms, and the regulation of hormone levels in perimenopausal women, as well as to define new directions for treatment and development in Busko-Zdrój.

MATERIALS AND METHODS

The study was conducted as part of project no. RPSW.01.02.00-26-0020/21 entitled: *«The use of crenotherapy with therapeutic sulphide water in alleviating menopausal symptoms»*, implemented under the Regional Operational Programme of the Świętokrzyskie Voivodeship for 2014–2020, co-financed by the European Union from the European Regional Development Fund. The project was carried out at the BRISTOL**** ART & Medical SPA Hotel in Busko-Zdrój.

The study was conducted among women aged 45–60 (52,66±4,33) who reported experiencing at least 9 symptoms from a list of clinically recognized menopausal symptoms. These included: hot flashes, tension or nervousness, irritability, anxiety attacks, crying spells over trivial matters, difficulty falling asleep or insomnia, concentration problems, dizziness, headaches, heart palpitations, shortness of breath, lack of energy, and decreased interest in sexual activity. Preliminary selection also involved an analysis of a recruitment questionnaire to identify contraindications to crenotherapy.

A comparative study was conducted on a total sample of 100 menopausal women. The women were subjected to Femi Therapy, which included crenotherapy, diet and physical activity. The study group consisted of participants undergoing crenotherapy – i.e., drinking sulphide water – while the control group did not consume the sulphide water. The study participants were categorized into three groups based on Body Mass Index (BMI): normal weight (BMI 18.5-24.9 kg/m^2), overweight (BMI 25–29.9 kg/m^2), and obese (BMI >30 kg/m^2). Eligibility for the groups was determined by physicians and dietitians, based on patient interviews and health contraindications to crenotherapy. Table 1 presents the numbers of each group.

Participants in the study stayed at the hotel for 10 days under the supervision of a multidisciplinary team (dietitians, physicians, physiotherapist, and personal trainer), after which they continued the therapy at home for 20 days following specific guidelines provided during nutritional education by a dietician and recommendations from a personal trainer regarding physical activity. During the continuation of therapy at home, patients sent photos of the diary to specialists, which allowed them to maintain control over filling in the diary and adhering to the recommendations. After three months, long-term changes in lifestyle and symptom perception were also monitored.

The study group consumed a sulphide water blend (100 ml) from the Les Winiarski spring, mixed with freshly squeezed juice (200 ml). The control group received mineral water with juice in the same proportion. Table 2 presents the differences in the composition of these waters. Apart from this difference, all other aspects of the therapy – such as exercise, treatments, and diet – were implemented identically for both groups.

The diet provided during the hotel stay, as well as the nutritional recommendations for home continuation, were based on the recommendations of the normocalorie and Mediterranean diets and the healthy eating guidelines of the National Center for Nutritional Education. Physical activity included pelvic floor exercises, hormonal yoga, dance classes, personal training sessions, Nordic walking, and aqua aerobics. According to the assumptions, the participants were to perform at least 60 minutes of physical activity daily, both in the hotel and at home.

In both groups, the impact of crenotherapy was analyzed using both objective (measurable) and subjective (patient-reported) parameters. Assessments were conducted before the start of the therapy, during the therapy, after its completion, and three months post-intervention. These assessments included:

Table 1. Group size divided into study and control groups and groups according to BMI index

Groups	Group size	Group size according to BMI index		
		Proper body weight	Overweight	Obesity
Study group	70 women	32	27	11
Control group	30 women	10	15	5

Source: compiled by the authors of this study

Table 2. Comparison of the composition of sulphide water consumed by the study group and the mineral water drunk by the control group

Mineral content [mg/dm³]	Study group	Control group
	Sulphide water from the Les Winiarski spring	Buskowianka mineral water
Mineralization	12 700	797,40
H_2S, HS^-, S^{2-}	45,00	-
Iodine I^-	2,20	-
Chlorides Cl^-	5955,60	59,60
Sulphates SO_4^{2-}	1617,20	100,10
Bicarbonates HCO^{3-}	399,80	433,30
Bromides Br^-	5,00	-
Fluorine	-	0,20
Sodium Na^+	3896,80	24,35
Potassium K^+	106,80	8,04
Calcium Ca^{2+}	340,68	130,90
Magnesium Mg^{2+}	221,18	27,13

Source: compiled by the authors based on [5,6]

- Symptom tracking through a patient diary maintained over the 30-day therapy period (10 days at the facility and 20 days at home),
- Bone density testing (densitometry),
- Laboratory tests of blood and urine (including hormone levels),
- Body temperature imaging (thermographic photos),
- Dietary analysis of body composition and measurements.

The primary research tool was a diary in which participants recorded information related to food intake, course of therapy, menopausal symptoms, medications, and emotional well-being.

In order to check the significance of the differences obtained in the two studied groups, a mean comparison test was performed. For this purpose, the t-statistic was calculated and compared with the critical value selected from the t-student tables.

The study was conducted with the approval of the Bioethics Committee operating under the Świętokrzyskie Medical Chamber in Kielce. In accordance with the Committee's recommendations, all participant data, consents, and declarations were secured and stored in compliance with applicable legal regulations and the internal procedures of the research and development institution.

Due to the large number of tests conducted and data collected, this article presents only selected findings, focusing primarily on the impact of crenotherapy on anthropometric measurements, the occurrence of selected menopausal symptoms, and long-term changes in dietary habits and lifestyle. The remaining results will be presented in subsequent articles.

RESULTS

THE IMPACT OF FEMI THERAPY ON BODY WEIGHT, COMPOSITION, AND CIRCUMFERENCE MEASUREMENTS

In the normal weight group, some participants had BMI values bordering on overweight and showed abnormalities in body composition analysis, which qualified them for improvement. In this group, body weight decreased by 1.4 kg in the treatment group and by 0.6 kg in the control group (Table 3), leading to a corresponding reduction in BMI by 0.5 kg/m^2 and 0.2 kg/m^2, respectively. Visceral fat levels decreased by 0.7 points in the treatment group and 0.1 points in the control group. Femi Therapy also had a significant effect on body circumferences: a total reduction of 6.3 cm in the treatment group and 3.1 cm in the control group. Additional circumferential changes are detailed in Table 3. Statistically significant differences were obtained when comparing body weight, fat tissue mass and waist and hip circumferences.

Among overweight participants, the average body weight reduction was 2.7 kg in the treatment group and 2.4 kg in the control group, resulting in a BMI decrease of 1.0 kg/m^2 and 0.9 kg/m^2, respectively. Visceral fat levels decreased by 0.8 points in the treatment group and 0.9 points in the control group. Favorable reductions were also observed in waist and hip circumferences:

- Waist: −3.2 cm (treatment), −2.9 cm (control)
- Hips: −2.8 cm (treatment), −2.2 cm (control)

Further details are shown in Table 3. A statistically significant difference was obtained when comparing the percentage of body fat.

Table 3. Comparison of the effects of crenotherapy on body weight, composition, and circumference in the treatment and control groups over 30 days

Changes in measurements	Proper body weight		Student's t-test	Overweight		Student's t-test	Obesity		Student's t-test
	Study group	Control group	|t|	Study group	Control group	|t|	Study group	Control group	|t|
body weight, kg	-1,4	-0,6	2,033*	-2,7	-2,4	0,311	-4,0	-3,4	0,343
body fat, kg	-1,2	-0,4	2,317*	-2,0	-2,4	1,665	-3,0	-2,2	0,744
body fat, %	-1,3	-0,3	1,871	-1,4	-2,1	2,082*	-1,5	-1,1	0,473
total body circumferences, cm	-6,3	-3,1	-	-9,0	8,9	-	11,3	-10,1	-
waist circumference, cm	-2,5	-0,9	2,471*	-3,2	-2,9	0,611	-3,3	-2,9	0,355
hip circumference, cm	-1,8	-0,5	2,724*	-2,8	-2,2	1,131	-3,0	-3,7	0,689
arm circumference, cm	-0,5	-0,5	0,401	-0,9	-1,0	1,006	-1,4	-1,0	0,574
thigh circumference, cm	-1,3	-1,2	0,365	-1,8	-2,3	1,114	-2,9	-2,2	0,993
calf circumference, cm	-0,2	0,0	0,888	-0,3	-0,5	1,490	-0,7	-0,3	1,341

** – statistically significant t-test results*
Source: compiled by the authors of this study

Among women diagnosed with obesity, an average weight loss of 4.0 kg was recorded in the treatment group and 3.4 kg in the control group. BMI decreased by 1.5 kg/m^2 and 1.3 kg/m^2, respectively. Visceral fat levels dropped by 0.7 points in the treatment group and 0.8 points in the control group.

A substantial overall reduction in body circumference was observed:

- Treatment group: –11.3 cm
- Control group: –10.1 cm

Waist circumference decreased by 3.3 cm (treatment) and 2.9 cm (control).

Interestingly, in the case of gluteofemoral (hip/thigh) obesity, a larger reduction in hip circumference was recorded in the control group (3.7 cm) compared to the treatment group (3.0 cm). Other measurement changes are listed in Table 3. The differences presented in this group were not statistically significant.

Three months after starting the therapy, long-term effects on body weight and composition were assessed. It was observed that individuals who adhered to healthy dietary principles and regularly engaged in physical activity maintained the achieved weight reduction. In many cases, further weight loss was noted.

After three months:

- 52% of participants maintained their post-intervention weight,
- 17% continued to lose weight,
- 31% experienced weight gain.

THE IMPACT OF FEMI THERAPY ON LONG-TERM CHANGES IN DIETARY HABITS AND LIFESTYLE

Femi Therapy had a favorable effect on participants' lifestyle, leading to improved diet quality and increased physical activity.

Based on nutritional diaries, participants adopted regular eating patterns with appropriate meal frequency, better composition of balanced meals, greater intake of fruits, vegetables, and whole grains, and adequate hydration. Many women from both the treatment and control groups reported low water intake prior to the therapy – often only 1–2 glasses per day. After 30 days of therapy, both groups increased their water consumption to an average of 8.5 glasses per day, in line with dietary recommendations (1.5 to 2 liters per day).

Follow-up monitoring three months later showed that 43% of participants continued to follow healthy eating principles, 55% followed them partially, and 2% did not follow them at all.

Additionally, both groups increased their daily physical activity duration by approximately 70 minutes after the 30-day therapy period compared to baseline. In the treatment group, physical activity increased from an average of 23 minutes to 92 minutes per day, while in the control group, it increased from 26 minutes to 99 minutes per day. After the project ended, 31% of participants maintained this increased level of physical activity.

DISCUSSION

Menopausal symptoms and related health conditions can negatively affect women's daily functioning and diminish

their quality of life. As demonstrated by numerous studies, dietary habits and lifestyle – including physical activity – may influence not only the onset of menopause but also its progression. Furthermore, maintaining a healthy body weight, adopting nutritious eating habits, and engaging in regular physical activity help reduce the risk of diseases commonly associated with menopause.

There is no conclusive evidence that menopause is directly associated with an increased prevalence of excess body weight. However, some studies have indicated that the decline in estrogen levels contributes to changes in body composition, including an increase in visceral fat and central obesity in postmenopausal women [4,7]. Based on body composition analysis by Pachocka, menopausal women were found to have a higher fat mass and lower muscle mass compared to premenopausal women [2]. Another study showed that hormonal changes during menopause resulted in a 32% increase in gynoid fat and a 44% increase in visceral fat [8].

It is important to note that hormonal changes alone do not fully account for shifts in body composition and the development of related diseases. Modifiable factors such as lifestyle and diet also play a significant role. Research shows that the development of obesity with age is influenced by reduced physical activity, sedentary behavior, excessive intake of dietary fats, sucrose, and fructose, irregular eating patterns, and socioeconomic factors [9,10].

In the present study, obese women in the Femi Therapy group experienced an average fat mass reduction of 3 kg over one month. For comparison, another study involving perimenopausal women on a low-calorie Mediterranean diet reported an average fat mass reduction of 2.3 kg over eight weeks [8]. This suggests that sulphide water consumption – one of the key distinguishing factors in the Femi Therapy – may have contributed significantly to greater fat loss. However, one should be cautious when comparing the results of these studies because they also differed in other elements, such as physical activity.

Studies have also shown that the diets of menopausal women are often high in calories, irregular, and dominated by animal fats and red meat. This results in low carbohydrate intake and high intake of protein, total fat, and saturated fatty acids [2, 11].

In a study by Friedrich, the effect of dietary modification on the quantity and distribution of body fat in obese menopausal women was examined. Nutritional education led to a reduction in dietary energy intake and improved nutritional quality. These changes were associated with weight loss and reductions in both subcutaneous and visceral fat [12]. Similarly, the present study demonstrated the positive effect of nutrition education, which contributed to more regular meal patterns, increased consumption of fruits, vegetables, whole grains, and dietary fiber, and a reduction in fatty meats in favor of lean meats and fish.

Lifestyle also plays a key role in maintaining health, improving well-being, and alleviating menopausal symptoms. Physical activity is particularly important. Exercise improves balance, enhances cognitive function, and significantly reduces the severity of menopausal symptoms [13,14].

Studies have confirmed that postmenopausal physical activity contributes to reductions in BMI and waist-to-hip ratio [15]. Physical exercise of at least moderate intensity has also been shown to improve bone density [16,17]. Other authors observed that physical activity reduced body weight, improved motor coordination and physical fitness, enhanced motivation among postmenopausal women [18], and positively impacted mental health [19].

However, another study found that nearly 90% of menopausal women report reduced quality of life and a reluctance to engage in physical activity due to climacteric symptoms [20]. Following Femi Therapy, an increase in daily physical activity duration was observed, and nearly one-third of participants maintained this higher level of activity after the project concluded. Additionally, a follow-up study conducted three months after the therapy showed that over 54% of the women reported improved quality of life.

Based on the discussed findings, it is evident that nearly every study evaluates the effects of different training protocols, making direct comparison difficult. Furthermore, in our study, physical activity was assessed using a diary and self-assessment. Nonetheless, the results clearly support recommending physical activity as a fundamental component of women's preventive healthcare.

CONCLUSIONS

In summary, the results of the analyses conducted are promising and show that Femi Therapy, an important element of which is crenotherapy with sulphide water, can help improve body weight and composition, as well as lifestyle.

In addition, it has also been shown that the studied therapy may have an impact on reducing menopausal symptoms, hormonal changes and other aspects of menopause related to bone demineralization or slowing down metabolic processes, as well as changes in body temperature – helping to reduce the occurrence of hot flashes. However, further studies are needed to confirm the effectiveness of Femi Therapy. They should include greater control of confounding factors such as physical activity and diet.

The results of the study have been implemented on the commercial market and have garnered significant interest among health tourists. Moreover, as part of the project, a patent application was submitted under the number P.445939, entitled: *"Use of crenotherapy in alleviating menopausal symptoms."*

REFERENCES

1. Rumianowski B, Brodowska A, Karakiewicz B et al. Environmental factors influencing the age of natural menopause onset in women. Prz Menopauz. 2012; 5: 412-416. doi: 10.5114/pm.2012.31468.
2. Pachocka LM. Comparative analysis of the lifestyle of obese women before and during the perimenopausal period. Rocz Panstw Zakl Hig. 2010; 61(4): 389-393.
3. Iwanowicz-Palus GJ, Stadnicka G, Bień A. Determinant factors of health in rural women in their perimenopausal period. Ann Agric Environ Med. 2013; 20: 96-100.
4. Dunneram Y, Greenwood DC, Cade JE. Diet, menopause and the risk of ovarian, endometrial and breast cancer. Proc Nutr Soc. 2019; 78: 438-448. doi: 10.1017/S0029665118002884.
5. https://buskowianka.com/o-wodzie/ [accessed 06.05.2025].
6. http://www.hydrogeotechnika.pl/woda-siarczkowa/ [accessed 06.05.2025].
7. Godziejewska-Zawada M. Obesity and diabetes in menopausal women – prevention and treatment. Prz Menopauz. 2013;1:1-9. doi: 10.5114/pm.2013.33413.
8. Lombardo M, Perrone MA, Gusiewa E et al. Losing Weight after Menopause with Minimal Aerobic Training and Mediterranean Diet. Nutrients. 2020;12(8): 2471. doi: 10.3390/nu12082471.
9. Pugliese G, Barrea L, Laudisio D et al. Mediterranean diet as tool to manage obesity in menopause: A narrative review. Nutrition. 2020; 79-80:110991. doi: 10.1016/j.nut.2020.110991.
10. Hidalgo-Mora JJ, Cortés-Sierra L, García-Pérez MA, et al. Diet to Reduce the Metabolic Syndrome Associated with Menopause. The Logic for Olive Oil. Nutrients. 2020;12(10): 3184. doi: 10.3390/nu12103184.
11. Dąbrowska J, Naworska B, Dąbrowska-Galas M et al. Overweight and obesity in perimenopausal women measured by bioelectrical impedance analysis. Prz Menopauz. 2013;3: 260-265 doi: 10.5114/pm.2013.36596.
12. Friedrich M. The effect of dietary composition on the amount and distribution of body fat in obese menopausal women. Human Nutrition and Metabolism. Supplement. 2004; 31(2): 71-77.
13. Piotrowska S, Majchrzycki M. Physical exercise in postmenopausal women. Prz Menopauz. 2013; 4:347-351. doi: 10.5114/pm.2013.37854.
14. McCullough LE, Eng SM, Bradshaw PT et al. Fat or fit: the joint effects of physical activity, weight gain, and body size on breast cancer risk. Cancer. 2012;118: 4860-4868. doi: 10.1002/cncr.27433.
15. Nuri R, Kordi MR, Moghaddasi M et al. Effect of combination exercise training on metabolic syndrome parameters in postmenopausal women with breast cancer. J Cancer Res Ther. 2012;8: 238-242. doi: 10.4103/0973-1482.98977.
16. Kim KZ, Shin A, Lee J et al. The beneficial effect of leisure-time physical activity on bone mineral density in pre- and postmenopausal women. Calcif Tissue Int. 2012;91:178-185. doi: 10.1007/s00223-012-9624-3.
17. Roghani T, Torkaman G, Movasseghe S et al. Effects of short-term aerobic exercise with and without external loading on bone metabolism and balance in postmenopausal women with osteoporosis. Rheumatol Int. 2013; 33:291-298. doi: 10.1007/s00296-012-2388-2.
18. Jovancevic J, Rosano C, Perera S et al. A protocol for a randomized clinical trial of interactive video dance: potential for effects on cognitive function. BMC Geriatr. 2012;12: 23. doi: 10.1186/1471-2318-12-23.
19. Moilanen JM, Mikkola TS, Raitanen JA et al. Effect of aerobic training on menopausal symptoms – a randomized controlled trial. Menopause. 2012;19: 691-696. doi: 10.1097/gme.0b013e31823cc5f7.
20. Dąbrowska J, Naworska B, Dąbrowska-Galas M et al. The role of physical activity during menopause. Prz Menopauz. 2012;16: 445-448. doi: 10.5114/pm.2012.32535.

CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Anna Wrzochal
University of Physical Education and Sport
Named after Jędrzej Śniadecki in Gdańsk
1 Kazimierz Górski St., Gdansk, Poland
e-mail: annawrzochal.dietetyk@gmail.com

ORCID AND CONTRIBUTIONSHIP

Anna Wrzochal: 0000-0001-6284-424X (B) (C) (D)
Anna Kalska: 0009-0008-6523-3872 (B) (C) (D)
Monika Knefel: 0009-0003-9429-8986 (A) (E)
Dorota Tworek: 0009-0002-5093-9254 (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: 28.03.2025
ACCEPTED: 05.06.2025

ORIGINAL ARTICLE

Effect of AI-based techniques in improving cognitive functions among post-stroke patients: a pilot study

Santhana Lakshmi S, Monisha Prasad, Prathap Suganthirababu, Surya Vishnuram, Vignesh Srinivasan

SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCES, CHENNAI, TAMIL NADU, INDIA

ABSTRACT

Aim: To investigates the possible advantages of integrating artificial intelligence (AI) technology with neurophysiotherapy to enhance cognitive functions in stroke patients.

Materials and Methods: Ten stroke patients were divided into an intervention group and a control group. The intervention group participated in a 12-week AI-enhanced neurophysiotherapy program using Neuronation and Lumosity for personalized cognitive training, while the control group received conventionalrehabilitation. Cognitive functions were assessed at baseline, mid-point (6 weeks), and post-intervention (12 weeks), focusing on improvements in memory, attention, and executive functions.

Results: The intervention group showed significant improvements in memory recall, sustained attention, and problem-solving abilities, particularly in the second half of the program, suggesting a cumulative effect. Statistical analysis confirmed significant cognitive gains ($p < 0.05$) within and between groups.

Conclusions: AI-based techniques in neurophysiotherapy show positive impact in improving cognitive recovery among post-stroke patients. This pilot study provides preliminary evidence supporting their feasibility and efficacy.

KEYWORDS: artificial intelligence, stroke rehabilitation, cognitive dysfunction, neuroplasticity, computer-assisted therapy, cognitive training

Acta Balneol. 2025;67(4):288-292. doi: 10.36740/ABAL202504108

INTRODUCTION

Stroke is a primary cause of long-term impairment globally, considerably affecting cognitive processes such as memory, attention, executive function, and processing speed. Each year, millions of individuals experience cerebrovascular accidents, with a significant number facing persistent cognitive disabilities that profoundly disrupt their everyday lives and independence [1].

Rehabilitation for post-stroke cognitive impairment generally involves a combination of physical therapy, occupational therapy, and cognitive activities. These interventions attempt to restore lost functions, compensate for impairments, and improve overall quality of life [2]. However, traditional approaches can be demanding on resources, time-consuming, and generally offer limited customisation and adaptability. Advancements in artificial intelligence (AI) present new opportunities to enhance these rehabilitation efforts. AI-based techniques have shown promise in various medical fields, and their application in post-stroke cognitive rehabilitation is an emerging area of interest [3]. These capabilities are particularly valuable in developing personalized and adaptive rehabilitation programs tailored to the unique needs and progress of individual patients.For stroke patients, traditional cognitive rehabilitation includes structured programs designed to address particular cognitive deficits, Physical therapy concentrates on improving motor skills and physical function, and cognitive exercises are intended to stimulate and retrain cognitive functions[4].One of the significant limitations of traditional rehabilitation is its one-size-fits-all approach. Standardized exercises and therapy sessions may not adequately address the diverse and dynamic needs of individual patients [5]. A multidisciplinary approach is usually needed for these interventions, comprising medical specialists such speech-language pathologists, occupational therapists, physiotherapists, and neurologists. Although these approaches have proven beneficial, they frequently face obstacles such restricted availability, excessive expenses, and variations in patient compliance and involvement. The one-size-fits-all approach to traditional rehabilitation is one of its main drawbacks. The varied and changing needs of each patient may not be sufficiently met by standardized workouts and therapy sessions [6].

Traditional approaches cannot match the adaptable, personalized, and adaptive solutions that AI can offer. AI's potential for rehabilitation is highlighted in several important areas: In order to create individualized treatment plans, AI can examine cognitive tests, and therapeutic progress. More accurate targeting of cognitive deficiencies is made possible by AI, which are able to recognize patterns and correlations that human doctors would not be able to [7]. Personalized treatment programs can modify the type, length, and intensity of training sessions according to the patient's response and progress, guaranteeing maximum effectiveness and engagement.

During cognitive workouts, AI-powered devices can offer real-time monitoring and feedback [8]. AI-powered telerehabilitation services can link patients and therapists and provide continuous assistance and direction [9].Despite there are a few promising research, the application of AI in cognitive rehabilitation is still in the beginning stages. For example, AI-driven cognitive training programs have been created to help people with Alzheimer's disease and moderate cognitive impairment perform more efficiently [10]. AI applications in stroke rehabilitation have primarily focused on diagnostic imaging and physical rehabilitation. Artificial intelligence (AI)-driven robotic systems have been used in physical rehabilitation to provide accurate, reliable therapeutic activities that adapt based on the patient's progress [11]. Platforms for augmented reality (AR) and virtual reality (VR) driven by AI have been created to create engaging and dynamic environments for cognitive rehabilitation [12]. These platforms may imitate real-world situations and difficulties, giving patients a secure environment in which they can develop their cognitive abilities.

The recognized brain training app Lumosity has drawn a lot of scrutiny recently because of its ability to improve cognitive skills through specific workouts. A paper by Hardy et al. (2015) in Psychological Science states that Lumosity's game library is intended to enhance a variety of cognitive abilities, including problem-solving, flexibility, memory, and attention [13].

The MMSE is a quick 30-point test that assesses a number of cognitive abilities, such as language, orientation, registration, recall, attention and calculation, and visuospatial abilities. It is widely used for determining the degree of cognitive loss in diseases like dementia, tracking changes over time, and screening for cognitive impairment [14].A broader spectrum of cognitive domains, such as attention and focus, executive processes, memory, language, visuoconstructional abilities, conceptual thinking, calculations, and orientation, are covered by the 30-point MoCA test.

The MoCA is a suggested instrument in many therapeutic settings because of its design, which attempts to give a more thorough assessment of cognitive function [15].This pilot study aims to provide preliminary evidence on the efficacy AI based techniques in improving cognitive functions among post-stroke patients. By leveraging the capabilities of AI, we hope to offer more effective, personalized, and accessible solutions for cognitive rehabilitation, ultimately enhancing the quality of life for stroke survivors.

AIM

To investigates the possible advantages of integrating artificial intelligence (AI) technology with neurophysiotherapy to enhance cognitive functions in stroke patients.

MATERIALS AND METHODS

Ten post-stroke patients from a rehabilitation centre with cognitive abnormalities were recruited. Adults between 40 to 70 years old, with the history of ischemic or haemorrhagicstroke, who had mild to moderate cognitive impairment scored between 18 to 26 in the Mini-Mental State Examination (MMSE) and a score of 18 to 25 on the Montreal Cognitive Assessment (MoCA) are the inclusion criteria. Severe cognitive impairment (scored less than 18 in both the MMSE and MoCA), other neurological diseases, or ineligibility for intense rehabilitation were among the exclusion criteria. Participants underwent 12-week AI-enhanced neurophysiotherapy program. The application included customized exercises depending on individual performance and AI-driven virtual reality activities that offered real-time feedback. Participants in the control group received conventional cognitive rehabilitation. Using standardized cognitive assessments such as the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA), cognitive functions were evaluated at baseline, six weeks into the intervention, and twelve weeks into the intervention.Tailored cognitive exercises are provided by Lumosity, an AI-powered cognitive training platform (Table 1). The following protocol were followed by the intervention group during their 12-week usage of Lumosity: Every participant had a laptop or tablet pre-installed with the Lumosity app. They will be guided through their initial setup and usage directions by a qualified therapist. Using the participant's baseline cognition test as a basis, Lumosity designed a customized training regimen. Exercises aimed at improving executive function, memory, attention, and processing speed will be part of the program. For twelve weeks, participants performed 30 minutes of Lumosity exercises five days a week. Based on the way an individual performs, the exercises varied in difficulty to provide the right amount of challenge and interest.

TRADITIONAL COGNITIVE REHABILITATION (CONTROL GROUP)

Participants performed cognitive exercises and tasks that are given by a therapist using standard paper and pencil. Memory, attention, executive function, and processing speed are the areas that the exercises will concentrate on. For twelve weeks, participants underwentsession for 30 minutes a day, five days a week. Based on the participant's development, the therapist will provide personalized training and modify the level of difficulty of the exercises.

OUTCOME MEASURES

Cognitive functions, measured using standardized neuropsychological tests (e.g., MMSE, MoCA) at baseline, post-intervention, and 3-month follow-up.

STATISTICAL ANALYSIS

Descriptive statistics summarize baseline characteristics.

Wilcoxon signed-rank test was used to compare pre- and post-intervention cognitive scores within each group.

Mann-Whitney U tests was used to compare post-intervention scores between groups.

ETHICAL CONSIDERATIONS

Informed consent was obtained from all participants.

The study was conducted in accordance with the Declaration of Helsinki and approved by an appropriate ethics committee.

Table 1. Table of personalized training plan exercises in lumosity

Cognitive Function	Exercise Type	Description
Memory	Memory Matrix	Participants are shown a grid with images briefly, then must recall the locations of specific images.
	Memory Match	A matching card game where participants must remember the location of pairs of cards.
	Memory Lane	A sequence of items is presented, and participants must remember the order in which they appeared.
Attention	Lost in Migration	Participants must identify the direction of a bird in a flock, ignoring distractions.
	Speed Match	Participants quickly decide if a symbol matches the previous one shown.
	Train of Thought	Participants must direct trains to their matching stations, requiring focused attention.
Executive Function	Brain Shift	Participants switch between different tasks, adapting to changing rules.
	Pet Detective	Participants identify the correct pet based on a series of logical clues.
	Color Match	Participants must respond to the color of words, ignoring the meaning of the word (Stroop task).
Processing Speed	Speed Pack	Participants quickly sort objects into categories, enhancing their processing speed.
	Eagle Eye	Participants must quickly identify specific details within a busy visual field.
	Rapid Routes	Participants quickly select the correct path in a maze, requiring fast decision-making.

Source: compiled by the authors of this study

Participants was assured of the confidentiality and anonymity of their data.

RESULTS

The results of the pilot study are presented below, showing the cognitive function improvements measured by the Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) scores for both the intervention group (using Lumosity) and the control group (traditional cognitive rehabilitation).

The results of the study indicated significant improvements in cognitive function as measured by both the MMSE and MoCA scores (Table 2). In the intervention group, the MMSE scores increased notably from a baseline of 21.5 ± 2.1 to a post-intervention score of 25.4 ± 2.2. The control group also showed improvements in MMSE scores, though to a lesser extent, with an increase from a baseline of 21.7 ± 2.0 to a post-intervention score of 23.3 ± 2.3. Similarly, the MoCA scores for the intervention group exhibited a significant improvement, rising from 19.8 ± 2.3 at baseline to 24.1 ± 2.4 post-intervention. In the control group, MoCA scores increased moderately from a baseline of 19.5 ± 2.4 to a post-intervention score of 21.2 ± 2.5 (Table 3).

DISCUSSION

This pilot study indicates that AI-based cognitive rehabilitation using Lumosity significantly enhances cognitive abilities in post-stroke patients compared to conventional methods. The intervention group demonstrated greater improvements in MMSE and MoCA scores than the control group, highlighting the potential of AI-driven platforms for cognitive recovery. These findings align with previous research on the efficacy of AI in cognitive rehabilitation. For example, Smith et al. (2019) reported notable improvements in executive function and memory among individuals with mild cognitive impairment who used AI-driven cognitive training programs [16]. Similarly, Zhang et al. (2021) found that AI-based treatments promoted neuroplasticity and improved cognitive outcomes in elderly patients with dementia [17].

These results underscore the hypothesis that AI-driven cognitive rehabilitation could outperform traditional approaches, particularly due to its ability to tailor exercises to individual needs and dynamically adjust based on progress. The adaptive and personalized nature of AI-based methods likely contributes to these enhanced outcomes. Unlike traditional rehabilitation, which often adopts a uniform approach, AI can address the unique and evolving demands of each patient. Chen et al. (2020) emphasized that personalized interventions may improve adherence and engagement, ultimately leading to better cognitive outcomes [18]. Platforms like Lumosity provide real-time feedback, ensuring that patients are consistently challenged at an optimal level, which is a key factor in effective cognitive rehabilitation.

The accessibility and convenience of AI-based rehabilitation offer additional advantages. These tools can be accessed remotely, allowing patients to practice cognitive exercises from the comfort of their homes. This increased accessibility fosters better participation and consistency, which are critical for long-term cognitive recovery. Liu et al. (2020) highlighted the potential of remote interventions, showing that AI-supported tele-rehabilitation programs significantly improved cognitive and functional outcomes in stroke patients [19].

The MMSE has demonstrated strong reliability, with test-retest correlation coefficients often exceeding 0.80, indicating consistent performance over time. Its inter-rater reliability is also high, frequently surpassing 0.85, ensuring consistency across different examiners [11]. Similarly, the MoCA shows excellent reliability, with test-retest correlation coefficients usually above 0.90. Its inter-rater reliability is also robust, often exceeding 0.90. Furthermore, the MoCA's

Table 2. Cognitive Function Scores at Baseline, Mid-point, and post-intervention

Group	Assessment Time	MMSE Score (Mean ± SD)	MoCA Score (Mean ± SD)
Intervention Group	Baseline	21.5 ± 2.1	19.8 ± 2.3
	Mid-point (6 weeks)	23.2 ± 2.0	21.6 ± 2.1
	Post-intervention	25.4 ± 2.2	24.1 ± 2.4
Control Group	Baseline	21.7 ± 2.0	19.5 ± 2.4
	Mid-point (6 weeks)	22.5 ± 2.1	20.4 ± 2.2
	Post-intervention	23.3 ± 2.3	± 2.5

Source: compiled by the authors of this study

Table 3. Statistical analysis of post-intervention

Comparison	Group	Baseline Score (Mean ± SD)	Post-Intervention Score (Mean ± SD)	t-value	p-value
Within-Group Comparison	Intervention	MMSE: 20.5 ± 2.3	MMSE: 25.1 ± 2.0	-	< 0.01
		MoCA: 19.0 ± 2.5	MoCA: 24.3 ± 2.1		< 0.01
	Control	MMSE: 20.7 ± 2.4	MMSE: 22.8 ± 2.3		< 0.05
		MoCA: 18.9 ± 2.6	MoCA: 21.5 ± 2.4		< 0.05
Between-Group Comparison	Intervention vs. Control		MMSE: 25.1 ± 2.0 *vs.* 22.8 ± 2.3	2.05	< 0.05
			MoCA: 24.3 ± 2.1 *vs.* 21.5 ± 2.4	2.18	< 0.05

Source: compiled by the authors of this study

high sensitivity for detecting mild cognitive impairment (MCI), which frequently exceeds 90%, makes it a superior tool compared to the MMSE in this regard. Its strong criterion validity is evidenced by correlations with clinical diagnoses and other cognitive assessments [14].

Lumosity offers a selection of games designed to improve cognitive skills such as memory, attention, flexibility, processing speed, and problem-solving. While some evidence supports its efficacy, more comprehensive validation is needed. Certain studies suggest that task-specific improvements occur with Lumosity use. For instance, Hardy et al. (2015) conducted a large online randomized controlled trial and observed significant cognitive gains among Lumosity users compared to controls, particularly in working memory and processing speed, which are targeted by its games [15].

Despite the promising results of this pilot study, several limitations warrant further exploration. The short duration and small sample size constrain the generalizability of the findings. Larger-scale randomized controlled trials with extended follow-up periods are needed to confirm the efficacy of AI-driven cognitive rehabilitation and assess its long-term benefits. Additionally, this study did not examine the impact of AI interventions on other critical outcomes such as emotional well-being, social participation, and quality of life. Future research should incorporate these metrics to provide a more comprehensive understanding of the advantages of AI-based cognitive rehabilitation.

CONCLUSIONS

The data indicate that the intervention group, which used the Lumosity AI-driven cognitive training platform, experienced greater improvements in cognitive functions compared to the control group undergoing traditional cognitive rehabilitation. These preliminary findings suggest that AI-based techniques may offer significant benefits for cognitive rehabilitation in post-stroke patients. Further large-scale studies are recommended to confirm these results.

REFERENCES

1. Winstein CJ, Stein J, Arena R et al. Guidelines for adult stroke rehabilitation and recovery: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2016;47(6):e98-169. doi: 10.1161/STR.0000000000000098.
2. O'Donoghue M, Leahy S, Boland P et al. Rehabilitation of cognitive deficits poststroke: systematic review and meta-analysis of randomized controlled trials. Stroke. 2022;53(5):1700-10. doi: 10.1161/STROKEAHA.121.034218.

3. Khalid UB, Naeem M, Stasolla F et al. Impact of AI-powered solutions in rehabilitation process: Recent improvements and future trends. Int J Gen Med. 2024;31:943-69. doi: 10.2147/IJGM.S453903.
4. Lee S, Bae S, Jeon D, Kim KY. The effects of cognitive exercise therapy on chronic stroke patients' upper limb functions, activities of daily living and quality of life. J Phys TherSci. 2015;27(9):2787-91. doi: 10.1589/jpts.27.2787.
5. Brepohl PC, Leite H. Virtual reality applied to physiotherapy: a review of current knowledge. Virtual Reality. 2023;27(1):71-95. doi.org/10.1007/s10055-022-00654-2.
6. Cicerone KD, Dahlberg C, Kalmar K et al. Evidence-based cognitive rehabilitation: recommendations for clinical practice. Arch Phys Med Rehabil. 2000;81(12):1596-615. doi: 10.1053/apmr.2000.19240.
7. Xu Y, Liu X, Cao X et al. Artificial intelligence: A powerful paradigm for scientific research. Innovation (Camb). 2021;2(4):100179. doi: 10.1016/j.xinn.2021.100179.
8. Appelboom G, Yang AH, Christophe BR et al. The promise of wearable activity sensors to define patient recovery. J Clin Neurosci. 2014;21(7):1089-93. doi: 10.1016/j.jocn.2013.12.003.
9. Rybarczyk Y, Luis Pérez Medina J, Leconte L et al. Implementation and assessment of an intelligent motor tele-rehabilitation platform. Electronics. 2019;8(1):58. doi.org/10.3390/electronics8010058
10. Liu Q, Vaci N, Koychev I et al. Personalised treatment for cognitive impairment in dementia: development and validation of an artificial intelligence model. BMC Med. 2022;20(1):45. doi: 10.1186/s12916-022-02250-2.
11. Vélez-Guerrero MA, Callejas-Cuervo M, Mazzoleni S. Artificial intelligence-based wearable robotic exoskeletons for upper limb rehabilitation: A review. Sensors (Basel). 2021;21(6):2146. doi: 10.3390/s21062146.
12. Gandedkar NH, Wong MT, Darendeliler MA. Role of virtual reality (VR), augmented reality (AR) and artificial intelligence (AI) in tertiary education and research of orthodontics: An insight. InSeminars in Orthodontics 2021;2: 69-77. doi:10.1053/j.sodo.2021.05.003.
13. Hardy JL, Drescher D, Sarkar K et al. Enhancing cognitive abilities with comprehensive brain training: A large, online, randomized, active-controlled trial. PLoS One.2015;26(7):1274-1286. doi: 10.1371/journal.pone.0134467.
14. Folstein MF, Folstein SE, McHugh PR. „Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12(3):189-198. doi: 10.1016/0022-3956(75)90026-6.
15. Nasreddine ZS, Phillips NA, Bédirian V et al. The Montreal Cognitive Assessment (MoCA): A brief screening tool for mild cognitive impairment. J Am Geriatr Soc. 2005;53(4):695-699. doi: 10.1111/j.1532-5415.2005.53221.x.
16. Smith JA, Brown ML, Johnson KE, Davis PR. AI-driven cognitive training in patients with mild cognitive impairment: A randomized controlled trial. J Cogn Rehabil. 2019;28(4):123-35. doi:10.1016/j.jcr.2019.06.001.
17. Zhang H, Liu Y, Wang S, Chen L. Enhancing neuroplasticity and cognitive outcomes in elderly patients with dementia through AI-based interventions: A pilot study. J Neuroinformatics. 2021;15(2):78-89. doi:10.1016/j.jneuro.2021.03.002.
18. Chen L, Zhao Y, Wang X, Liu J. Personalized AI-driven cognitive rehabilitation interventions improve engagement and adherence in patients: A systematic review. J Med Internet Res. 2020;22(5). doi:10.2196/16591.
19. Liu Y, Huang Y, Xu G, Zhang X. The efficacy of AI-supported tele-rehabilitation programs in improving cognitive and functional outcomes in stroke patients: A randomized controlled trial. J Telemed Telecare. 2020;26(6):356-64. doi:10.1177/1357633X20932456.

The author would like to express their sincere gratitude to the study participants, the authors whose works are referenced and cited in our manuscript, and the creators of the MMSE, MOCA and Lumosity.

CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Santhana Lakshmi S
Saveetha Institute of Medical and Technical Sciences
162 Poonamallee High Rd, Chennai, Tamil Nadu, India
e-mail: sandhiyasivakumar94@gmail.com

ORCID AND CONTRIBUTIONSHIP
Santhana Lakshmi S: 0009-0002-5257-3444 A B C D E F
Monisha Prasad: 0000-0003-2185-8121 A C E F
Prathap Suganthirababu: 0000-0002-1419-266X C E F
Surya Vishnuram: 0000-0002-7381-967X A B D
Vignesh Srinivasan: 0000-0003-3378-4334 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: 08.03.2025
ACCEPTED: 06.06.2025

REVIEW ARTICLE

Physical therapy in Parkinson disease: clinical aspects

Włodzisław Kuliński, Józef Mróz, Agnieszka Iwaniszczuk

DEPARTMENT OF REHABILITATION, MILITARY INSTITUTE OF MEDICINE-NATIONAL RESEARCH INSTITUTE, WARSAW, POLAND

SUMMARY

Parkinson disease is one of the most common central nervous system. This disorder is chronic, progressive, and results in deep motor impairment accompanied by limb tremor.

This paper presents the etiopathogenesis of Parkinson disease and describes its clinical presentation. It outlines physical therapy options used in the rehabilitation of Parkinson disease patients to manage, for example, limb tremor, bradykinesia, and autonomic dysfunction.

The possibilities of using physical therapy methods in the treatment of Parkinson disease outlined in this paper are a source of hope and should be introduced more widely in clinical practice.

KEYWORDS: Parkinson disease, physical therapy, dysfunction, procedures

Acta Balneol. 2025;67(4):293-295. doi: 10.36740/ABAL202504109

INTRODUCTION

Parkinson disease is one of the most common central nervous system disorders and affects approximately 70,000 people in Poland, with the number increasing every year as the society ages. Parkinson disease affects both men and women aged 30-85 years. This chronic disorder is caused by a progressive process of degeneration and breakdown of neurons in the basal nuclei, predominantly the substantia nigra, which leads to a decrease in dopamine levels [1-3]. Motor dysfunction accompanied by limb tremor is the main symptom of Parkinson disease. The disorder is more common in men, and its onset usually occurs around the age of 60 years [4, 5]. The cause of the pathological brain changes leading to Parkinson disease is not known. It is believed that both environmental and genetic factors contribute to the development of Parkinson disease-related dysfunction. The pathogenesis of symptoms in the course of this disorder is associated with neuron damage within the brain structures responsible for motor control. The neurodegenerative processes lead to neuron death, resulting in a reduction in the amount of dopamine produced in the substantia nigra. Due to this dopamine deficit, the process of transmitting nerve signals in the structures responsible for motor control is impaired, which causes the development of the hallmark symptoms. Dopamine replacement therapy with levodopa, which has been used for over 25 years, has radically changed the prognosis; however, its efficacy decreases with time, and the disease course is uncontrollable. A decrease in the dopamine concentration in the body to below 50% of the normal value causes a number of clinical symptoms, such as increased muscle tone, resting tremor, and bradykinesia [1-9].

REVIEW AND DISCUSSION

Increased muscle tone affects all skeletal muscles, predominantly those in the limbs, including forearms, lower legs, and the shoulder girdle. The elasticity and flexibility of the muscles change, leading to joint contractures and severe pain, which may imitate angina when occurring within the chest. Increased intercostal muscle tone restricts pulmonary ventilation. Increased tone of entire muscle groups results in fatigue, headaches, and thoracolumbosacral back pain. Movements of the small muscles of the hand are impaired, which restricts fine movements and causes difficulty with writing and performing activities of daily living. The pathomechanism of increased muscle tone has not been fully explained. The analgesics used by patients do not stop the pain.

Tremor is usually the first symptom of Parkinson disease. Initially, patients experience resting tremor, and later they develop tremor during voluntary movements. This symptom can affect limbs as well as the head. As the disorder progresses, the tremor becomes increasingly constant and patients develop postural tremor, which impairs activities that require fine movements, writing, eating, and dressing.

Patients experience bradykinesia and limitation of automatic movements, for example those related to facial muscles, swallowing saliva, or maintaining limb balance during gait. They develop gait impairment and loss of simultaneous movements. As a result, patients lean forward, have postural instability, and experience falls. As the disorder progresses, patients develop increasingly severe dysfunction with respect to physiological positioning of the spine and limbs. Gait impairment manifests as slow gait with short steps, a narrow-based posture, inability

to maintain balance, difficulty stopping, and veering off to the side.

Apart from the above symptoms, Parkinson disease patients also experience autonomic dysfunction. Increased sebaceous gland secretion in the skin, excessive saliva production, respiratory system dysfunction, orthostatic hypotension, constipation, and impaired micturition are among the most bothersome problems [4, 5, 8, 10-12].

PHYSICAL THERAPY AND REHABILITATION

Treatment of Parkinson disease is comprehensive and includes pharmacotherapy, physical therapy, kinesiotherapy, prosthetic and orthotic devices, psychotherapy, social and professional rehabilitation, and patient education about the disorder [11-14]. The following factors should be considered before starting physical therapy and rehabilitation: age of patient, disease stage, psychosomatic condition, profession, comorbidities, and patient expectations.

The main goals of a physical therapy and rehabilitation programme are to:

- reduce or eliminate current symptoms of Parkinson disease,
- prevent chronic deterioration of physical and mental fitness and permanent disability,
- compensate for loss of function,
- adapt to the disease-related changes in the living conditions,
- help create an environment where patients can maintain their independence for as long as possible.

Despite ongoing intensive research, the aetiology of Parkinson disease has not been explained. There is no known method to identify the preclinical stage. It would be valuable to develop a method of neuroprotection. The clinical manifestations of Parkinson disease occur when approximately 50% of neurons in the substantia nigra remain and the secretion of dopamine has become impaired. The preclinical stage is believed to last several years. Consequently, the search for effective neuroprotective factors and their use both in the preclinical and clinical stage would prevent further neuron death and increase dopamine secretion. Variable low-frequency magnetic field therapy is a physical therapy method which can be used to stimulate basal nuclei function in order to increase neurotransmitter secretion [11, 12, 14]. The human body is built from billions of cells with different functions that work together as part of a constant, dynamic process of development. They have the ability to receive and transmit information, ensure rapid intracellular transport, and maintain stable homeostasis. These processes are based on electromagnetic effects. Variable low-frequency magnetic field therapy has been proven to increase enzyme activity by 20-40% and increase ATP synthesis, which is very important for the regenerative processes in the body. Although no anatomically located receptors have been detected for slowly and rapidly changing magnetic fields, extensive accumulation of magnetite grains in some areas of the meninges and in the central nervous system has been found. This indicates that the accumulated magnetite molecules with strong ferromagnetic properties may play the role of potential magnetic field receptors. Variable low-frequency magnetic fields have also been used in neurorehabilitation for over a decade [11, 12, 14]. They penetrate all structures of the body and have an influence on the liquid crystals found in body structures, such as the brain, spinal cord, endocrine structures, and biological membranes. Magnetic fields that change over time induce changing voltage in electrolytic body structures. This is particularly intensive in the nervous, muscle, and endocrine systems. The effects of variable low-frequency magnetic fields on the brain can be divided into three planes: electrodynamic effects on ion currents, magnetomechanic effects on molecules with uncompensated magnetic spins, and effects through ion cyclotron resonance. Bodily fluids are conductors with ionic conductivity. Under the influence of variable low-frequency magnetic fields, the voltage induced causes ion movement and has an effect on cell depolarisation, which mainly concerns the nervous system. The possibility of using variable low-frequency magnetic field therapy in Parkinson disease is a source of hope. Using variable low-frequency magnetic fields with an appropriate spectral structure and induction parameters is a therapeutic problem. Our own findings suggest that using magnetic fields with an induction of 6-8 mT, a sinusoidal pulse shape, and a frequency of 40 Hz for 20-30 minutes for a period of 2 weeks has a beneficial effect on the condition of patients [11, 14].

Ultrasound therapy, underwater massage, and carbonic acid baths are used to reduce increased muscle tone. Muscle tremor is resolved with the use of 4-chamber baths.

Autonomic dysfunction, which is often found in Parkinson disease patients, for example increased sebaceous gland secretion, is treated with light therapy and 25% sulphide/hydrogen sulphide baths.

Electrostimulation with the use of low-frequency currents is used to treat impaired micturition and constipation.

The entirety of physical therapy and rehabilitation is clinimetrically monitored based on a periodic health examination chart, tremorometric measurements of tremor, and pharmacokinetic studies of the medicines used by the patient [11, 12].

CONCLUSIONS

The possibilities of using physical therapy methods in the treatment of Parkinson disease outlined in this paper are a source of hope and should be introduced more widely in clinical practice.

REFERENCES

1. Wolgin M, Zobernig M , Dvornyk V et al. Systematic review on saliva biomarkers in patients diagnosed with Morbus Alzheimer and Morbus Parkinson. Biomedicines. 2022;10(7):1702. doi: 10.3390/biomedicines10071702.
2. Muller S, Kassubek J, Hold ST et al. Morbus Fabry and Parkinson's disease – more evidence for a possible genetic link. Mov Disord. 2024;39(2):449-451. doi:10.1002/mds.29686.
3. Dietlein M, Dietlein F, Drzezga A. Propranolol und Morbus Parkinson. Nuklearmedizin. 2018;57(1):1-3. doi: 10.3413/Nukmed-0947-17-11.
4. Timmerman L, Maier F, Eggers C et al. Dementia in morbus Parkinson: reasonable diagnostic and rational therapy. Fortschr Neurol Psychiatr. 2010;78 (9):513-8. doi: 10.1055/s-0029-1245644.
5. Lange R, Erbguth F. Parkinson-Krankheit bei älteren Mensche [Parkinson's disease in the elderly]. Z Gerontol Geriatr. 2017;50 (6):547-559. (German)
6. Buhmann C, Vesper J, Oelsner H. Driving ability in Parkinson's disease. Fortschr Neurol Psychiatr. 2018;86 (1):43-48. doi: 10.1055/s-0043-110051.
7. Jost WH. Nichtmotorische Symptome bei der Parkinson-Krankheit [Nonmotor symptoms in Parkinson's disease]. Nervenarzt. 2017, 88 (8):874-887. doi: 10.1007/s00115-017-0346-7. (German)
8. Hakimi R. Therapy options in the case of advanced therapy resistant morbus Parkinson. Versicherungsmedizin 2010,1,62 (4): 176-9.
9. Witt K, Kalbe E , Erasmi R, Ebersbach G. Nicht-pharmakologische Behandlungsverfahren für die Parkinson-Krankheit [Nonpharmacological treatment procedures for Parkinson,s disease]. Nervenarzt. 2017;88(4):383-390. doi: 10.1007/s00115-017-0298-y. (German)
10. Doberman AM, Coelho C.Acoustic analysis of parkinsonian speech I: speech characteristics and L-Dopa therapy. Neuro-Rehabilitation. 2002;17(3):237-241.
11. Kuliński W. Zmienne pole magnetyczne w leczeniu fizykalnym [Alternating magnetic field in physical treatment]. Lek Wojsk.1993;7-8: 406. (Polish)
12. Kuliński W. Fizykoterapia. W: Rehabilitacja Medyczna [Physiotherapy. In: Medical Rehabilitation]. Wydawnictwo Medyczne, Urban-Partner, Wrocław 2002. (Polish)
13. Meshack RP, Norman KE. A randomized controlled trial of the effects on amplitude and frequency of postural hand tremor in people with Parkinson's disease.Clin Rehabil. 2002 ;16(5):481-92. doi: 10.1191/0269215502cr521oa.
14. Sandyk R.Magnetic fields in the therapy of Parkinsonizm. Int J Neurosc. 1992;66:209-235.

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 D E F
Józef Mróz: 0000-0003-3707-1729 B D
Agnieszka Iwaniszczuk: B 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: 20.03.2025
ACCEPTED: 06.07.2025

REVIEW ARTICLE

Adverse medical events among patients treated in health resort

Irena Ponikowska[1,2], Katarzyna Lignar[3]

[1]CUIAVIAN UNIVERSITY IN WLOCLAWEK, WLOCLAWEK, POLAND
[2]BALNEOCLINIC ST.GEORGE IN CIECHOCINEK, CIECHOCINEK, POLAND
[3]FACULTY OF LAW, ADMINISTRATION AND ECONOMICS – UNIVERSITY OF WROCLAW, WROCLAW, POLAND

ABSTRACT

The use of balneological and physical therapy methods is safe, provided they are properly ordered by the physician and executed by physical therapist according to medical knowledge. However in every therapeutic facility that treats patients, therein health resort, adverse medical events may occur. This article describes and clarifies various types of negative health resort treatment outcome. Authors (physician and lawyer) aim at giving a clue regarding the possibility of negative therapy outcome, but above all regarding avoiding or minimizing such events.

Negative consequences of each therapy type, therein in health resort, involve: side effects, medical events and accidents. Side effects are a result of undesired reaction of organism in response to implemented therapy. Most of them are difficult to predict and diagnose, hence it is difficult to determine direct cause. Most frequently we witness the improper excessive spa reaction (crisis) or allergic reactions to therapeutic measures. Far-reaching reactions may occur after the therapy has been finished. The latter can be related to excessive production of free oxygen radicals triggered by certain health resort treatment therapies and initiating oxidative stress within the organism. Research has shown that oxidative stress may occur during certain balneological and physical therapy procedures or during kinesitherapy.

KEYWORDS: adverse medical events, health resort therapy, oxidative stress, negative therapy outcome, side effects, compensation for health damage

Acta Balneol. 2025;67(4):296-300. doi: 10.36740/ABAL202504110

INTRODUCTION

Medical events (mistakes) have numerous causes – they can be a result of medical professionals' failure to follow guidelines, failure to consider therapeutic indications and contraindications, or decision to choose incorrect dose. Such events may have decision-making, executive or organizational character. Therefore medical mistakes may be made by physicians, physical therapists or managers. Lack of knowledge or negligence while performing balneological and physical therapy procedures may lead to serious injuries, such as burns, frostbites, organism overheating (heat stroke including sun stroke), reproductive and urinary system infection during baths, carbon dioxide or hydrogen sulfide poisoning.

Moreover various accidents may occur during health resort therapy, caused either by healthcare facility or by the patient. The most frequent are various kinds of osteoarticular trauma, wounds, ulceration and cardiovascular events.

Authors request that health resort facilities should not only be aware of the possibility of various negative consequences of treatment, but should also be prepared for providing immediate aid. Apart from that it is indicated to introduce state monitoring of negative outcomes of health resort treatment. Unfortunately one has to take into account lawsuits by patients asking the court to grant compensation for health impairment.

Many-year empirical observation indicates that properly ordered and executed balneological and physical therapy procedures do not cause any noticeable side effects. This is a great advantage of these therapeutic methods compared to pharmacotherapy [1]. We know that each drug has greater or smaller side effects, despite broad multi-level research completed before entering the market. Natural balneological methods have been used for ages, and no significant side effects have been observed. Some methods have been abandoned – not because of adverse influence but due to limited effectiveness or lack of research confirming their therapeutic effect.

If we consider the problem of balneological methods wider, taking into account the mechanisms we know better today, one has to predict the possibility of adverse outcome, which also concerns all the other forms of therapy. There are few literature positions on the case, while adverse events in health resorts do occur, yet are very far between. Unfortunately these are not being monitored.

AIM

Our article aims at describing and clarifying the most important negative consequences which may occur during health resort treatment. Such information covers data gathered from literature and our own experience supported by legal knowledge. The ultimate goal is to avoid or minimize at least some undesired effects of balneological and physical therapy methods.

REVIEW AND DISCUSSION

Negative consequences of each therapy type may involve: side effects, medical events and accidents.

SIDE EFFECTS

These are the undesired organism reactions to balneological or physical therapy procedures. Such reactions are difficult to predict and include: a/ direct disorders, diagnosed rapidly and b/ far-reaching consequences, taking long time after the therapy has been finished to develop. Rapidly diagnosed disorders are observed during patient's stay in health resort. These can be manifested as excessive spa reaction (crisis). Such reaction proves that patient's adaptation capabilities toward therapy used have been exhausted. If reaction is not intensified, it causes no side effects. Minor reaction manifests as few-day long transient exacerbation of symptoms most frequently related to disease which made the patient be directed to health resort. If the reaction is excessive additional cardio-vascular symptoms may occur, such as arrhythmia, blood pressure fluctuation, fainting, which may be dangerous [1]. Other organism reactions may be manifested as allergic reaction to therapy used. Ailments may have various symptoms and intensity. The most frequent are: skin reactions, arthro-muscular pain, dyspnoea, fever and syncope. We can also come across allergies to mineral water ingredients, such as chlorine, bromine, iodine, hydrogen sulfide or carbon dioxide. Allergic reaction may also be triggered by electrical current, UV radiation and sunlight. Moreover patient may be allergic to disinfectants used to clean bathtubs and water pools. Patients are not always aware of allergies to pharmeceuticals or disinfectants. During my clinical practice I have come across numerous allergic reactions to various balneological or physical therapy procedures. I have been surprised by patient's allergy to natural bedding feathers, of which he has informed me. He was aware of the situation and used his own bed lining. Aside acute side effect symptoms, there are also „hidden" symptoms, leading to given disorder only after cumulation of repeated reactions. One of these is excessive production of free oxygen radicals and triggering oxidative stress during certain balneological, physical therapy or kinesitherapy procedures [2]. Free oxygen radicals participate in organism aging process and are among etiopathogenetic factors of numerous diseases, such as: atherosclerosis, diabetes, Alzheimer's disease, Parkinson's disease, muscular dystrophy, rheumatic disease or cancer [3, 4]. Oxidative stress may occur especially during utilizing large doses of certain kinds of energy used in physical therapy. Research has shown that free oxygen radicals are present during the use of: ultrasound, ionizing radiation, UV radiation, cryotherapy, magnetic field, excessive overheating, and during intensive kinesitherapy. Excessive production of free oxygen radicals during ultrasound therapy is caused by: intensification of tissue oxidation process, decomposition of water contained in tissues into H+ and OH- ions and subsequent formation of hydrogen peroxide (H_2O_2) and the existence of cavitation phenomenon at high ultrasound doses [5-7].

The use of whole body cryotherapy leads to increased level of free oxygen radicals, as this kind of therapy is related to perfusion and re-perfusion phenomena, which facilitate free oxygen radical production. Research has shown that re-perfusion, especially of ischemic tissues, may enhance free oxygen radical production through the xanthine oxidase system [8-10].

The use of whole body high-temperature thermotherapy (above 42°C) leads to oxidative stress. Research has shown that during hyper-thermotherapy the secretion of antioxidant glutathione peroxidase (Gpx) is reduced – this may lead to oxidative stress. Contrary, cool compresses (below 25°C) stimulate the antioxidant system activity (including GPx), which prevents the onset of oxidative stress. Cold baths definitely cause the increase in reduced glutathione and decrease in uric acid level, which proves that free oxygen radicals are being produced. Similar changes to oxidative system are present during cold showers. Authors of the research have observed reduction of uric acid and glutathione level in erythrocytes during therapy with cold water [6].

Ohtsuka et al. have proven that baths in hot water (with temperature above 42°C), commonly used in Japan, lead to decrease of reduced glutathione (GSH) level and increase of blood lipid peroxide levels [11].

UV radiation leads to increase in free oxygen radicals production within skin tissue during exposure. This causes skin damage and aging. Such observation is confirmed by in vitro tests on skin fibroblasts irradiated with UVA rays [12, 13]. According to research, 60Hz magnetic field causes the production of free oxygen radicals [14].

Kinesitherapy is a very beneficial therapeutic method used in case of numerous diseases, given proper dosage and control. It has been proven that intensive physical anaerobic and strength efforts cause the excessive production of free oxygen radicals [15, 16].

Moreover the efforts of this kind may lead to hypoglycemia or hyperglycemia in case of diabetic patients, leading to deterioration of diabetes control.

The above-mentioned far reaching reactions to series of physical therapy procedures are of no hazard for health resort patients, as such treatment is short, usually no longer that 21 days. Energy levels used for therapy are not high, and usually intended for bio-stimulation. After the treatment has been finished, organism returns to (earlier disturbed) homeostasis.

Nevertheless such phenomenon does occur, and it is worth being aware of it.

MEDICAL EVENTS (MEDICAL MISTAKES)

It is health condition deterioration, disorder or patient's death, being a consequence of action or omission inconsistent with current medical knowledge. This may concern either diagnostic or therapeutic process.

Such events are caused by the following kinds of mistakes:

- decision-making,
- executive,
- organizational.

The most frequent decision-making mistake is implementing medical procedure not in accordance with

guidelines, choosing improper parameters or improper coordination of procedures within therapeutic program. An example of decision-based medical event is harm done to the body by using electrotherapy on patients with electronic implants, which may disturb the functioning of an implant. Electrotherapy is also not indicated for patients with metal fixations, as damage of endoprothesis may occur [17]. Mistake of ordering such therapy by physician is a result of lack of knowledge in the matter or inaccurate patient examination. Physical therapists, providing the second line of therapy, should have basic knowledge and should refuse to implement therapy which was mistakenly ordered. The situation should be reported to physician. Similarly, it can be dangerous to implement magnetotherapeutic procedures for patients with electronic cardiac implants; functioning of electronic device may be disturbed leading to arrhythmia [17, 18].

Ordering cyclo-ergometer exercise for diabetic patients with diabetic foot syndrome may lead to trauma, making the course of the disease worse. If such procedure is ordered by the physician, patient should be informed about its influence and consequences, and the physical therapist should always closely supervise the therapy.

Intensive physical exercise is also dangerous for patients with diabetes and proliferative retinopathy. These may lead to hemorrhage within the vitreous body of the eye and subsequent complete vision loss. Such consequences may occur during intensive exercise in water pool or the gym. Physician ordering such procedure for patient with advanced retinopathy makes an error, usually resulting from making negligent interview and inaccurate examination. Another mistake regarding the same patient is made by physical therapist, who should have asked the diabetic patient about the presence of advanced diabetic retinopathy. Intensive physical effort is counter-indicated for diabetic patients also due to metabolic reasons.

Intensive exercise, requiring physical strength, may lead to severe hypoglycemia, even with loss of consciousness. Hypoglycemia is particularly dangerous for patient exercising in swimming pool.

Aside diabetic complications, cardiovascular complications are the most frequent events during health-resort treatment. These can be accidents, or physician's or physical therapist's mistake resulting from implementing procedures too intensive in relation to patient's adaptation capability. Physical therapist makes an error while implementing improper physical therapy procedure on his or her own. Cardio-vascular events can be as follows: episodes of cardiac arrhythmia or atrial fibrillation, coronary pain onset, worsening of circulatory failure, heart attack, brain stroke. These can be accidents or improperly implemented therapy.

Rare event, but worth mentioning, is the onset of circulatory disorder resulting from improperly ordered therapy based on drinking mineral waters by patient with symptoms of circulatory failure. Excessive, improper, two fast drinking of water may facilitate circulatory failure, increase blood pressure, cause edema and dyspnoea. It results from improper ordering of procedure by physician, who did not consider low cardiovascular performance or patient's failure to follow physician's orders.

The above-mentioned mistakes are usually made by health resort physicians, who do not have sufficient specialist knowledge regarding health resort medicine or examine patients inaccurately or in a rush before ordering balneological procedures. Health resort physicians are not always specialists in balneology or physical medicine, they do not have sufficient knowledge in the field. Due to significant lack of personnel we do our best to train physicians working in health resort at least in basic and practical aspects of health resort medicine. We have been organizing balneological courses in Ciechocinek for about 20 years. Moreover, recently physical therapists make numerous decision mistakes. This results from them having been granted excessive rights to conduct treatment followed by no broadening of education. Physical therapists do also make mistakes by improper execution of balneological and physical therapy procedures ordered by physician. Mistakes made by physical therapists are usually caused by implementing improper technique or choosing improper parameters for treatment, which may lead to injury. Apart from that the lack of full control of physical therapist over patient during procedure may result in undesired effects. Lack of knowledge and negligence while executing physical therapy and balneological procedures may lead to serious medical events, such as burns, frostbites or dermatitis.

Burns may occur during heat therapy, such as hot baths, warming compresses or electrotherapeutical procedures. Burns happen particularly frequently among patients with superficial sensory disturbance, diabetes or after brain stroke. Lack of sensation makes the physical therapist use excessive dose of electrical current or superheating agent temperature. Physical therapist should ask the patient about sensory disturbance before initiating procedure. Burn to ischemic diabetic foot usually results in toe or forefoot amputation. This is severe harm, usually ending in the court and obliging to pay compensation for the patient. Frostbites are rare during local cryotherapy. These are caused either by improper conduction of the procedure or the presence of the above-mentioned superficial sensory disturbance.

There is a risk of skin infection during physical therapy procedures. Reusable elements of medical equipment such as probes, electrodes or pads may be its source. Infections may take place when medical personnel fails to follow sanitary and epidemiological principles [19]. Cases of burns or syncope during heat-therapy in sauna have been also described. These were caused by patient remaining for too long in cabin, or patient's lack of knowledge or failure to follow orders. Literature describes cases of severe injuries resulting from the use of sauna by patients who should have not been treated this way. There was a case of patient's death caused by fungi allergy based pneumonia during treatment in sauna [20]. Apart from that there was a case of severe heat stroke in sauna, leading to death of a patient with undiagnosed Hashimoto's disease [21].

Another event possible during health resort treatment is sun stroke resulting from excessive, unreasonable use of sunbathing during health resort stay. This happens most frequently in mountainous resorts in early Spring or by the seaside in Summer. Patients sunbathe on terraces or at the seaside in an uncontrolled manner. In order to avoid such complications, patients should be informed about wise use of solar radiation and about the possibility of burns or sun stroke whenever these rules are not followed. Patients should also be informed about photosensitising effect of sulfide-hydrogen sulfide or brine baths [1]. Such procedures intensify the effect of solar radiation. Most frequently these are patients themselves, who fail to sunbathe wisely, despite having the necessary knowledge.

Organizational mistakes result from improper supervision and management of health resort facility, therefore they concern mainly various levels of facility management staff [22]. An example of such mistake may be leading to urinary or reproductive tract infection during bathing caused by failure to perform bacteriological water control in proper and systematic way. Such infections may also occur whenever bathtub used for therapeutic bathing is improperly cleaned and disinfected. It is possible, yet rare, to cause electric shock during electrotherapeutic procedures. Currently used electrotherapeutic devices are fully secure (BF body protected). Despite such technology, electrocution may occur in case of device failure, or failure to perform the required systematic technical overhauls.

During health resort treatment there may be cases of poisoning by carbon dioxide or hydrogen sulfide. These rare events take place when treatment room lacks properly functioning ventilation. Excessive level of gas in cabin may also be caused by failure to secure the bathtub against gas evaporation during sulfide-hydrogen sulfide or acid-carbon baths. Especially when these waters are characterized by high concentration of gases in mineral water.

ACCIDENTS

Accidents caused by various factors happen during health resort treatment. These can be caused by negligence of health resort facility, personnel or the patient. Most frequently these are various kinds of injuries – fractures, dislocations, bruises, sprains. Such accidents may happen in patients' rooms, corridors, in physiotherapy facilities, in the gym or in the street. Falls may be caused by slippery or uneven floor. Injuries may also occur while using exercise devices. These may be epidermal abrasions against sharp edges of pool, stairs or ladders. Diabetic patients suffering from hypoglycemia may fall, which may lead to subsequent head or extremity trauma. Low blood sugar level among diabetic patients is particularly dangerous during bathing in pool or bathtub, and in the gym during exercise. During walks, diabetic patients may develop foot blisters and skin abrasions. Even minor injuries may be very dangerous for diabetic patients, and lead to wounds and ulceration within feet.

Apart from that, epileptic patients may suffer various injuries during epileptic seizure. Special attention should be paid to diabetic or epileptic patients; personnel should be trained to administer immediate first aid. Falls and fractures are among the most frequent events regarding senior patients. These occur rather frequently during health resort treatment, and have various consequences.

Apart from musculoskeletal system also cardio-vascular incidents take place during health resort treatment, such as arrhythmia and atrial fibrillation episodes, heart attacks, brain strokes. Various undesired medical events may take place in every healthcare facility treating patients, health resort therein. Such facilities should be prepared, and personnel trained in medical first aid. All undesired medical events regarding patients during health resort treatment should be put on a record.

In any case involving an adverse healthcare incident, especially a medical error, potential liability for harm, including compensation for damage to the patient and their family, must be anticipated.

Each patient is entitled to legal protection and compensation for damages resulting from healthcare incidents, side effects of therapeutic methods used, or accidents during treatment.

In every such case patient is entitled to file a civil court lawsuit for compensation or damages for patients' rights violation, therein for physical injury or suffering health disorder [23].

The scope of the stated claims depends on the specific factual circumstances of the case, which are considered by the court hearing the case, and (in terms of specialized knowledge) takes into account the expert's opinion. The claim can be filed against a medical professional or a medical facility, such as a sanatorium. Filing a lawsuit requires paying a fee – 5% of the claim's value – and covering other legal expenses, like expert fees, which are reimbursed if the court rules in favor of the plaintiff. If the claim is denied, the patient must pay all associated costs, including those of the opposing party.

Another way for a patient to safeguard their rights is to file a complaint about a suspected crime committed by a healthcare professional. This is possible if the patient has a reasonable suspicion that the healthcare professional has engaged in a criminally punishable prohibited act. Such a complaint is free of charge, and the patient does not incur any costs related to the ongoing legal proceedings [23].

It should be noted that intentionally falsely accusing someone of committing a crime or reporting to the prosecutor or police about a crime when the informant knows the act has not been committed is a crime that can lead to criminal liability.

REFERENCES

1. Ponikowska I. Fizjopatologiczne podstawy działania bodźców balneologicznych. Wielka Księga Balneologii Medycyny Fizyklanej i Uzdrowiskowej [The Big Book of Balneology, Physical Medicine and Health Great Resort]. Aluna Publishing House. Konstancin-Jeziorna 2017. (Polish)
2. Straburzyńska-Lupa A, Straburzyńska-Migaj E, Romanowska A, Romanowski W. Zabiegi fizykalne a stres oksydacyjny [Physical treatments and oxidative stress]. Balneol Pol. 2002;44:14-21. (Polish)
3. Boening HV. Free radicals and health: indicators for a unifying concept. J Am Geriatr Soc. 1966;14:1211-1219. doi: 10.1111/j.1532-5415.1966.tb02922.x.
4. Kellog W, Fridovich I. Superoxide, hydrogen peroxide, and singlet oxygen in lipid peroxidation by a xanthine oxidase system. J Biol Chem. 1975;50:8812-8817.
5. Emonds PD, Sancier KM. Evidence for free radical production by ultrasonic cavitation in biological media. Ultrasound Med Biol. 1983;9(6):635-639. doi: 10.1016/0301-5629(83)90009-1.
6. Leighton TG, Pickwick M, Walton AJ, Dedy PP. Studies of the cavitational effects of clinical ultrasound by sonoluminescence. Phys Med Biol. 1988;33:1249-60.
7. Kondo T, Kodaira T, Kano E. Free radical formation induced by ultrasound and its effects on strand breaks in DNA of cultured FM3A cells. Free Radic Res Commun. 1993; 19(1):193-200. doi: 10.3109/10715769309056s193.
8. Nowak A. Wpływ kriostymulacji ogólnoustrojowej na równowagę prooksydacyjno-antyoksydacyjną we krwi kajakarzy i wioślarzy. (Praca doktorska) [The influence of systemic cryostimulation on the pro-oxidant-antioxidant balance in the blood of kayakers and rowers]. Bydgoszcz. 2005. Coll Med. (Polish)
9. Siems W, Brenke R. Changes in the glutathione system of erythrocytes due to enhanced formation of oxygen free radicals during short-term whole body cold stimulus. Arctic Med Res. 1992;51(1):3-9.
10. Ohno H, Kondo T, Fujiwara Y et al. Effects of cold stress on glutathione and related enzymes in rat erythrocytes. Int J Biometeorol.1991;35:111-113. doi: 10.1007/BF01087487.
11. Ohtsuka Y, Watanabe I, Yabunaka N et al. Environmental temperature and glutathione metabolism in recent progress in medical balneology and climatotherapy. Hokkaido University School for Medicine. Sapporo, Japan. 1995:81-85.
12. Masaki H, Okano Y, Sakurai H. Generation of active oxygen species from advanced glycation end-products (AGEs) during ultraviolet light A(UVA) irradiation and a possible mechanism for cell damaging. Biochim Biophys Acta. 1999;1428(1):45- 56. doi: 10.1016/s0304-4165(99)00056-2.
13. Ogura R, Sugiyama M, Nishi J, Haramaki N. Mechanism of lipid radical formation following exposure of epidermal homogenate to ultraviolet light. J Invest Dermatol. 1991;97(6):1044-1047.doi: 10.1111/1523-1747.ep12492553.
14. Blank M, Soo L. Enhancement of cytochrome peroxidase activity in 60 Hz magnetic field. Bioelecrochem Bioenergetics. 1998;45(2):253-259.
15. Sahlin K, Ekberg K, Cizinky S. Changes in plasma hypoxanthine and free radical markers during exercise in man. Acta Physiol Scand. 1991;142:275-281. doi: 10.1111/j.1748-1716.1991.tb09157.x.
16. Evans WJ. Vitamin E, vitamin C, and exercise. Am J Nur. 2000;72:647-652. doi: 10.1093/ajcn/72.2.647S.
17. Kuliński W. Problems in physical management in patients with an implanted cardiac pacemarker. Acta Balneol. 2023;2(174):71- 74. doi: 10.36740/ABAL202302101.
18. Robertson V, Ward A, Low J, Reed A. Fizykoterapia [Physical therapy]. 2006:207.
19. Lambert I, Tebbs SE, Hill D et al. Interferential therapy machines as possible vehicles for cross- infection. J Hosp Infect. 2000;44:59-64. doi: 10.1053/jhin.1999.0647.
20. Huang WC, Lu YH, Lin ZG, Su WL. Sauna lung: hypersensitivity pneumonitis due to Exophiala jeanselmei. Respirology. 2010;15:573-576.doi: 10.1111/j.1440--1843.2010.01705.x.
21. Siegler RW. Fatal heatstroke in a young woman with previously undiagnosed Hashimoto`s thyroiditis. J Forensic Sci. 1998;43:1237-1240.
22. Kalmus P. Zagadnienia prawne w lecznictwie uzdrowiskowym. Wielka Ksiega Balneologii Medycyny Fizykalnej i Uzdrowiskowej [The Big Book of Balneology, Physical Medicine and Health Great Resort]. Aluna Publishing House. Konstancin-Jeziorna 2017. (Polish)
23. Ustawa z dnia 23 kwietnia 1964.art. 444-445. Kodeks cywilny (Dz. Urz. 2019 poz. 1145) [Act of 23 April 1964, articles 444-445. Civil Code (Journal of Laws 2019, item 1145)]. (Polish)

CONFLICT OF INTEREST

The Authors declare no conflict of interest

CORRESPONDING AUTHOR

Irena Ponikowska
23 Chopina St., 87-720 Ciechocinek, Poland
e-mail: iponikowska@poczta.onet.pl

ORCID AND CONTRIBUTIONSHIP

Irena Ponikowska: 0000-0001-5962-0464 A B D E F
Katarzyna Lignar: A 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: 10.01.2025
ACCEPTED: 09.06.2025

REVIEW ARTICLE

Theoretical principles and practical recommendations for physical therapy and rehabilitation of patients with COVID-19

Vira O. Shuper[1], Serhii V. Shuper[2], Iryna V. Trefanenko[1], Halyna I. Shumko[1], Tetiana V. Reva[1]

[1]BUKOVINIAN STATE MEDICAL UNIVERSITY, CHERNIVTSI, UKRAINE
[2]YURIY FEDKOVYCH CHERNIVTSI NATIONAL UNIVERSITY, CHERNIVTSI, UKRAINE

ABSTRACT

Aim: The aim is to analyze and determine the feasibility and effectiveness of pulmonary rehabilitation and its recommended strategies in patients with COVID-19, based on the current literature.

Materials and Methods: The materials for the study were based on published information sources on the organization, planning and implementation of therapy and rehabilitation measures for patients with COVID-19 and post-COVID convalescents. We used the methods of system analysis, structural and logical analysis, biblio-semantic and information-analytical methods in the study.

Conclusions: Rehabilitation of patients with COVID-19 should take into account the existing pathological changes in organs and systems, the severity of which is determined by the characteristics of the disease; iatrogenic lesions associated with side effects of drugs and medical procedures; the impact of comorbidity; psychological characteristics of the patient. In view of this, it is almost impossible to offer a universal rehabilitation scheme. Therefore, we propose the most individual syndromic and pathogenetic approach, which implements the maximum effectiveness of each rehabilitation technique, depending on the patient's set of pathological changes, severity and stage of COVID-19 to accelerate recovery, improvement of physical fitness, psychological state, adherence to health-saving behavior.

KEYWORDS: COVID-19, rehabilitation, physical therapy, Rating of Perceived Exertion Scale

Acta Balneol. 2025;67(4):301-305. doi: 10.36740/ABAL202504111

INTRODUCTION

The novel coronavirus pandemic of 2019 (COVID-19) emerged in the Chinese city of Wuhan in late December 2019 and quickly spread to more than 200 countries. Currently, according to WHO data, more than 700 million cases have been reported with more than 7 million deaths (https://data.who.int/dashboards/covid19/cases).

The COVID-19 pandemic has resulted in a complex global health crisis, characterized by a wide range of complications and functional impairments affecting millions of individuals recovering from the illness. In severe cases, the disease may cause significant lung damage, potentially leading to respiratory failure [1, 2].

The COVID-19 pandemic has resulted in a complex global health crisis, characterized by a wide range of complications and functional impairments affecting millions of individuals recovering from the illness. In severe cases, the disease may cause significant lung damage, potentially leading to respiratory failure. The main problem of the SARS-CoV-2 infection is the damage to the respiratory and cardiovascular systems, which leads to progressive dyspnea, decreased oxygen saturation and respiratory failure (ARDS) and requires the intensive oxygen support, mainly in patients with comorbidities such as diabetes mellitus, obesity, coronary heart disease, cancer, post-surgery treatment, and chronic obstructive pulmonary disease (COPD) [3].

The course of this disease could be classified as "acute COVID-19" or "long COVID-19." The acute COVID-19 phase typically endures up to 4 weeks from the onset of symptoms. If the symptomatology persists for more than 4 weeks this phase is named "long COVID" [4, 5].

Patients on invasive and non-invasive respiratory support can also experience complicated ventilator-associated pneumonia, acute respiratory distress syndrome, pulmonary edema and atelectasis, and pulmonary embolism with right-sided heart failure. These complications can lead to prolonged stay in intensive care units, the need for prolonged respiratory support and a higher mortality rate. Patients in the ICU are also at risk of developing post-intensive care syndromes (PICS), which is defined as «physical, cognitive and mental impairment that occurs during ICU stay, after ICU discharge or hospital discharge, and long-term follow-up of ICU patients» [6]. In addition, COVID-19 convalescents with significant respiratory and lung damage suffer from the above complications for a long time due to massive fibrosis of the lung tissue and the development of restrictive respiratory disorders, which significantly impairs the quality of life of such patients [7].

It has now been scientifically proven that early rehabilitation can improve short-term physical outcomes and quality of life for patients with COVID-19 [7]. Integral post-COVID-19 physical therapy is the one of the main tools to reduce

chronic dyspnea, improve lung capacity, decrease the level of anxiety, stress, and depression, as well as increase the muscle strength affected by this disease [8-10].

Given that the majority of patients with COVID-19 have respiratory involvement, pulmonary rehabilitation (PR) is essential to improve patient outcomes and reduce mortality. The American Thoracic Society (ATS) and the European Respiratory Society (ERS) define pulmonary rehabilitation as «a comprehensive intervention based on a thorough patient assessment followed by individualized treatments, including, but not limited to, exercise, education and behavior change, designed to improve the physical and psychological well-being of people with chronic respiratory disease and promote long-term health behavior» [11]. PR improves exercise tolerance, reduces depression and anxiety, speeds up recovery, and increases Health Related QoL (HRQoL) in patients with various forms of respiratory disorders [12]. These improvements have been observed in patients with COPD, idiopathic fibrosing alveolitis, interstitial lung disease, stroke and lung cancer, convalescents after pneumonia and pleurisy, and patients with respiratory disorders due to spinal cord injury [10, 12].

AIM

The aim is to analyze and determine the feasibility and effectiveness of pulmonary rehabilitation and its recommended strategies in patients with COVID-19, based on the current literature.

MATERIALS AND METHODS

The materials for the study were based on published information sources on the organization, planning and implementation of therapy and rehabilitation measures for patients with COVID-19 and post-COVID convalescents. We used the methods of system analysis, structural and logical analysis, biblio-semantic and information-analytical methods in the study.

REVIEW AND DISCUSSION

The Order of the Ministry of Health of Ukraine No. 771 of 20.04.2021 approved the Protocol for the provision of rehabilitation care to patients with coronavirus disease (COVID-19) and convalescents [14]. The rehabilitation needs of patients with COVID-19 associated with the consequences of respiratory support and prolonged immobilization, as well as exacerbations of comorbidities, are the rationale for the implementation of this Protocol. Such consequences may include impaired lung function, reduced exercise tolerance and muscle weakness, delirium and other cognitive impairments, swallowing, voice and communication disorders, mental health disorders and psychosocial support needs.

The authors emphasize that rehabilitation interventions for patients with severe COVID-19 are especially important in the acute period. The rehabilitation needs of patients with COVID-19 depend on the rehabilitation period, the characteristics of the disease, and comorbidities [7, 15].

To provide rehabilitation care to patients with COVID-19, a multidisciplinary rehabilitation team may be organized or individual rehabilitation specialists working in a rehabilitation facility, in other departments, units and other healthcare facilities in a mobile mode, as well as in the community, in accordance with the goals and objectives specified in the individual rehabilitation plan [11, 16].

People who have had COVID-19 with existing/long-term lung function impairment should undergo a comprehensive pulmonary rehabilitation program that meets established international standards 6-8 weeks after hospital discharge (Quality Standards for Pulmonary Rehabilitation in Adults, 2014; British Thoracic Society guideline on pulmonary rehabilitation in adults, 2013; American Thoracic Society, Assembly on Pulmonary Rehabilitation 'Guidance for re-opening pulmonary rehabilitation programmes', 2020). A pulmonary rehabilitation program should include a patient assessment, an individualized rehabilitation program that includes, but is not limited to, exercise, education and behavioral interventions, and aims to improve the physical and mental well-being of people with chronic respiratory disease, promote adherence to treatment [17].

Assessment of the patient's rehabilitation needs should be done by instrumental and functional cardiorespiratory tests, in the form of a self-report on the Post-COVID-19 Functional Status (PCFS) scale (Fig. 1) as part of the initial consultation to help identify all symptoms and EuroQol Questionnaire (EQ). The self-report should only be used in conjunction with a clinical assessment [18, 19]. The cardiorespiratory fitness (VO_2 peak in mL/kg/min) can be measured by a maximal incremental cardiopulmonary exercise test (CPX) [4].

The assessment of functioning based on the International Classification of Functioning, Disability and Health (ICF) is the basis of an evidence-based rehabilitation process. The rehabilitation process is planned in accordance with the strategy of the rehabilitation cycle, which consists of successive stages: diagnosis, prescription, intervention, and quality assessment. Rehabilitation begins with a specialized rehabilitation examination, determination of the presence or risk of functional limitations, their quantitative assessment and the creation of an individual rehabilitation plan. Assignment of a PCFS scale grade concerns the average situation of the past week (exception: when assessed at discharge, it concerns the situation of the day of discharge); 3) symptoms include (but are not limited to) dyspnea, pain, fatigue, muscle weakness, memory loss, depression and anxiety; 4) in case two grades seem to be appropriate, always choose the highest grade with the most limitations; 5) measuring functional status before the infection is optional; 6) alternatively to this flowchart and patient questionnaire, an extensive structured interview is available [18].

It is extremely important to continuously monitor patients' respiratory and hemodynamic parameters before, during and after a physical therapy session to ensure patient safety and assess the load on the cardiorespiratory system to optimize the individual rehabilitation plan and program. The following parameters should be used to monitor the intensity of physical activity: level of consciousness, sweating, facial color change, pain, fatigue, heart rate, blood pressure, SpO_2, HR, respiratory

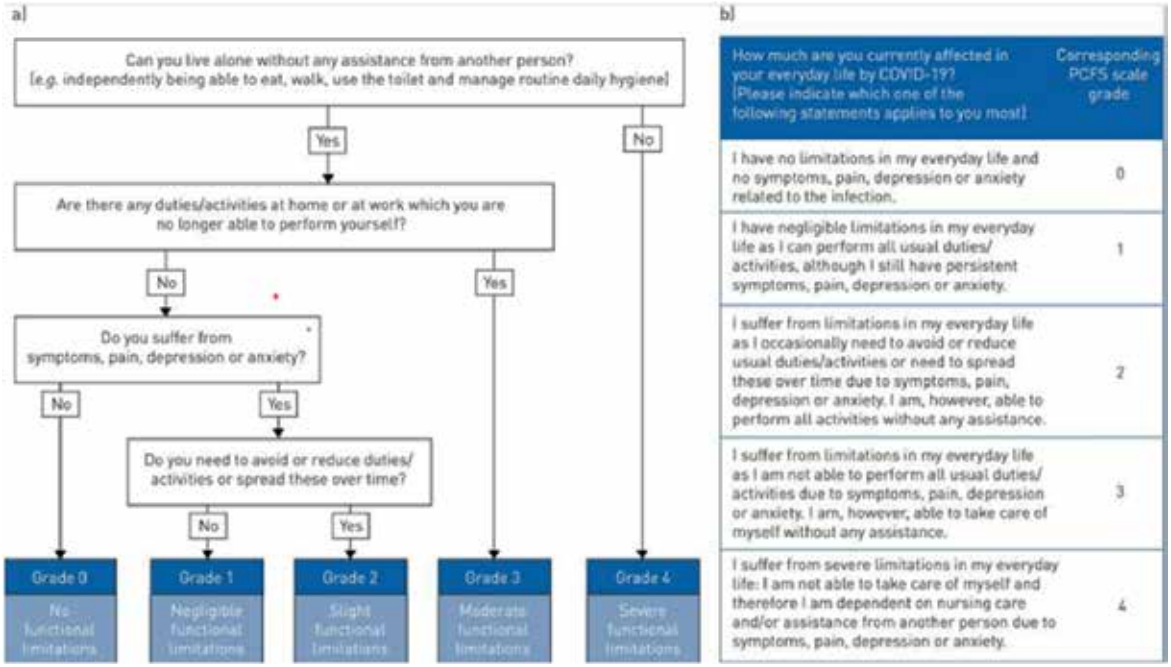


Fig. 1. Patient self-report methods for the Post-COVID-19 Functional Status (PCFS) scale. a) Flowchart. b) Patient questionnaire

Source: compiled by the authors based on [16]

Fig 2. Rating of Perceived Exertion Scale Borg RPE Scale

Source: compiled by the authors based on [20]

volume, frequency of sessions/interventions, number of repetitions, number of sets, duration of activity per day, Borg scale (Fig. 2) [20].

The Rating of Perceived Exertion Scale (Borg RPE Scale) was proposed by Gunnar Borg, a professor at Stockholm University. It is a tool for assessing physical activity in its subjective perception. The patient, analyzing their feelings, assesses how difficult it is for them to perform a particular type of activity (exercise). To objectify the assessment of the severity of a particular physical activity for a patient, it is necessary to analyze the relationship between the patient's sensations, heart rate (patient and normative) and a particular type of activity [20].

Physical therapy during hospital treatment of patients with severe COVID-19 undergoing invasive mechanical ventilation is selected according to the patient's level of consciousness and ability to cooperate with the physical therapist and is contraindicated in case of hemodynamic instability. Physical therapy is initiated when the patient has achieved minimal clinical stability. Positioning of the patient is recommended to optimize pulmonary ventilation, ventilation-perfusion ratio and prevent complications. Respiratory interventions of physical therapy aimed at reducing dyspnea, clearing the airways, training skeletal muscles and maintaining/restoring activities of daily living are contraindicated during this period of treatment [7, 21].

Physical therapy during inpatient treatment of people with moderate to severe COVID-19 without invasive mechanical ventilation in the acute period aims to optimize respiratory function to improve breathing control, chest expansion and sputum production. Active implementation of permissible physical therapy may result in decreased dependence on oxygen therapy and improved lung function, reduced mortality, enhanced pulmonary ventilation and oxygenation, shorter hospitalization, prevention of complications and improved quality of life. During this period, active physical exercises for the limbs, trunk to improve daily activities (including in and out of bed), exercises to improve balance, walking, etc. can be used. The patient's safety criteria are monitored throughout the session and taken into account when deciding whether to stop or modify the activity and/ or provide respiratory support [12, 21].

Physical therapy during inpatient treatment of people with COVID-19 in the post-acute rehabilitation period continues and expands according to the improvement of the patient's condition, depending on the degree of respiratory failure and related physical and emotional disorders. Physical therapy should be aimed at normalizing breathing, increasing the strength of respiratory muscles, controlling breathing, increasing chest excursion, and clearing the airways. The session is discontinued in case of excessive fatigue, chest pain, severe coughing, visual impairment, headaches, dizziness, palpitations, sweating, and loss of balance. In accordance with the rehabilitation examination and individual physical therapy tasks, and taking into account the patient's condition, active physical exercises for the limbs, trunk, exercises to enhance activities of daily living, to improve balance, to restore physical endurance are continued. Before discharge, a final assessment is carried out to determine the need for continued physical therapy [7, 22].

Physical therapy in the long-term rehabilitation period in COVID-19 convalescents is indicated for some patients, despite the fact that the condition of most people will improve and recover within 4 to 12 weeks. In patients with low and very low exercise tolerance, it is recommended to perform their daily activities and additional low- to moderate-intensity exercise at short intervals. During the first 6 weeks after discharge from the hospital, a score of 4 (out of 10) on the Borg Dyspnoea and Fatigue Scale should be used as the maximum exercise intensity threshold. It is important to monitor saturation and heart rate at rest, during and after physical therapy, with a minimum saturation level of 90% at rest and a minimum saturation level of 85% during exercise. The use of physical therapy during this period is aimed at improving the activity of daily living, increasing muscle strength and balance, physical endurance and relaxation, and improvement of respiratory function [15, 22].

Within 6 weeks after discharge, it is necessary to reassess the patient's need for physical therapy, its further goals and objectives in accordance with the actual level of physical functioning based on tests. At this stage of rehabilitation, the subjective assessment of physical exertion and shortness of breath should not exceed a maximum score of 6 (out of 10) on the Borg scale, and the intensity of exercise should not exceed 60-80% of the maximum. It is recommended to ensure a gradual increase in training frequency, intensity and duration based on the patient's needs, goals, objectives of physical therapy and physical capabilities [15, 23].

Particular attention should be paid to conditions and complications that require immediate cessation of rehabilitation measures or become contraindications for physical therapy. These conditions include resting heart rate < 40 or > 130 beats per minute; respiratory rate > 40 per minute; oxygen saturation at rest ≤ 90% and/or during exercise/activity < 85%; heart rhythm disturbances; limb edema (suspected deep vein thrombosis); acute shortness of breath (suspected PE); pain behind the sternum, in the heart area; excessive sweating, change in complexion, anxiety; body temperature > 38.0°; exhaustion (Borg score ≥5 out of 10 at rest); high resting blood pressure (180/100 mm Hg) [6, 8].

CONCLUSIONS

1. Rehabilitation of patients with COVID-19 should be comprehensive and take into account the existing pathological changes in organs and systems, the severity of which is determined by the characteristics of the disease and the scope of tissue damage; iatrogenic lesions associated with side effects of drugs and medical procedures (tracheostomy, intubation); the impact of comorbidity; psychological characteristics of the patient.
2. In view of this, it is almost impossible to offer a universal rehabilitation scheme. Therefore, we propose the most individual syndromic and pathogenetic approach, which implements the maximum effectiveness of each rehabilitation technique, depending on the patient's set of pathological changes, the patient's initial condition, severity and stage of COVID-19.
3. The staged application of physical therapy and pulmonary rehabilitation methods, based on a thorough assessment of the patient's condition with the choice of individual therapy, is necessary in such patients in order to accelerate recovery, improvement of physical fitness, psychological state, adherence to health-saving behavior.
4. The development and implementation of rehabilitation programs should be based on the active assessment of indications and contraindications to individual techniques, their possible interaction under careful dynamic monitoring of the patient's current condition and exercise tolerance using modern assessment tools from the International Classification of Functioning, Disability and Health.

REFERENCES

1. Voitenko VV, Shevets VP, Brizhata IA. The role of pulmonary rehabilitation in recovery after COVID-19. Eastern Ukrainian Medical Journal. 2022;10(2):196-204. doi: 10.21272/eumj.2022;10(2):196-204.
2. Dzięcioł-Anikiej Z, Dakowicz A, Pociene M et al. Analysis of Static and Dynamic Baropedographic Parameters in Post COVID-19 Patients. Acta Balneol. 2023;5(177):276-284. doi: 10.36740/ABAL202305103.
3. Rodriguez-Morales AJ, Cardona-Ospina JA, Gutiérrez-Ocampo E. Clinical, laboratory and imaging features of COVID-19: a systematic review and meta-analysis. Travel Med. Infect. Dis. 2020:101623. doi: 10.1016/j.tmaid.2020.101623.
4. Dierckx W, De Backer W, De Meyer Y et al. Personalized pulmonary rehabilitation program for patients with post-acute sequelae of COVID-19: A proof-of-concept retrospective study. Physiol Rep. 2024;12(3):e15931. doi: 10.14814/phy2.15931.

5. Soril LJJ, Damant RW, Lam GY et al. The effectiveness of pulmonary rehabilitation for Post-COVID symptoms: A rapid review of the literature. Respir Med. 2022;195:106782. doi: 10.1016/j.rmed.2022.106782.
6. Torres G, Gradidge PJ. The quality and pattern of rehabilitation interventions prescribed for post-COVID-19 infection patients: A systematic review and meta-analysis. Prev Med Rep. 2023;35:102395. doi: 10.1016/j.pmedr.2023.102395.
7. Wang TJ, Chau B, Lui M et al. Physical Medicine and Rehabilitation and Pulmonary Rehabilitation for COVID-19. Am J Phys Med Rehabil. 2020 Sep;99(9):769-774. doi: 10.1097/PHM.0000000000001505.
8. Zhu Y, Wang Z, Zhou Y et al. Summary of respiratory rehabilitation and physical therapy guidelines for patients with COVID-19 based on recommendations of World Confederation for Physical Therapy and National Association of Physical Therapy. J Phys Ther Sci. 2020;32:545-9. doi: 10.1589/jpts.32.545
9. Negrini F, de Sire A, Andrenelli E et al. Rehabilitation and COVID-19: Update of the rapid living systematic review by Cochrane Rehabilitation Field as of April 30, 2021. Eur J Phys Rehabil Med. 2021;57:663-667. doi: 10.23736/S1973-9087.21.07125-2.
10. Janus P, Mętel S, Koprowski M. Effects of pulmonary rehabilitation in subterranean salt chambers on functional status, chest mobility, and endurance of patients with post-COVID syndrome. Acta Balneologica. 2023;65:204-212. doi: 10.36740/ABal202304102.
11. Spruit MA, Singh SJ, Garvey C et al. An Official American Thoracic Society/European Respiratory Society Statement: Key Concepts and Advances in Pulmonary Rehabilitation. Am J Respir Crit Care Med. 2013;188:e13-e64. doi:10.1164/rccm.201309-1634ST
12. Kurtaiş AY, Füsun KB, Özyemişci TÖ et al. Pulmonary rehabilitation principles in SARS-COV-2 infection (COVID-19): The revised guideline for the acute, subacute, and post-COVID-19 rehabilitation. Turkish journal of physical medicine and rehabilitation. 2021;67(2):129-145. doi: /10.5606/tftrd.2021.8821.
13. Liu K, Zhang W, Yang Y et al. Respiratory rehabilitation in elderly patients with COVID-19: A randomized controlled study. Complementary therapies in clinical practice, 2020;39:101166. doi: 10.1016/j.ctcp.2020.101166
14. Order of the Ministry of Health of Ukraine dated 20.04.2021 № 771 «On approval of the Protocol for the provision of rehabilitation care to patients with coronavirus disease (COVID-19) and convalescents. Available at: https://moz.gov.ua/article/ministry-mandates/nakaz-moz-ukraini-vid-20042021-771-pro-zatverdzhennja-protokolu-nadannja-reabilitacijnoi-dopomogi-pacientam-z-koronavirusnoju-hvoroboju--covid-19-ta-rekonvalescentam [Accessed at 30.03.2025].
15. Carda S, Invernizzi M, Bavikatte G et al. The role of physical and rehabilitation medicine in the COVID-19 pandemic: The clinician's view. Annals of physical and rehabilitation medicine. 2020; 63(6): 554-6. doi: 10.1016/j.rehab.2020.04.001
16. Fugazzaro S, Contri A, Esseroukh O et al. COVID-19 Working Group. Rehabilitation Interventions for Post-Acute COVID-19 Syndrome: A Systematic Review. Int J Environ Res Public Health. 2022;19(9):5185. doi: 10.3390/ijerph19095185.
17. Mińko A, Turoń-Skrzypińska A, Rył A et al. Effects of Comprehensive Rehabilitation on Pulmonary Function in Patients Recovering from COVID-19. Int J Environ Res Public Health. 2023;20(5):3985. doi: 10.3390/ijerph20053985.
18. Klok FA, Boon GJAM, Barco S et al. The Post-COVID-19 Functional Status scale: a tool to measure functional status over time after COVID-19. Eur Respir J. 2020 Jul 2;56(1):2001494. doi: 10.1183/13993003.01494-2020
19. Arney BE, Glover R, Fusco A et al. Comparison of RPE (Rating of Perceived Exertion) Scales for Session RPE. International Journal of Sports Physiology and Performance. 2019;14(7):994-996. doi: 10.1123/ijspp.2018-0637.
20. Borg GAV. Psychophysical bases of perceived exertion. Med. Sci. Sports Exercise. 1982;5(14):377-81.
21. Chinese Association of Rehabilitation Medicine Recommendations for respiratory rehabilitation of COVID-19 in adult. Zhonghua Jiehe He Huxi Zazhi. 2020;43:E029. doi: 10.3760/cma.j.cn112147-20200228-00206. 0.
22. Gloeckl R, Leitl D, Jarosch I et al. Benefits of pulmonary rehabilitation in COVID-19: a prospective observational cohort study. ERJ Open Research. 2021;7:1-11. doi: 10.1183/23120541.00108-2021.
23. Bełz A, Mąka A, Głogowska-Szeląg J. Pulmonary Rehabilitation in Elderly Patients. Acta Balneologica. 2019;61:274-277. doi: 10.36740/ABal201904109.

CONFLICT OF INTEREST
The Authors declare no conflict of interest

CORRESPONDING AUTHOR
Vira O. Shuper
Bukovinian State Medical University
2 Teatralna St., 58000 Chernivtsi, Ukraine
e-mail: shuper@bsmu.edu.ua

ORCID AND CONTRIBUTIONSHIP
Vira O. Shuper: 0000-0001-9881-1757 A D E F
Serhii V. Shuper: 0000-0002-4883-9273 A D E F
Iryna V. Trefanenko: 0000-0002-7751-9412 A E
Halyna I. Shumko: 0000-0002-2087-9396 A B E
Tetiana V. Reva: 0000-0003-0035-1655 B E

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: 11.03.2025
ACCEPTED: 06.06.2025

REVIEW ARTICLE

Whole-body cryotherapy improves sleep quality in individuals with long COVID and other chronic conditions

Aleksandra Modlińska

NICOLAUS COPERNICUS UNIVERSITY, TORUN, POLAND

ABSTRACT

Aim: The purpose of this literature review is to summarize current findings on the relationship between long COVID syndrome (LCS) and other chronic diseases, sleep disorders, and to assess the potential benefits of whole-body cryotherapy (WBC) as a complementary form of therapy.

Materials and Methods: This review covers the current body of international scientific literature from last decade. Randomized controlled trials, systematic reviews and clinical case reports were included in the analysis, allowing for a multifaceted and critical evaluation of the available empirical data. This approach makes it possible not only to identify potential mechanisms of action of WBC in the context of LCS and co-occurring disorders, but also to assess the quality and consistency of the available evidence, which has important implications for further research and clinical practice.

Conclusions: WBC may improve sleep quality in people with LCS and other chronic diseases by promoting muscle recovery, reducing inflammation and improving mental well-being. Although the current data are mainly associative, further studies with larger samples and longer follow-up are needed to confirm these effects. In the future, WBC may become part of a multidisciplinary approach to treating sleep disorders in patients with chronic conditions, supporting their overall health and quality of life.

KEYWORDS: long COVID syndrome, chronic conditions, whole-body cryotherapy, sleep quality

Acta Balneol. 2025;67(4):306-309. doi: 10.36740/ABAL202504112

INTRODUCTION

Long COVID syndrome (LCS), also known as post-acute sequelae of SARS-CoV-2 infection (PASC), refers to a constellation of symptoms that persist for weeks or months after the initial recovery from COVID-19. The World Health Organization (WHO) defines it as symptoms that continue for more than three months post-infection, lasting at least two months and not attributable to other diagnoses [1]. This phenomenon has garnered extensive research since the onset of the pandemic due to the diverse and debilitating effects it has on affected individuals.

Research highlights a significant prevalence of sleep disturbances among individuals affected by long COVID. For instance, studies by Orru et. al report that approximately one in four COVID-19 survivors experiences sleep disorders, with insomnia being one of the most common complaints [2]. In other studies, approximately one-third (33%) of all surveyed individuals reported low-quality sleep alongside insomnia, assessed through the Athens Insomnia Scale (AIS) [3]. A recent comprehensive review of ten distinct studies examining rest quality, applying the Pittsburgh Sleep Quality Index (PSQI), demonstrated that nearly one in every four post-COVID individuals was diagnosed with some form of sleep-related disorder (prevalence ranging between 19.2% and 30.3%) [4]. Comparable frequencies were observed in another large-scale systematic review encompassing 52 publications and a total of 18,917 individuals; in fact, sleep disruption represented the most commonly noted neuropsychiatric manifestation in subjects between 14 to 182 days following recovery from COVID-19, revealing an overall pooled frequency of 27.4% [5]. Similarly, an initial face-to-face follow-up investigation conducted in Wuhan, China, identified disturbances in sleep as among the most frequently documented complications in a group of 1733 patients released from hospital care, six months after symptom onset, impacting approximately 26% of the studied sample [6]. Corresponding outcomes were noted in research carried out across various European countries, including France and the United Kingdom, where sleep-related issues were reported by 30.8% and 24% of individuals, respectively, during the 3–4 month interval following the emergence of symptoms and hospital admission [7, 8].

The mechanisms contributing to sleep difficulties among long COVID patients can be complex. Letícia et al. suggest that symptoms such as fatigue can precipitate insomnia and subsequently exacerbate overall health and quality of life [9]. Furthermore, chronic conditions related to sleep disruptions, such as obstructive sleep apnea, may also develop post-COVID, compounding the issue [10]. Another factor is that stress and anxiety caused by the social consequences of the pandemic also predispose to sleep disorders [11].

Whole-body cryotherapy (WBC) has gained popularity as a therapeutic technique utilized for its physiological and

physical benefits for healthy individuals and people with different chronic diseases. WBC involves exposing the entire body to extremely cold temperatures, typically ranging from -60°C to -140°C, for brief durations of one to four minutes within specially designed cryochambers [12, 13, 14]. Research indicates that WBC can significantly enhance sleep quality among healthy individuals. For instance, a randomized controlled trial demonstrated that three minutes of whole-body cryotherapy following evening exercise improved subjective sleep quality in physically active men [12]. Additionally, WBC has shown promise in combating post-exercise muscle damage, which could contribute to improved sleep by alleviating discomfort that typically hinders restful sleep [14, 15].

WBC has emerged as a potential intervention to address sleep quality issues associated with LCS and other chronic conditions, such as multiple sclerosis (MS) [16], rheumatoid arthritis (RA), or depression [17]. As evidence accumulates regarding the prevalence of sleep disturbances among long COVID patients, exploring the possible benefits of WBC becomes increasingly relevant.

AIM

The purpose of this literature review is to summarize current findings on the relationship between long COVID syndrome (LCS) and other chronic diseases, sleep disorders, and to assess the potential benefits of whole-body cryotherapy (WBC) as a complementary form of therapy.

MATERIALS AND METHODS

This review covers the current body of international scientific literature from last decade. Randomized controlled trials, systematic reviews and clinical case reports were included in the analysis, allowing for a multifaceted and critical evaluation of the available empirical data. This approach makes it possible not only to identify potential mechanisms of action of WBC in the context of LCS and co-occurring disorders, but also to assess the quality and consistency of the available evidence, which has important implications for further research and clinical practice.

REVIEW AND DISCUSSION

WHOLE BODY CRYOTHERAPY FOR SLEEP QUALITY IN HEALTHY INDIVIDUALS

WBC initiates physiological responses such as vasoconstriction–vasodilation cycles, a decrease in core body temperature, and an increase in parasympathetic outflow, all of which are believed to contribute to enhanced restorative processes that underlie sleep quality [18]. Evidence suggests that WBC can improve sleep quality through various mechanisms. A study conducted by Douzi et al. indicated that a brief WBC session enhanced subjective sleep quality among physically active individuals. The improvement in sleep quality was attributed to two primary factors: a reduction in muscle soreness and an overall enhancement of psychological well-being. The cooling effect of WBC likely alleviates discomfort related to physical exertion that can disrupt sleep, thereby enabling better rest [19]. Moreover, the physiological response triggered by WBC, such as increased parasympathetic activity, has been linked to improved heart rate variability and a better recovery state, which may foster better sleep quality. Cold therapy may also induce delayed relaxation that can help individuals fall asleep more quickly and experience deeper sleep cycles [20]. Specifically, WBC facilitates reductions in inflammatory markers and muscle soreness, thereby promoting recovery and potentially leading to better sleep outcomes in physically active populations [12]. It is also worth noting that if WBC is used at the right time, it can help to mimic the natural changes in core temperature within the circadian cycle. In the Hoshikawa study, seven athletes underwent evening partial body cryostimulation (PBC) at 6:00 PM. Core body temperature at 10:30 PM was observed to be lower on the day of PBC compared to the control day. Despite these changes, there were no differences in subjective sleep quality or next-morning sleepiness between PBC and control days. This study suggests that evening cryostimulation (both WBC or PBC) may affect core body temperature in a manner consistent with the natural circadian rhythm, but this does not necessarily translate into subjective improvements in sleep quality [21].

WHOLE BODY CRYOTHERAPY FOR SLEEP QUALITY IN LCS

The potential role of whole-body cryotherapy in mitigating sleep disturbances associated with LCS is primarily rooted in its physiological and psychological effects. WBC involves exposing the body to extremely low temperatures for a short duration, which has been shown to reduce inflammation and alleviate pain, both of which could positively impact sleep [12, 19]. WBC's effects on mood enhancement and reduction in psychological distress could also be critical. Studies indicate that reducing inflammation via cryotherapy may improve symptoms of anxiety and depression, thus indirectly enhancing sleep quality for LCS patients suffering from these conditions. Given the psychological and physiological burden that LCS represents, engaging in cryotherapy could aid in restoring a more balanced state conducive to better sleep [22].

Unfortunately, there is little information about the impact of WBC on sleep quality in people after COVID. The case report by Gobbi et al. explores the integration of WBC into a multidisciplinary rehabilitation program for a 75-year-old male patient recovering from LCS. Following an extended hospitalization involving intensive care and mechanical ventilation, the patient exhibited significant physical deconditioning, including sarcopenia, moderate malnutrition, and peripheral neuropathy. Upon admission to the rehabilitation unit, assessments revealed a low Functional Independence Measure (FIM) score of 73/126 and diminished handgrip strength. The rehabilitation strategy encompassed nutritional support, physiotherapy, and the introduction of WBC sessions. Starting three weeks into the rehabilitation, the patient underwent 15 WBC sessions at -110°C, each lasting two minutes. Post-WBC, the patient reported immediate improvements in respiratory comfort and sleep quality. Over

the subsequent weeks, there were notable enhancements in muscle strength, joint mobility, and overall physical performance. By the end of the seven-week rehabilitation period, the patient's FIM score had increased to 124/126, and he was capable of walking over 100 meters unaided [23]. The findings by Gobbi et al. suggest that WBC may serve as a beneficial adjunct in the rehabilitation of post-COVID-19 patients, potentially accelerating recovery and improving functional outcomes. However, the author acknowledges that the observed improvements cannot be solely attributed to WBC due to the concurrent therapies administered. Further research with larger cohorts is recommended to isolate the effects of WBC and validate its efficacy in LCS rehabilitation [23].

WHOLE BODY CRYOTHERAPY FOR SLEEP QUALITY IN OTHER CHRONIC CONDITIONS

The application of WBC extends to chronic disease management, particularly for conditions like MS, RA, depression, and chronic back pain. For patients with MS, studies reveal that whole-body cryotherapy can improve psychological well-being, reduce symptoms associated with depression, and enhance functional status, all of which are vital for improving overall sleep quality [16, 24, 25]. The beneficial impact of WBC on physical and psychological functioning underscores its role as a potential adjunct therapy in managing chronic conditions.

In individuals with RA, enhanced recovery from physical exertion through WBC is envisaged to positively impact sleep quality by alleviating the fatigue that is often associated with the condition. Moreover, this study shows that cryotherapy can modulate inflammatory responses, thereby addressing symptoms that disrupt sleep in individuals with chronic conditions [25].

Additional research indicates that the analgesic effects of cryotherapy, which result from the increase in endorphins and the decrease in chronic inflammation markers, can further alleviate conditions that impair sleep quality, such as low back pain and anxiety [3, 26]. For individuals with pre-existing conditions like insomnia or chronic fatigue syndrome, the regular application of WBC may thus offer adjunctive benefits to the currently applied therapeutic protocols aimed at improving sleep. It is worth remembering, that variables such as temperature, session frequency, and methodological approach, along with the recipient's sex, lifestyle factors, and coexisting health conditions, can collectively affect the impact of cryostimulation on central nervous system (CNS) function. Future investigations should aim to develop standardized cryostimulation protocols tailored to specific populations, outlining both the boundaries and optimal exposure required to elicit cognitive and sleep enhancement [27].

CONCLUSIONS

In conclusion, WBC appears to offer significant benefits for sleep quality in both healthy individuals and those with LCS or chronic diseases. The mechanisms underlying these improvements include enhanced recovery from muscle soreness, optimization of pro-inflammatory factors level, and improvements in psychological well-being. While the current evidence is mainly associative, further research with larger sample sizes and long-term follow-ups is necessary to fully elucidate the potential of WBC in sleep therapy across diverse populations. This could pave the way for incorporating WBC into multidisciplinary treatment approaches aimed at improving sleep outcomes in chronic conditions.

REFERENCES

1. Perlis RH, Santillana M, Ognyanova K et al. Prevalence and Correlates of Long COVID Symptoms Among US Adults. JAMA Netw Open. 2022;5(10):e2238804. doi: 10.1001/jamanetworkopen.2022.38804.
2. Orrù G, Bertelloni D, Diolaiuti F et al. Long-COVID Syndrome? A Study on the Persistence of Neurological, Psychological and Physiological Symptoms. Healthcare (Basel). 2021;9(5):575. doi: 10.3390/healthcare9050575.
3. Zielińska-Nowak E, Lipert A, Kikowski Ł, Miller E. Impact of Whole-Body Cryotherapy on Pain, Sleep Quality, Functional Status, and Quality of Life in Multiple Sclerosis: A Comparative Study with Follow-Up. J Pers Med. 2025;15(2):46. doi: 10.3390/jpm15020046.
4. Tarsitani L, Vassalini P, Koukopoulos A et al.Post-traumatic Stress Disorder Among COVID-19 Survivors at 3-Month Follow-up After Hospital Discharge. J Gen Intern Med. 2021;36(6):1702-1707. doi: 10.1007/s11606-021-06731-7.
5. Arnold DT, Hamilton FW, Milne A et al. Patient outcomes after hospitalisation with COVID-19 and implications for follow-up: results from a prospective UK cohort. Thorax. 2021;76(4):399-401. doi: 10.1136/thoraxjnl-2020-216086.
6. Yuan K, Gong YM, Liu L et al.Prevalence of posttraumatic stress disorder after infectious disease pandemics in the twenty-first century, including COVID-19: a meta-analysis and systematic review. Mol Psychiatry. 2021;26(9):4982-4998. doi: 10.1038/s41380-021-01036-x.
7. Badenoch JB, Rengasamy ER, Watson C et al.Persistent neuropsychiatric symptoms after COVID-19: a systematic review and meta-analysis. Brain Commun. 2021;4(1):fcab297. doi: 10.1093/braincomms/fcab297.
8. Garrigues E, Janvier P, Kherabi Y et al.Post-discharge persistent symptoms and health-related quality of life after hospitalization for COVID-19. J Infect. 2020 ;81(6):e4-e6. doi: 10.1016/j.jinf.2020.08.029.
9. Letícia A, Neves RG, Vieira YP et al. Long COVID symptoms and sleep problems: a population-based study. J Sleep Res. 2025;34(2):e14327. doi: 10.1111/jsr.14327.
10. Menzler K, Mayr P, Knake S\ et al. Undiagnosed obstructive sleep apnea syndrome as a treatable cause of new-onset sleepiness in some post-COVID patients. Eur J Neurol. 2024;31(3):e16159. doi: 10.1111/ene.16159.

11. Zerbini G, Taflinger S, Reicherts P et al.Perceived risk of COVID-19 exposure and poor COVID-19 prognosis impair sleep: The mediating and moderating roles of COVID-19-related anxiety and knowledge. J Sleep Res. 2022;31(5):e13569. doi: 10.1111/jsr.13569.
12. Douzi W, Dupuy O, Tanneau M et al. 3-min whole body cryotherapy/cryostimulation after training in the evening improves sleep quality in physically active men. Eur J Sport Sci. 2019;19(6):860-867. doi: 10.1080/17461391.2018.1551937.
13. Elfahem R, Abbès B., Bouchet B et al. Whole-body cryostimulation: new insights in thermo-aeraulic fields inside chambers. Inventions. 2023;8(4):81. doi: 10.3390/inventions8040081.
14. Chun E, Joseph R, Pojednic R. Whole-Body Cryotherapy Reduces Systemic Inflammation in Healthy Adults: Pilot Cohort Study. Interact J Med Res. 2024;13:e60942. doi: 10.2196/60942.
15. Capodaglio P, Cremascoli R, Piterà P, Fontana JM. Whole-Body Cryostimulation: A Rehabilitation Booster. J Rehabil Med Clin Commun. 2022 ;5:2810. doi: 10.2340/jrmcc.v5.2810.
16. Pawik M, Kowalska J, Rymaszewska J. The effectiveness of whole-body cryotherapy and physical exercises on the psychological well-being of patients with multiple sclerosis: A comparative analysis. Adv Clin Exp Med. 2019;28(11):1477-1483. doi: 10.17219/acem/104529.
17. Rymaszewska J, Lion KM, Pawlik-Sobecka L et al. Efficacy of the Whole-Body Cryotherapy as Add-on Therapy to Pharmacological Treatment of Depression-A Randomized Controlled Trial. Front Psychiatry. 2020;11:522. doi:10.3389/fpsyt.2020.00522.
18. Tabisz H, Modlinska A, Kujawski S et al. Whole-body cryotherapy as a treatment for chronic medical conditions? Br Med Bull. 2023;146(1):43-72. doi: 10.1093/bmb/ldad007.
19. Doets JJR, Topper M, Nugter AM. A systematic review and meta-analysis of the effect of whole body cryotherapy on mental health problems. Complement Ther Med. 2021;63:102783. doi:10.1016/j.ctim.2021.102783.
20. Hoshikawa M, Dohi M, Nakamura M. Effects of evening partial body cryostimulation on the skin and core temperatures. J Therm Biol. 2019;79:144-148. doi: 10.1016/j.jtherbio.2018.12.016.
21. Chang KC, Ahorsu DK, Tsai HC et al. Parallel Mediating Effects of Sleep Quality, Psychological Distress, and Self-Stigma in the Associations Between Long COVID Symptoms and Quality of Life Among Taiwanese Individuals With Mental Health Illness. Brain Behav. 2024;14(10):e70094. doi: 10.1002/brb3.70094.
22. Gobbi M, Trotti G, Tanzi M et al. POST-COVID SYMPTOMS AND WHOLE-BODY CRYOTHERAPHY: A CASE REPORT. J Rehabil Med Clin Commun. 2022;5:1000075. doi: 10.2340/20030711-1000075.
23. Alito A, Fontana JM, Franzini Tibaldeo E et al. Whole-Body Cryostimulation in Multiple Sclerosis: A Scoping Review. J Clin Med. 2024;13(7):2003. doi: 10.3390/jcm13072003.
24. Dziedzic A, Maciak K, Miller ED et al.Targeting Vascular Impairment, Neuroinflammation, and Oxidative Stress Dynamics with Whole-Body Cryotherapy in Multiple Sclerosis Treatment. Int J Mol Sci. 2024;25(7):3858. doi: 10.3390/ijms25073858.
25. Klemm P, Hoffmann J, Asendorf T et al. Whole-body cryotherapy for the treatment of rheumatoid arthritis: a monocentric, single-blinded, randomised controlled trial. Clin Exp Rheumatol. 2022;40(11):2133-2140. doi: 10.55563/clinexprheumatol/lrff6k.
26. Barłowska-Trybulec M, Zawojska K, Szklarczyk J, Góralska M. Effect of whole body cryotherapy on low back pain and release of endorphins and stress hormones in patients with lumbar spine osteoarthritis. Reumatologia. 2022;60(4):247-251. doi: 10.5114/reum.2022.119040.
27. Latour E, Judek R, Latour M et al. Cryotherapy for improvement of cognitive functions and mental wellbeing. Acta Balneol. 2024;66(4):283-290. doi:10.36740/abal202404112.

CONFLICT OF INTEREST
The Author declare no conflict of interest

CORRESPONDING AUTHOR
Aleksandra Modlińska
Nicolaus Copernicus University
20 Swietojanska St., 85-077 Torun, Bydgoszcz, Poland
e-mail: aleksandra.modlinska@cm.umk.pl

ORCID AND CONTRIBUTIONSHIP
Aleksandra Modlińska: 0000-0003-3425-7202 A B D 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: 29.03.2025
ACCEPTED: 04.07.2025

REVIEW ARTICLE

120 years of the Polish Balneological Society. Tradition and modernity

Włodzisław Kuliński – Editor-in-Chief of Acta Balneologica

DEPARTMENT OF REHABILITATION, MILITARY INSTITUTE OF MEDICINE-NATIONAL RESEARCH INSTITUTE, WARSAW, POLAND

ABSTRACT

The origins of the Polish Balneological Society go back to 1858, when the Balneological Committee was established as part of the Cracow Scientific Society. It was set up together by Prof. Józef Dietl, Prof. Józef Majer, and Prof. Fryderyk Skobel. The Polish Balneological Society was created on 15 January 1905 in Cracow, and it continues its scientific and organisational activities to this day.

The society was set up by Prof. Ludomił Korczyński, Dr Zygmunt Wąsowicz, Dr Stanisław Kwiatkowski, Dr Maksymilian Leon Cercha and Dr Jan Regiec. Cracow was selected to be the Society's seat as the legacy of Prof. Dietl and his student, Prof. Edward Korczyński, the Jagiellonian University's Rector, was still alive there. In 1966, the Society became the Polish Association of Balneology, Bioclimatology and Physical Medicine, which is still active today. Its main goals are to promote the scientific achievements in the field of balneology through organising conferences and meetings. Scientific papers are published in *Acta Balneologica*. The articles published in this bimonthly journal include peer-reviewed original papers, review papers, and case studies concerning thermal medicine: balneology, bioclimatology, balneochemistry, hydrogeology, and physical medicine – physiotherapy as well as rehabilitation. *Acta Balneologica* provides media patronage for many scientific medical events every year. The journal is indexed by the Ministry of Science and Higher Education, Index Copernicus, Web of Science (ESCI), and the Polish Medical Bibliography. *Acta Balneologica* is published under the patronage of the Committee for Rehabilitation, Physical Culture and Social Integration of the Polish Academy of Sciences.

KEYWORDS: Balneological Committee, Polish Balenological Society, history and modernity

Acta Balneol. 2025;67(4):310-314. doi: 10.36740/ABAL202504113

The Polish Balneological Society was created on 15 January 1905 in Cracow, and Ludomił Korczyński, MD, PhD was elected its President. A plan of activities was developed based on the experience of the Balneological Committee [1-3].

The Balneological Committee was part of the Cracow Medical Society and was established in 1858 by Józef Dietl, who was also Head of the Department of Pathology and Therapy at the Jagiellonian University. In 1861, Dietl was elected Rector; he was also a member of the Galician parliament and fought for the complete independence of Galicia, for which he was removed from the university by the Austrian government. He was also elected President of Cracow (Fig. 1).

Prof. Dietl focused on the importance of etiopathogenesis in the process of diagnosis and promoted the strengthening of the body's immunity as part of treatment through a hygienic lifestyle, climate therapy, and the use of mineral waters. He developed the first classification system for therapeutic waters, determined indication for their use, and contributed to the growth of the following Polish health resorts: Krynica, Szczawnica, Iwonicz, and Swoszowice [1, 2].

Józef Dietl described therapeutic factors and determined indications for the use of mineral waters. Józef Dietl was considered to be the person who had revived Polish thermal stations, and he contributed to their growth. Balneology was taught as a separate subject at the Medical Faculty. The Society was transformed into the Academy of Learning in 1872, and a new Balneological Committee was set up as part of the Academy, still with Dietl as its Head. On 3 January 1877, the Cracow Medical Society established a permanent Committee for balneology, climatology, and national hydrology. Only physicians were full members of the Committee.

The first session of the newly-created Committee took place on Saturday, 27 January 1877. The first president was Prof. Edward Korczyński, an internist who had been Head of the Department of Pathology and Therapy at the Jagiellonian University since 1874 (Fig. 2). He was a great clinician, and he built upon Dietl's legacy through his intensive scientific work [1-4].

He continued the research and work of the previous Committee led by Józef Dietl. Moreover, he emphasised the need to quickly develop balneology as a branch of medicine and considered it to be an exact science. In his opinion, the Committee's obligations included promotion of the principles of hygiene and dietetics as well as growth of Polish thermal stations.

His efforts led to the creation of the Polish Balneological Society on 15 January 1905 in Cracow. The Society was established by Prof. Ludomił Korczyński, Dr Zygmunt Wąsowicz, Dr Stanisław Kwiatkowski, Dr Maksymilian Leon Cercha and Dr Jan Regiec. Cracow was selected to be the Society's seat as the tradition of Prof. Dietl and his student,

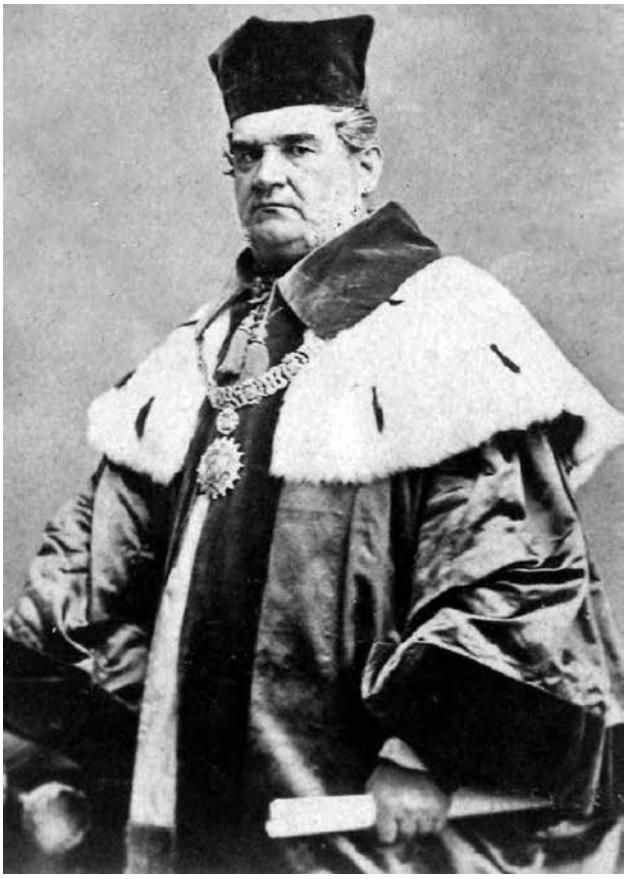


Fig. 1. Józef Dietl (1804-1878)

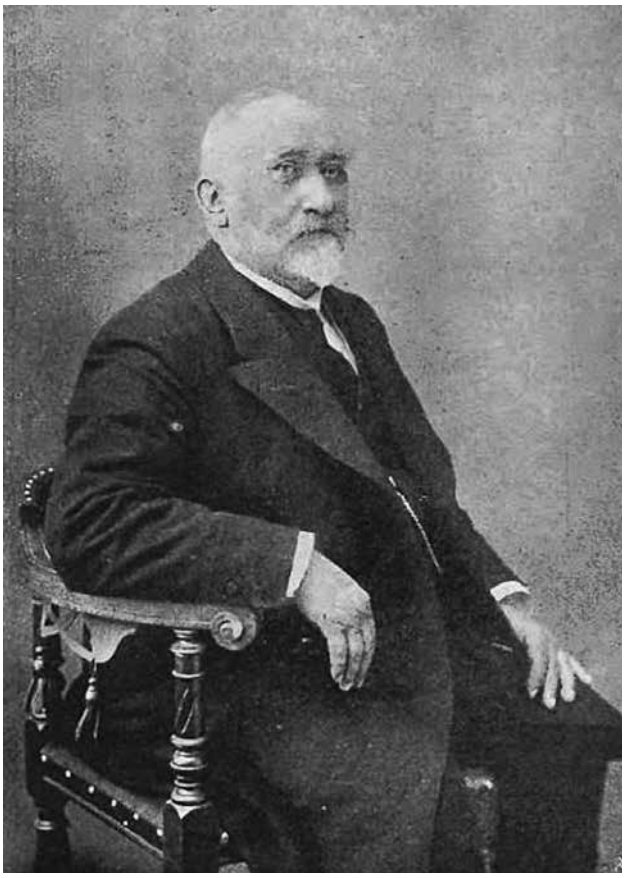


Fig. 2. Edward Korczyński (1844-1905)

Prof. Edward Korczyński, the Jagiellonian University's Rector, was still alive there. The first president was Prof. Ludomił Korczynski (1905-1906), and he was followed by Count Jan Potocki (1907-1909). The Society approved its statutes and took over all the previous studies of both Balneological Committees that had been active in the 19th century. The first Meeting of the Polish Balneological Society took place in May 1905 in Cracow and included 200 people who travelled from the three partitions. Medical speeches were presented, and it was agreed that an economic-trade health resorts association needed to be created; as a result, the National Association of Health Resorts and Thermal Stations was set up in Lviv in 1908, which encompassed the three partitions [2, 3].

The Third Meeting of the Polish Balneological Society took place in April 1914 in Krynica, where a motion was put forward to create a department of balneology at the Jagiellonian University.

Following the address of the Society's Management Board to the Vienna Parliament, the parliament decided to establish a department of balneology at the Jagiellonian University in 1914; however, World War I began and the department was not opened. The programme of the Third Polish Balneological Meeting from 1914 can be seen below (Fig. 3).

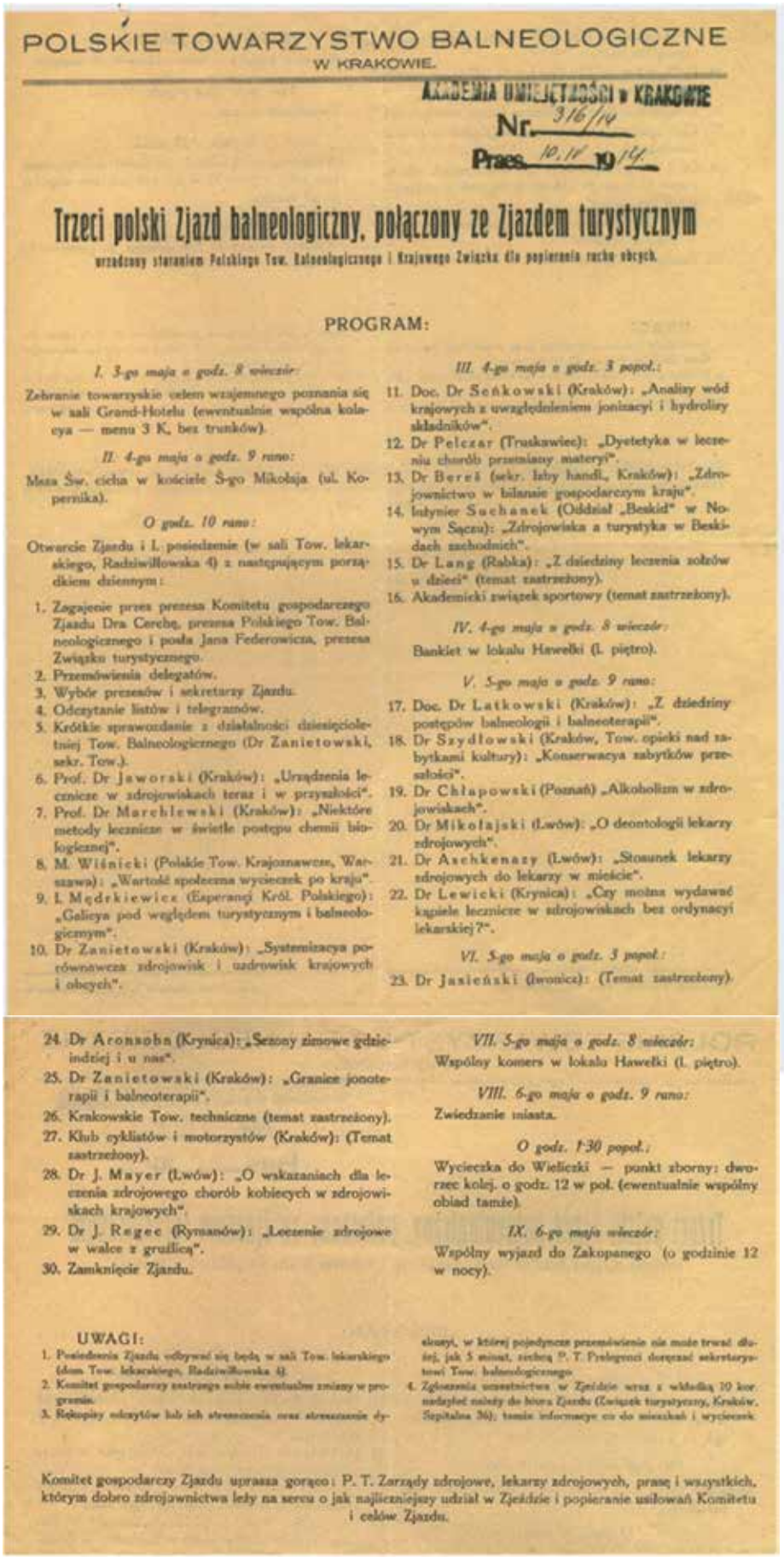
After World War I, the Polish Balneological Society resumed its activity in 1923, as did the National Association of Health Resorts and Thermal Stations in Lviv.

As a result of further changes and due to an increased range of activities, it transformed into the Association of Polish Health Resorts, with its seat in Warsaw, in 1926. Thermal stations were overseen by the Ministry of Social Welfare via the Department of Healthcare and the National Health Resorts Council.Health resorts commissions operated in thermal stations as part of the local government. In 1925, the number of thermal stations clients exceeded 125 000 people.

After World War II, the Polish Balneological Society was reactivated on 30 May 1954 after a balneological meeting that took place in Inowrocław. This was initiated by Prof. Sabatowski and Prof. Jankowiak. The Society elected its Management Board and President (Prof. Antoni Sabatowski). The Balneoclimatological Institute in Poznań was selected to be the seat of the Management Board [4-8].

During the next balneological meeting, which took place in 1956 in Lądek-Zdrój, Prof. Józef Jankowiak was elected President. A resolution was adopted at the conference to describe the bioclimatological characteristics of all thermal stations and set up three biometeorological research stations in a typical mountain, lowland, and seaside thermal station. In 1976, Dr. Zdzisław Szamborski, the then Head of the Polish Health Resorts Federation, was selected President.

In 1978, a new president of the Society was elected – Prof. Gerard Straburzyński, Head of the Balneoclimatological Institute. Subsequent meetings took place regularly every two years [4-8].



POLSKIE TOWARZYSTWO BALNEOLOGICZNE
W KRAKOWIE.

Trzeci polski Zjazd balneologiczny, połączony ze Zjazdem turystycznym

urządzony staraniem Polskiego Tow. Balneologicznego i Krajowego Związku dla popierania ruchu obcych.

PROGRAM:

I. 3-go maja o godz. 8 wieczór:

Zebranie towarzyskie celem wzajemnego poznania się w sali Grand-Hotelu (ewentualnie wspólna kolacya — menu 3 K. bez trunków).

II. 4-go maja o godz. 9 rano:

Msza Św. cicha w kościele Ś-go Mikołaja (ul. Kopernika).

O godz. 10 rano:

Otwarcie Zjazdu i I. posiedzenie (w sali Tow. lekarskiego, Radziwiłłowska 4) z następującym porządkiem dziennym:

1. Zagajenie przez prezesa Komitetu gospodarczego Zjazdu Dra Cerchę, prezesa Polskiego Tow. Balneologicznego i posła Jana Federowicza, prezesa Związku turystycznego.
2. Przemówienia delegatów.
3. Wybór prezesów i sekretarzy Zjazdu.
4. Odczytanie listów i telegramów.
5. Krótkie sprawozdanie z działalności dziesięcioletniej Tow. Balneologicznego (Dr Zanietowski, sekr. Tow.).
6. Prof. Dr Jaworski (Kraków): „Urządzenia lecznicze w zdrojowiskach teraz i w przyszłości".
7. Prof. Dr Marchlewski (Kraków): „Niektóre metody lecznicze w świetle postępu chemii biologicznej".
8. M. Wiśnicki (Polskie Tow. Krajoznawcze, Warszawa): „Wartość społeczna wycieczek po kraju".
9. I. Mędrkiewicz (Esperanci Król. Polskiego): „Galicya pod względem turystycznym i balneologicznym".
10. Dr Zanietowski (Kraków): „Systemizacya porównawcza zdrojowisk i uzdrowisk krajowych i obcych".

III. 4-go maja o godz. 3 popoł.:

11. Doc. Dr Sečkowski (Kraków): „Analizy wód krajowych z uwzględnieniem jonizacyi i hydroliry składników".
12. Dr Pelczar (Truskawiec): „Dyetetyka w leczeniu chorób przemiany materyi".
13. Dr Bereš (sekr. Izby handl., Kraków): „Zdrojownictwo w bilansie gospodarczym kraju".
14. Inżynier Suchanek (Oddział „Beskid" w Nowym Sączu): „Zdrojowiska a turystyka w Beskidach zachodnich".
15. Dr Lang (Rabka): „Z dziedziny leczenia zołzów u dzieci" (temat zastrzeżony).
16. Akademicki związek sportowy (temat zastrzeżony).

IV. 4-go maja o godz. 8 wieczór:

Bankiet w lokalu Hawełki (I. piętro).

V. 5-go maja o godz. 9 rano:

17. Doc. Dr Latkowski (Kraków): „Z dziedziny postępów balneologii i balneoterapii".
18. Dr Szydłowski (Kraków, Tow. opieki nad zabytkami kultury): „Konserwacya zabytków przeszłości".
19. Dr Chłapowski (Poznań) „Alkoholizm w zdrojowiskach".
20. Dr Mikołajski (Lwów): „O deontologii lekarzy zdrojowych".
21. Dr Aschkenazy (Lwów): „Stosunek lekarzy zdrojowych do lekarzy w mieście".
22. Dr Lewicki (Krynica): „Czy można wydawać kąpiele lecznicze w zdrojowiskach bez ordynacyi lekarskiej?".

VI. 5-go maja o godz. 3 popoł.:

23. Dr Jasieński (Iwonicz): (Temat zastrzeżony).
24. Dr Aronsohn (Krynica): „Sezony zimowe gdzieindziej i u nas".
25. Dr Zanietowski (Kraków): „Granice jonoterapii i balneoterapii".
26. Krakowskie Tow. techniczne (temat zastrzeżony).
27. Klub cyklistów i motorzystów (Kraków): (Temat zastrzeżony).
28. Dr J. Mayer (Lwów): „O wskazaniach dla leczenia zdrojowego chorób kobiecych w zdrojowiskach krajowych".
29. Dr J. Regec (Rymanów): „Leczenie zdrojowe w walce z gruźlicą".
30. Zamknięcie Zjazdu.

VII. 5-go maja o godz. 8 wieczór:

Wspólny komers w lokalu Hawełki (I. piętro).

VIII. 6-go maja o godz. 9 rano:

Zwiedzanie miasta.

O godz. 1·30 popoł.:

Wycieczka do Wieliczki — punkt zbiorny: dworzec kolej. o godz. 12 w poł. (ewentualnie wspólny obiad tamże).

IX. 6-go maja wieczór:

Wspólny wyjazd do Zakopanego (o godzinie 12 w nocy).

UWAGI:

1. Posiedzenia Zjazdu odbywać się będą w sali Tow. lekarskiego (dom Tow. lekarskiego, Radziwiłłowska 4).
2. Komitet gospodarczy zastrzega sobie ewentualne zmiany w programie.
3. Rękopisy odczytów lub ich streszczenia oraz streszczenie dyskusyi, w której pojedyncze przemówienie nie może trwać dłużej, jak 5 minut, zechcą P. T. Prelegenci doręczać sekretaryatowi Tow. balneologicznego.
4. Zgłoszenia uczestnictwa w *Zjeździe* wraz z wkładką 10 kor. nadsyłać należy do biura Zjazdu (Związek turystyczny, Kraków, Szpitalna 36); tamże informacye co do mieszkań i wycieczek.

Komitet gospodarczy Zjazdu uprasza gorąco: P. T. Zarządy zdrojowe, lekarzy zdrojowych, prasę i wszystkich, którym dobro zdrojownictwa leży na sercu o jak najliczniejszy udział w Zjeździe i popieranie usiłowań Komitetu i celów Zjazdu.

Fig. 3. The programme of the Third Polish Balneological Meeting from 1914

Undoubtedly, the activity of any society largely depends on the work done by the Management Board, and particularly its President. A list of Presidents of the Polish Balneological Society since its creation in 1905 is presented below.

1905-1907 – Prof. Ludomił Korczyński
1907-1909 – Count Jan Potocki
1910-1913 – Prof. Stanisław Pareński
1914-1923 – Dr Maksymilian Leon Cercha
1924-1935 – Prof. Ludomił Korczyński
1936-1939 – Prof. Tadeusz Tempka
1954-1956 – Prof. Antoni Sabatowski
1956-1976 – Prof. Józef Jankowiak
1976-1978 – Dr Zdzisław Szamborski
1978-1993 – Prof. Gerard Straburzyński
1993-1997 – Dr Eugeniusz Gawlak
1997-2013 – Prof. Irena Ponikowska
2013-2024 – Dr Jacek Chojnowski
2024 – Prof. Joanna Głogowska-Szeląg

POLISH BALNEOLOGICAL SOCIETY – PUBLISHING

Acta Balneologica is the bimonthly scientific journal of the Polish Association of Balneology and Physical Medicine. The journal was first published in 1905.

After World War II, in 1951, the publication of *Balneologia Polska*, a scientific balneological journal, was resumed, with Dr. J. Dobrzyński as the editor. Prof. Roguski was the next editor in 1955-1958, and he was followed by Prof. J. Jankowiak in 1958. A quarterly journal titled *Wiadomości Uzdrowiskowe* was created in 1956, with Prof. Jankowiak as the editor; it continued to be published until the end of 1967 and then transformed into the *Balneologia Polska* quarterly journal in 1968. The editor-in-chief of *Balneologia Polska* was Prof. Józef Jankowiak in 1968–1979, Prof. Gerard Straburzyński in 1980-1992, and then Prof. Szymon Kubiak in 1994-2000. Prof. Włodzisław Kuliński has been the editor-in-chief of *Acta Balneologica* since 2001. On the centenary of the Society's creation, we returned to the original name: *Acta Balneologica* [6-8].

The articles published in the bimonthly journal include peer-reviewed original papers, review papers, and case studies concerning thermal medicine: balneology, bioclimatology, balneochemistry, hydrogeology, and physical medicine – physiotherapy as well as rehabilitation. The journal is unique for its subject matter both in Poland and in Europe. As a result, the journal attracts both authors and readers, in Poland and abroad. *Acta Balneologica* provides media patronage for many scientific medical events every year. The journal is addressed to physicians, rehabilitators, physiotherapists who use knowledge from the field of balneology and physical medicine in their professional work, hospital department heads, hospital directors, managers of thermal stations, sanatoriums, public and private hospitals, health centres, SPA and wellness centres, and specialists from other areas of medicine.

The journal is indexed by the Ministry of Science and Higher Education, Index Copernicus, Web of Science (ESCI), and the Polish Medical Bibliography. *Acta Balneologica* is published under the patronage of the Committee for Rehabilitation, Physical Culture and Social Integration of the Polish Academy of Sciences.

Wydawnictwo Aluna (director: Dr. Anna Łuczyńska) is the journal's publisher. The journal is published regularly thanks to the commitment of the managing editor Barbara Domosławska and the entire team.

REFERENCES

1. Dietl J. Uwagi nad zdrojowiskami krajowymi ze względu na ich skuteczność, zastosowanie i urządzenie [Comments on national health resorts with regard to their effectiveness, use and equipment]. Kraków 1858. (Polish)
2. Zanietowski M. Sprawozdanie z czynności Polskiego Towarzystwa Balneologicznego za czas 1905-1909. Pamietniki Polskiego Towarzystwa Balneologicznego [Report on the activities of the Polish Balneological Society for the period 1905-1909. Memoirs of the Polish Balneological Society]. Wydawnictwo Towarzystwa, t II, s 220-227, Kraków 1909. (Polish)
3. Zieleniewski M. Posiedzenie Komisyi Balneologicznej w ck. Towarzystwie Naukowem Krakowskim w dniu 4 grudnia 1868 r. [Meeting of the Balneological Commission at the Imperial-Royal Kraków Scientific Society on December 4, 1868]. Gazeta Lekarska nr 43, Warszawa 24 kwietnia 1869. (Polish)
4. Rajchel L, Kuliński W, Rajchel J. Polskie Towarzystwo Balneologiczne – rys historyczny [Polish Balneological Society - a short history]. Balneol Pol. 2005;47: 56-59. (Polish)
5. Korczyński L. Józef Dietl jako balneolog. Pamiętnik Polskiego Towarzystwa Balneologicznego [Józef Dietl as a balneologist. Memoir of the Polish Balneological Society]. Wydawnictwo Towarzystwa t.VII. Nakład i własność PTB ; s7-36 Kraków 1928. (Polish)
6. Polski Słownik Biograficzny [Polish Biographical Dictionary]. Korczyński Ludomił 1867-1936. PAN, tXIV/1, z 60, s 51-52, 1968. (Polish)
7. Kowalenko H. Polskie Towarzystwo Balneologii, Bioklimatologii i Medycyny Fizykalnej – geneza i kolejne formy organizacyjne [Polish Society of Balneology, Bioclimatology and Physical Medicine – genesis and subsequent organizational forms]. Problemy Uzdrowiskowe. 1975;4/I:155-169. (Polish)
8. Kaden K. Lecznictwo Uzdrowiskowe [Thermal Medicine]. Problemy Uzdrowiskowe. 1975;4/I:37-69. (Polish)

CONFLICT OF INTEREST
The Author 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 B D 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: 12.04.2025
ACCEPTED: 04.06.2025

Wielka Księga Balneologii, Medycyny Fizykalnej i Uzdrowiskowej

Tom I Część ogólna

Tom II Część kliniczna

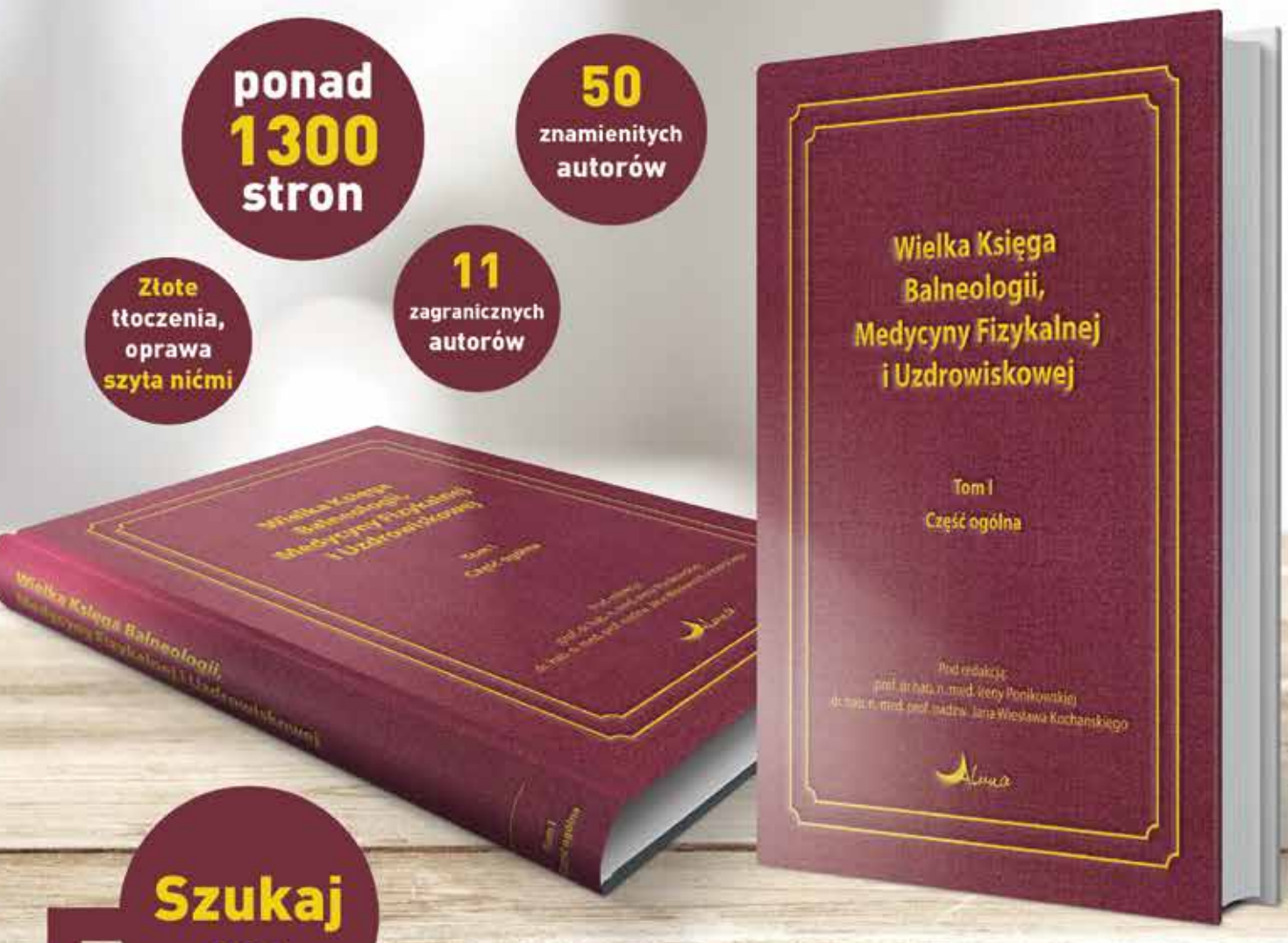
Pod redakcją:
prof. dr hab. n. med. Ireny Ponikowskiej
dr. hab. n. med. prof. nadzw. Jana Wiesława Kochańskiego

ponad 1300 stron

50 znamienitych autorów

11 zagranicznych autorów

Złote tłoczenia, oprawa szyta nićmi



Szukaj na

www.actabalneologica.pl