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- Scoliosis as a clinical and social problem
- Influence of rehabilitation with the use of sulphide and hydrogen sulphide baths
- Hypertonic saline inhalation therapy among patients with moderate asthma
- Balneotherapy in urology
- Characterization of humic substances in waters and their therapeutic applications – a review
- Assessment of the quality of life of patients after cardiac surgeries by means of the WHOQOL-BREF questionnaire
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CONTENTS

EDITORIAL ARTICLE

Scoliosis as a clinical and social problem: case study

Włodzisław Kuliński, Agata Iwańska 5

ORIGINAL ARTICLES

Influence of rehabilitation with the use of sulphide and hydrogen sulphide baths on the concentration of the brain-derived neurotrophic factor (BDNF) and selected parameters of cognitive, executive and affect functions in multiple sclerosis patients

Katarzyna Gniadek-Olejniczak, Katarzyna Jozwik-Plebanek, Rafał Smolinski, Marta Kania-Pudło, Józef Mróz 12

Hypertonic saline inhalation therapy among patients with moderate asthma and functional dyspepsia commorbidity

Mariana V. Rostoka-Reznikova, Marianna I. Tovt-Korshynska, Renata Y. Pohoriliak, Vasyl V. Kaliy, Svitlana M. Opalenyk, Yaroslava H. Rusyn, Ivan I. Myhovych 20

Assessment of the quality of life of patients after cardiac surgeries by means of the WHOQOL-BREF questionnaire

Joanna Łuczak, Lesia Rudenko 25

Restoration of the act of swallowing and rehabilitation of patients with tumors of the oral cavity

Anna Kushta, Serhii Shuvalov, Viktoriia Nahaichuk 29

Evaluation of the impact of a comprehensive psychiatric rehabilitation program on the improvement of cognitive functions in patients of the Mental Health Support Centre in Tarnowskie Gory using the Wisconsin Card Sorting Test

Joanna Agnieszka Smolarczyk, Paweł Dębski, Magdalena Odziomek-Hojka, Marta Szeląg, Magdalena Piegza, Robert Pudlo 35

Method of physical improvement of higher education students by means of functional training in the aspect of health-preservation

Olena V. Otravenko, Olena M. Shkola, Valeriy O. Zhamardiy, Olena M. Pavliuk, Alina V. Radchenko, Viktoriia I. Donchenko, Svitlana G. Myronenko 40

REVIEW ARTICLES

Balneotherapy in urology

Natalia Gębka-Adamczyk, Dorota Gębka, Jakub Adamczyk, Joanna Głogowska-Szeląg 49

Methodological potential of phenomenology and hermeneutics in research on valeological, rehabilitation and physiotherapeutic activities

Vira O. Dubinina, Alina L. Hrytsenko, Hanna I. Savonova, Yuliia A. Lazutkina 53

Characterization of humic substances in waters and their therapeutic applications – a review

Joanna Ziemska, Tomasz Szynal, Małgorzata Mazańska, Jolanta Solecka 60

IN MEMORY

In memory of Professor Wiesław Kochański (1932-2023) 69

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EDITORIAL ARTICLE

Scoliosis as a clinical and social problem: case study

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ABSTRACT

This is a case study of a 7-year-old boy with thoracolumbar scoliosis. An examination revealed trunk, shoulder and scapular asymmetry, pelvic obliquity, head and shoulder protraction, and reduced flexibility of the paraspinal and pelvic muscles. The child underwent a 1-year rehabilitation programme according to the Functional Individual Therapy of Scoliosis (FITS) method and three-plane manual therapy of foot defects as well as scoliotic curve correction with asymmetric exercises and the use of Thera-Band. After one year of rehabilitation, a physical and radiographic examination showed a considerable reduction in the Cobb angle as well as the angle of trunk rotation. Regular scoliosis screening should be offered to children and adolescents in kindergartens and schools.

KEY WORDS: scoliosis, clinical and social problem, children

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INTRODUCTION

Normal body posture involves a harmonised system of individual sections of the trunk and limbs in a standing position. It determines the figure as an individual feature of a person, which also depends on one's health, age, lifestyle and well-being. After birth, a child gradually develops their posture and acquires the skills necessary to control it, with reflex habits playing an important role. Incorrect habits lead to postural defects; consequently, it is very important to teach children how to maintain normal body posture from a very young age. Maintaining normal body posture ensures proper spinal curvatures as well as proper muscle tone and function in the muscles that stabilise the spine [1-6].

Nowadays, more and more people present to rehabilitation clinics with musculoskeletal disorders. The majority are children, in whom postural, spinal and foot defects are not difficult to detect. The lifestyle that is being promoted these days does not encourage young people to be active, which leads to a decreased level of physical activity. Lack of exercise leads mostly to muscle weakness, which may affect muscle function. Abnormal posture patterns are also generated at school, where children spend the majority of their adolescence. Parents and teachers play an important role in maintaining normal posture and should work to prevent the development and promotion of bad habits in children [5-12].

Adolescent idiopathic scoliosis in children is one of the most common postural defects. This condition is a three-plane spine and trunk deformity characterised by the presence of a lateral curve in the frontal plane, abnormal curvatures in the sagittal plane, and vertebral rotation and torsion in the axial plane. It affects 2–3% of children, both girls and boys. As the child develops, untreated scoliosis may lead to deformities in other spine-related bony parts, for example the rib cage, pelvis or limbs, as well as internal organs [6-8]. It also contributes to a reduced overall function and performance of the body and leads to pain. The Society on Scoliosis Orthopaedic and Rehabilitation Treatment and the Scoliosis Research Society recommend that scoliosis should be diagnosed when the Cobb angle is at least 10 degrees. To date, the aetiology of this disorder has not been fully explained and a multifactorial concept is deemed to be the most likely. Melatonin was proven to have both direct and indirect effects on normal musculoskeletal development. Increased levels of cellular calmodulin and calmodulin in biopsy samples from paraspinal muscles on the convex side of the deformity have been found in affected individuals. In turn, osteoprotegerin modifies osteoclast and osteoblast differentiation, influencing the calcium and phosphate metabolism of the cell, and may be responsible for spinal deformity present in adolescents. The role of growth factors and thrombospondins remains unclear. A number of genes have been discovered that predispose individuals to develop adolescent idiopathic scoliosis. What is the role of oestrogens in the development of this disorder? Learning more about the factors responsible for the development of this condition and for the progression of the deformity will help choose the right treatment [13-22].

Long-term health sequelae resulting form prolonged abnormal body posture lead to such problems as respiratory and cardiovascular disorders and a reduced level of physical performance [20-23]. When parents intervene too late, the child develops structural changes in the spine that affect their posture. Correct diagnosis and early rehabilitation with exercises tailored to each patient are necessary to prevent

the development of abnormalities and the establishment of deformity. Regular screening promotes early detection of this disorder; however, it is often skipped in schools and kindergartens. A mental complex associated with scoliosis is an important problem; the presence of trunk deformity often causes patients to have a poor body image and experience depressed mood and lower motivation and sometimes develop depression.

The process of treatment in scoliosis patients is difficult and complex, as indicated by the variety of methods used by those who attempt to treat this disorder.

The prevalence of lateral spinal deformities in developed countries increases with time and constitutes the main problem in the treatment and prevention.

The results of screening research presented by K. Dobosiewicz showed the following:

- A Cobb angle of less than 5 degrees is present in 42.8% of the population.
- A Cobb angle of less than 10 degrees is present in 17.6% of the population.
- A Cobb angle of less than 15 degrees is present in 6.3% of the population.
- A Cobb angle of less than 20 degrees is present in 3.4% of the population.
- A Cobb angle of less than 25 degrees is present in 1.8% of the population.

It is clear that the prevalence of scoliosis in children and adolescents has been growing [5-10].

The risk of progression of the deformity largely depends on the age of onset and on the Cobb angle and Risser grade at the time of diagnosis, which is why it is so important to monitor children's body posture, detect any abnormalities early and quickly introduce appropriate treatment.

Scoliosis treatment utilises two types of management: conservative and surgical. It is important to tailor the treatment to each patient based on patient history and natural course of the disorder [22-30].

CONSERVATIVE TREATMENT

Corrective exercises are the basic method of treatment in mild scoliosis (a Cobb angle of less than 25 degrees). Therapeutic exercises are used to correct, compensate, prevent and stop progression of the deformity.

Every conservative treatment method requires the patient and their carers to work together with healthcare professionals. Consequently, education and regular monitoring of treatment outcomes as well as evaluation and modification of the treatment methods used in the patient are important parts of conservative management [11-14].

Notable kinesiotherapy methods:

1. Dobosiewicz method (DoboMed), which focuses on the following:

- three-dimensional, active correction in three symmetric initial positions using proprioceptive and exteroceptive stimuli,
- increasing thoracic kyphosis,
- derotation, also called reverse rotation,
- correction (mobilisation) of the ribs on the concave side of the deformity,
- synchronising the individual exercise phases with the phases of the respiratory cycle.

These exercises mobilise the chest and spine using asymmetric breathing, which is how they are able to influence respiratory system function. They are performed in an all-fours supported position with a symmetrically positioned shoulder girdle and upper limbs and pelvic girdle and lower limbs.

2. FITS (Functional Individual Therapy of Scoliosis) was developed in 2003 in Poland by M. Białek and A. M'hango.

FITS is a diagnostic and therapeutic method for patients with scoliosis. It can be used as a sole method of correcting scoliosis, as supportive treatment (preparing the patient for surgery) or as a method of shoulder and pelvic girdle correction following surgical treatment.

3. The Schroth method was developed by Katharina Schroth in 1920 and is being continuously improved. Approximately 3,000 cases of scoliosis are treated with this method annually.

A method combining three-dimensional scoliosis correction with so-called Lehnert-Schroth breathing orthopaedic system. The breathing exercises used in this method consist in directing the inhaled air into a specific part of the lungs, which leads to the development of an internal correction mechanism.

Indications for surgical treatment in scoliosis patients:

- high values of the Cobb angle up to 40-45 degrees, progression of scoliosis, bone immaturity of the spine based on Risser grade (0-3), scoliosis with concomitant thoracic hypokyphosis or lordosis up to a Cobb angle of 40 degrees, large asymmetry of the trunk and chest.

The Adams forward bend test is the main method of detecting and locating scoliosis. The patient holds their palms together and slowly bends forward at the waist with their hands directed between their feet. This position helps better visualise the spinous processes. It also helps detect vertebral rotation in the form of rib hump and any muscular prominence in the lumbar section of the spine.

The examination of a patient with scoliosis also includes assessment of the length of specific muscle groups in the shoulder and pelvic girdle, in the lumbar section of the spine, and the ischiocrural muscle group. Scoliosis causes dysfunction in the form of muscle imbalance, which leads to contractures (hypertonicity).

The following accessory investigations are used to diagnose scoliosis:

- radiographic examination, scoliometer measurements, surface topography, computed tomography, magnetic resonance imaging, electrophysiological examination.

A scoliometer detects any trunk asymmetry, even if it is not associated with scoliosis. In order to avoid false results and unnecessary radiation exposure, the following threshold values were recommended:

- 0 to 3 degrees – physiological asymmetry of the trunk,
- 4 to 6 degrees – repeat examination required after 3-4 months,
- 7 degrees or more – referral to an orthopaedist and for a radiographic examination.

CASE REPORT

A 7-year-old boy presented with his mother to a corrective gymnastics centre in Tarnobrzeg to receive treatment for scoliosis. A history-taking with the mother revealed that the boy was her first child. The course of the pregnancy was normal and the child was born by natural labour with an Apgar score of 10. His development was normal until the age of 7 years. The boy underwent his first physiotherapeutic diagnostic work-up at the age of 7 years due to scapular asymmetry noticed by his mother. An anteroposterior (AP) radiographic image of the whole spine was obtained in a standing position in a radiographic imaging laboratory (Fig. 1). The boy was diagnosed with left thoracolumbar scoliosis with a Cobb angle of 13 degrees. The radiograph did not show any structural changes in the vertebrae. Bone maturity was described as Risser grade 0. Consequently, the child was referred to a rehabilitation clinic.

The patient presented to a rehabilitation clinic for the first time at the age of 7 years. He was assessed based on the available documentation, history-taking and a physical examination. The rehabilitation programme was based on the FITS method and three-plane manual therapy of foot defects and took place over one year.

During the examination, the child was in a standing position with his feet hip-width apart, his upper limbs hanging down freely, and his eyes looking ahead.

When looking at the child from the back, the examiner performed a trunk laterality test using a plumb line dropped from the C7 spinous process (Fig. 2). The distance between the intergluteal cleft and the plumb line, measured in millimetres, was used for trunk laterality assessment. The inferior angle of the scapulae and the top of the scoliosis curve were measured using a ruler and a plumb line. Scapular position was measured with a scoliometer and a ruler. The rotation value measured at the inferior angles of the scapulae was analysed.

The angle of trunk rotation (ATR) was measured with a scoliometer in a forward bend position. The highest value of the angle of rotation of the entire spine, measured at the top of rotation, was analysed.

When looking at the child from the back, the examiner also assessed the position of the gaps between arms and trunk, superior posterior iliac spines, greater trochanters of the femur and the feet and knees.

The position of the head and shoulders and the values of the spinal curvatures were assessed in a standing lateral position. When looking at the child from the front, the examiner focused on the position of the ribs and the superior anterior iliac spines, the shape of the chest and the position of the gaps between arms and trunk (Fig. 3).

The examination also assessed individual muscle groups: the examiner measured the length of ischiocrural muscles, thigh abductors (iliotibial band, tensor fasciae latae) – modified Ober test; hip flexors (iliopsoas muscle, rectus femoris muscle, tensor fasciae latae) (Fig. 4).

Manual assessment of the functional length of the lower limbs was the last examination performed in the boy.

The following was assessed in a standing position:

- height of iliac alae, position of superior posterior and superior anterior iliac spines, trochanter height, position of the feet (Fig. 5).

Fig. 1. Anteroposterior spinal radiograph obtained at the age of 7 years.

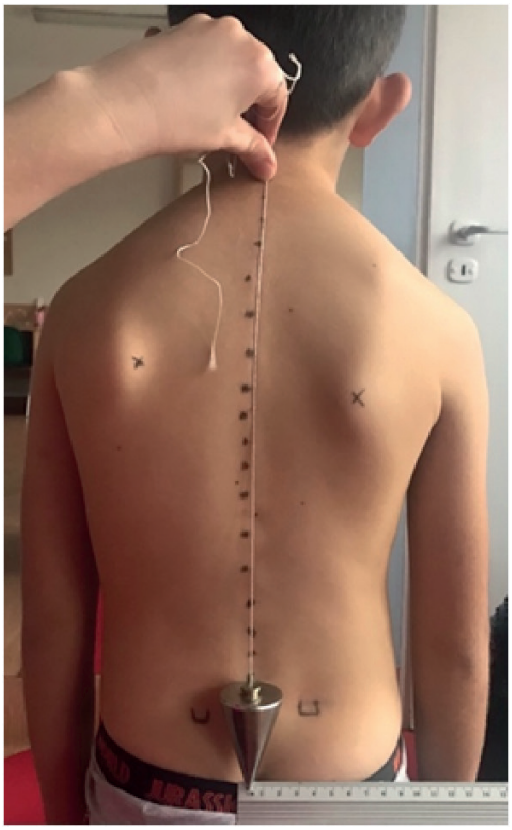

Fig. 2. Measurement of the distance between the intergluteal cleft and a plumb line.

Fig. 3. Evaluation of the child's posture from the front.

Fig. 4. Evaluation of gracilis muscle length.

Fig. 5. Evaluation of feet position.

Fig. 6. Evaluation of the position of the iliac alae.

Fig. 7. Measurement of lower limb length performed in a prone position.

The following was assessed in a sitting position:

- position of superior posterior iliac spines, position of the iliac alae (Fig. 6).

A physical examination showed trunk, shoulder and scapular asymmetry, pelvic obliquity (left superior posterior iliac

spine and left superior anterior iliac spine were lower). Head and shoulder protraction was found during lateral body posture assessment. The angle of trunk rotation measured with a scoliometer during the Adams test was 8 degrees to the left in the thoracolumbar section of the spine (Fig. 7).

Functional assessment of the musculoskeletal system revealed decreased flexibility of the following muscles: ischiocrural muscles, adductor magnus and adductor longus muscles, gastrocnemius muscles, soleus muscles and erector spinae.

THERAPEUTIC METHODS

The child underwent physiotherapy according to the Functional Individual Therapy of Scoliosis (FITS) method. The duration of the rehabilitation process was 1 year. In addition, the patient continued treatment at home, following the instructions given by the physiotherapist. The main treatment objectives were to increase postural stabilisation, relax the shortened muscles and fascia, reduce the scoliotic curve (a Cobb angle of 13 degrees) and the angle of trunk rotation (7 degrees to the left), correct asymmetry of the shoulders (left shoulder lowering), scapulae (left scapula lowering) and iliac alae (right iliac ala lowering) and reduce the deformity within the feet.

Deep massage of the following shortened muscles was performed to reduce muscle tone: ischiocrural muscles, adductor magnus in the left lower limb, soleus muscles, gastrocnemius muscles, right trapezius and erector spinae, taking the right side into account. Asymmetric exercises in corrective patterns were used to correct asymmetric positions of the scapulae and iliac alae. Correct foot loading training and the short foot exercise that stimulates the muscles of the medial arch of the foot were used to improve the abnormal position of the feet. Sensorimotor training on a roller was used to improve postural stabilisation.

The treatment also included correction of the deformity through learning correct postural patterns. Active correction of the scoliotic curve was conducted in the boy with the use of asymmetric exercises with Thera-Band. The patterns were selected based on type of scoliosis and the direction of vertebral rotation. The boy performed two exercises in five series of ten repetitions (Fig. 8).

The next stage consisted in correct foot loading training focused on three support points. The patient was in a siting position in a chair.

Next, the short foot exercise was used in the boy to correct the abnormal position of the medial arch of the foot. The exercise was done in five series of ten repetitions. Another element of treatment consisted in active improvement of lower trunk stabilisation using a rehabilitation roller and sensory pillow.

A body posture analysis based on photographs taken after one year of rehabilitation showed a considerable improvement in the boy's posture (Fig. 9). Photographic documentation revealed reduced asymmetry of the trunk, shoulders and scapulae, improved frontal plane position of the pelvis and improved position of the feet.

A follow-up radiograph obtained after one year of rehabilitation showed a Cobb angle of 5 degrees in the thoracolumbar section of the spine (Fig. 10).

Using this case of a 7-year-old patient, the authors explained how regular exercise and the combined efforts of patients, parents and physiotherapists working together promote body posture improvement. The patient participated in rehabilitation twice a week and performed additional exercises at home, all over a period of one year.

An analysis of this patient case indicates efficacy of scoliosis treatment with individually-selected FITS exercises. In the first stage, therapy focused on educating the patient and his parents. Deep massage was used in the patient, which helped lengthen and relax the shortened muscles and fascia and made it easier to perform three-plane corrective movements. Specific self-correction exercises in three planes contributed to better positions of the shoulders and scapulae and, more importantly, helped reduce the scoliotic curve. Correct foot loading training improved the position of the pelvis, helped achieve even weight-bearing distribution in the lower limbs and strengthened foot arch muscles. Sensorimotor and stabilisation training strengthened muscles in the lumbar section of the spine. Treatment effects described in the paper, based on physiotherapeutic and radiographic examinations, showed a considerable improvement in the value of the Cobb angle and the angle of trunk rotation.

Fig. 8. Exercises with Thera-Band in a corrected sitting position (as seen from the back).

Fig. 9. Photographic documentation of the patient's body posture in the frontal plane after one year of rehabilitation.

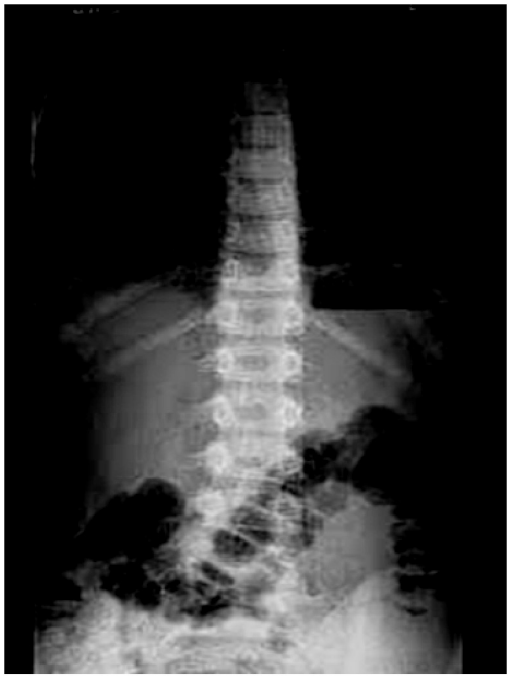

Fig. 10. AP radiograph of the spine after one year of rehabilitation.

Prevention plays the most important role in avoiding the development of scoliosis. Parents and children should be made aware of the risks of scoliosis. Untreated scoliosis eventually leads to reduced physical function and performance levels and to spinal pain. Consequently, it is very important to educate patients and to have parents and physiotherapists work together. Regular scoliosis screening should be offered in kindergartens and schools. Mandatory screening should be performed twice: at the age of 10 and 12 years in girls and at the age of 13 and 14 years in boys. The basic examination includes visual body posture evaluation and a forward bend test (Adams test) with measurement of the angle of trunk rotation done with the use of a Bunnell scoliometer. If the result is 7 degrees, a radiograph of the spine in a standing position is recommended as it will help diagnose the patient, assess the deformity and bone maturity and evaluate the possibility of implementing treatment. Parents should participate in enforcing and implementing the physiotherapist's instructions. It is also their responsibility to ensure that their child has the best conditions to develop normally and to encourage their child to take up physical activity, which has a positive effect on posture improvement and prevents worsening of deformities while restoring a normal spinal axis.

CONCLUSIONS

1. Scoliosis is a disorder that constitutes a significant clinical and social problem.
2. One-year physiotherapy programme following the FITS method and three-dimensional postural defect therapy as well as scoliotic curve correction with the use of asymmetric exercises and Thera-Band increased the height of the child, reduced the deformity and corrected the postural defect.
3. Prevention of postural defects should be more widespread in children and promoted among parents.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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ORIGINAL ARTICLE

Influence of rehabilitation with the use of sulphide and hydrogen sulphide baths on the concentration of the brain-derived neurotrophic factor (BDNF) and selected parameters of cognitive, executive and affect functions in multiple sclerosis patients

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ABSTRACT

Aim: To compare the blood serum BDNF concentration in MS patients before and after a standard three-week rehabilitation offered by the NHF. The study compared the expected growth of the BDNF concentration in a group of patients rehabilitated with the help of standard kinesiotherapy and a group of patients rehabilitated with kinesiotherapy plus sulphide and hydro sulphide baths as well as the results of the assessment of the cognitive and executive functions of MS patients in the two groups.

Materials and methods: Participants in the study were divided into 3 groups of 20 people each. Group 1. MS patients rehabilitated for 3 weeks in the Day Ward of the Rehabilitation Clinic – standard kinesiotherapy. Group 2. MS patients rehabilitated for 3 weeks in the Day Ward of the Rehabilitation Clinic – kinesiotherapy with sulphide baths. Group 3. Healthy volunteers – occasional BDNF determination. In the group of MS patients the BDNF concentration was determined prior to and after the rehabilitation. Group 3 was monitored for BDNF levels initially lower than in MS patients.

Results: Rehabilitation of MS patients with kinesiotherapy and sulphide baths causes a statistically higher growth of BDNF concentration than rehabilitation alone in this group of patients ($p<0.001$). Results of neuropsychological tests of MS patients rehabilitated with kinesiotherapy and balneotherapy elements are statistically better than of patients rehabilitated with kinesiotherapy ($p<0.033$).

Conclusions: Research findings show that sulphide and hydro sulphuric baths seem to be a valuable supplement to MS patients' rehabilitation.

KEY WORDS: multiple sclerosis, brain-derived neurotrophic factor (BDNF), rehabilitation in MS, sulphide and hydrogen sulphide baths

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INTRODUCTION

Multiple sclerosis (MS) has been subject of intensive research over the past years. The duration of the disease process, with its life-changing impact on the patient and the patient's whole family, makes MS occupy a particular place in neurology. Those having anything to do with MS affected patients may find it unjustified to call MS a disease entity given its variable clinical symptoms and different development dynamics.

The diagnosis of ICD-10: G35 tends to be seen as a 'large group of diseases' in which separate demyelinating diseases will gradually proceed to be distinguished such as, for instance, Devic's disease – neuromyelitis optica spectrum disorders (NMO-SD). Intensive research has also made MS a disease entity with a significant progress in the development of a growing array of effective therapies in the form of drug prescription programmes. The evolution of effective (disease-course-modifying) methods of treating MS, an autoimmune group disease, was further favoured by enormous progress in another field – immunology.

The chronic course of the disease along with new therapeutic possibilities extending survival in this group of patients poses new rehabilitation challenges. What has become crucial is to rehabilitate MS patients and maintain them in the best shape possible. This is where kinesiotherapy and selected methods of physiotherapy can become of significant importance.

Studies concerning the impact of balneological procedures on the functioning of MS patients are hard to be found in contemporary literature. Sulphide and hydrogen sulphide baths, long applied with positive effects in other autoimmune diseases, use of the H_2S gasotransmitter of signalling and cytoprotective role, easily penetrating the skin and the mucous membranes, regarded to be a PNS neuromodulator as well as the literature available on the subject inspired the authors to design and conduct the present study.

The brain-derived neurotrophic factor (BDNF) is a neutrophin involved in the process of the development and functioning of the nervous system, with a neuroprotective and, in particular, PNS plasticity-intensifying role. In MS patients, the blood serum BDNF concentration is reported to be lower than in healthy people [1-3]

It has been proved that a 24-week aerobic training with gradually increased exertion contributes to an increased BDNF blood serum concentration. No other studies on the influence of other forms of rehabilitation on the BDNF blood serum concentration in MS patients are available [1, 2, 4].

Hydrogen sulphide (H_2S), a gasotransmitter of signalling and cytoprotective role, easily penetrating the skin and mucous membranes is a recognized PNS neuromodulator. The functions of the H_2S as an immune response moderator are used in connective tissue diseases in the form of sulphide and hydrogen sulphide baths [3].

AIM

1) to compare the BDNF concentration in the group of MS patients before and after standard 3-week physiotherapy.
2) to compare the BDNF concentration in the group of patients after standard kinesiotherapy and the group of patients whose therapy included kinesiotherapy and sulphide and hydrogen sulphide baths;
3) to compare the results of the assessment of cognitive and executive functions in MS patients of the two groups;
4) to assess the influence of physiotherapy on body mass and the percentage composition of muscles, adipose tissue and aquatic tissue in the organism;
5) to observe possible influence of physiotherapy on basic laboratory parameters of study participants.

MATERIALS AND METHODS

CHARACTERISTICS OF THE STUDY GROUP AND THE CONTROL GROUP

The study covered 60 participants. The MS patients' group consisted of 42 people: 28 women and 14 men, randomly divided into two 21-patient groups; not differing in a statistically significant way in terms of age, sex and education. The 18 healthy participants included 9 women and 9 men. Participants in the control group did not differ in terms of age, sex and education from the MS patients' group. The age of the study participants ranged from 21 to 73 years.

Comparisons were made of the results of the planned examinations of MS patients who underwent physiotherapy based on standard kinesiotherapy and MS patients after standard kinesiotherapy with an addition of sulphide and hydrogen sulphide baths.

DIVISION OF PATIENTS INTO GROUPS

The patients were divided into 3 groups:

Group 1 – MS patients (21 people) who underwent 3-week physiotherapy in the Day Ward of the Rehabilitation Clinic – standard kinesiotherapy,

Group 2 – MS patients (21 people) who underwent 3-week physiotherapy in the Day Ward of the Rehabilitation Clinic – standard kinesiotherapy with an addition of sulphide and hydrogen sulphide baths

Group 0 – healthy volunteers (18 people) examined over a period of 3 weeks

EXAMINATIONS PERFORMED IN PATIENTS OF EACH GROUP

- neurological examination with an EDSS scale assessment, before the study and after 3-week physiotherapy,
- BDNF concentration before the commencement of the study and after its 3-week duration,
- additional laboratory examinations performed before the commencement of the study and after its 3-week duration: blood count with division of white blood cells, electrolyte level, CRP, level of d-dimers, glucose, creatinine,
- examination of body composition on the commencement of the study and after three weeks of physiotherapy (percentage of adipose tissue, muscle mass),
- neuropsychological tests – MMSE, Beck's depression scale, SF-36 – completed by the patient on the day of the commencement of the study and on the day of its completion.

INCLUSION AND EXCLUSION CRITERIA FOR MS PATIENTS AND HEALTHY VOLUNTEERS

Inclusion criteria for MS patients:

- MS patients aged > 20 years,
- minimum 2 years from disease diagnosis,
- EDSS < = 4, which means patients who will be able to participate in the planned kinesiotherapy programme,
- patients not treated for other reasons,
- immunomodulating treatment accepted – apart from glatiramer octane (Copaxone) as this drug itself causes growth of the BDNF concentration in patients,
- the last attack of the disease not later than 6 months ago.

Inclusion criteria for healthy volunteers:

- age > 20 years,
- no drugs taken in a continuous way,
- declaration of routine daily physical activity without additional physical exercises over the past 6 months.

Exclusion criteria:

- pregnancy,
- disease attack – in the course of the study and 6 months ago,
- modification of immuno-modifying treatment in the course of the study,
- diagnosis of another disease in the course of the study,
- EDSS > 4,
- hitherto healthy patients, with further diagnostics-requiring irregularities detected on neurological examination
- nicotine addiction, other addictions involving psychoactive substances,
- patients with a history of schizophrenia, transitory delusional disorders, depression, PTSD, affective bipolar disorder, nutritional disorders, autism, Huntington's disease, Alzheimer's disease, cardiovascular insufficiency, cardiac arrythmias.

STUDY PROTOCOL

Recruitment announcement for the study was placed on the Internet website of the Military Institute of Medicine and the Polish Multiple Sclerosis Society. The people reporting were randomly classified to Group 1 (patients to undergo kinesiotherapy and sulphide and hydrogen sulphide baths) and Group 2 (patients to undergo kinesiotherapy without baths) The healthy volunteers were family members and

friends of the employees of the Rehabilitation Clinic of the Military Institute of Medicine who satisfied the inclusion criteria.

On the day of the commencement of the study, MS patients from the two groups (1 and 2) had:

- an interview and a physical examination (assessment of the arterial tension, pulse) prior to the initiation of the kinesiotherapy,
- neurological examination with EDSS assessment,
- assessment of the BDNF concentration,
- assessment of basic, so-called laboratory, examinations,
- assessment of the body composition with Tanita MC 780,
- basic neuropsychological tests (MOCA, PHQ-9, EQ-5D).

Subsequently, the patients underwent the physiotherapy planned for a given group (1 or 2). Kinesiotherapy was provided under continuous control by a physiotherapist, specialist in medical rehabilitation.

On the day of the completion of the physiotherapy, MS patients from both groups (1 and 2) underwent:

- neurological examination with EDSS assessment,
- assessment of the BDNF concentration after the completion of the physiotherapy programme,
- assessment of basic laboratory examinations,
- assessment of the body composition with Tanita MC 780,
- basic neuropsychological tests (MOCA, PHQ-9, EQ-5D).

Two weeks after the completion of the physiotherapy, MS patients underwent a professional assessment of cognitive and executive functions performed by a neuropsychologist with the use of professional tests (KPD, CCT, WSCT, CVLT, TPWB).

The healthy volunteers had:

- an interview, a physical examination and a neurological examination,
- assessment of the BDNF concentration,
- professional assessment of cognitive and executive functions performed by a neuropsychologist with the use of professional psychological tests (KPD, CCT, WSCT, CVLT, TPWB).

LOCATION OF THE STUDY

All the examinations: physical, laboratory and those with the use of equipment and tests as well as the whole physiotherapy process were carried in the clinics, departments and laboratories of the Military Institute of Medicine in Warsaw.

The standard kinesiotherapy undergone by MS patients included exercises repeated for 5/7 days for 3 weeks, 5/7,

- rehabilitation bicycle – two 15-minute cycles – under RR and HR control,
- treadmill with rails – 15 minutes – one cycle per training
- exercises on the elliptical ergometer – 15 minutes – one cycle per training
- exercises – active and passive exercises against gravity for upper and lower extremities – 20 minutes per training

Group 2 – MS patients chosen at random for kinesiotherapy with sulphide and hydrogen sulphide baths for 5/7 days for 3 weeks, according to the recipe applied in the Rehabilitation Unit of the Rehabilitation Clinic of the Military Institute of Medicine:

176.4 ml of sodium sulphide solution (13%) with 110 ml 18% technical hydrochloric acid (50 mg H2S/l) in 200 l of 35-37'C water for 20 minutes.

MEASUREMENT OF THE BDNF BLOOD SERUM CONCENTRATION WITH PHOENIX TEST, REAGENTS, COURSE OF MEASUREMENT, CHARACTERISTICS OF THE METHOD

2 ml of venous blood were collected into a test tube with potassium edetate (the so-called morphological test tube) with an addition of aprotinin. The blood was centrifuged for 20 minutes and the obtained blood plasma was frozen at -70'C till the time of the measurement.

The measurement of Human BDNF was performed with the immunoenzymatic method (ELISA) with the use of the Phoenix Pharmaceutical INC. reagent set according to the producer's instruction.

ADDITIONAL LABORATORY EXAMINATIONS

In the MS groups, samples were collected for basic laboratory examinations on the first and last day of physiotherapy. They included: blood count, electrolyte concentration, creatinine, d-dimer, CRP.

ADDITIONAL QUESTIONNAIRES

Assessment of cognitive and executive functions.

On the first and last day of physiotherapy, patients underwent simple, generally accessible tests: MoCA, PHQ-9, EQ-5D.

Two weeks after the physiotherapy, MS patients underwent professional neuropsychological assessment of cognitive and executive functions with the use of the following scales:

CTT – Colour Trials Test
WSCT – Wisconsin Card Sorting Test
CVLT – California Verbal Learning Test

ANALYSIS OF BODY COMPOSITION – MUSCLE MASS, ADIPOSE TISSUE MASS

The analysis of the body composition was performed on the first and the last day of physiotherapy with the use of medically attested Tanita MC 780 monitor satisfying NAWI Class III standards, CE0122 EU certificate as well as Medical Device Directive MDD 93/42/EEC requirements concerning medical equipment.

The monitor uses technology based on the phenomenon of electrical bioimpedance (BIA). Currents of frequencies varying in the course of the procedure pass through the patient's body which allows to estimate the quantity of individual body components [5].

RESULTS

The results of the study were statistically processed with the use of SAS programme version 9 and SPSS IBM statistics version 27.

Analysis of the study participants qualified to the three study groups (Table 1).

Comparison of the BDNF blood serum concentration of study participants on the day physiotherapy was begun (Fig. 1).

Table 1. Participants in the study. Participants in individual groups did not differ in terms of sex, age and education

	Group 1	p	Group 2	p	Group 0
Group size	21	NS	21	NS	18
Sex - percentage of women F/M	14/21 (68%)	NS	14/21 (68%)	NS	9/18 (50%)
Age	50 (21-63)	NS	50 (29-67)	NS	39 (22-73)
Education - years of study	15 (8-23.5)	NS	17 (12-18)	NS	18 (14-24)

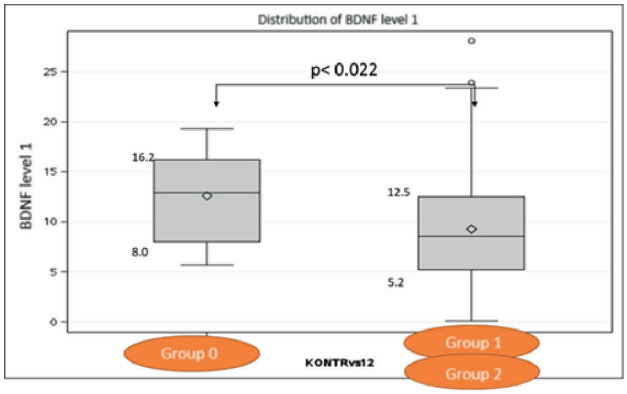

Fig. 1. BDNF blood serum concentration in Groups 0, 1, 2 on the day the study was begun.
The BDNF concentration was reported to be significantly higher in healthy people than in MS patients recruited for the study (p<0.022).

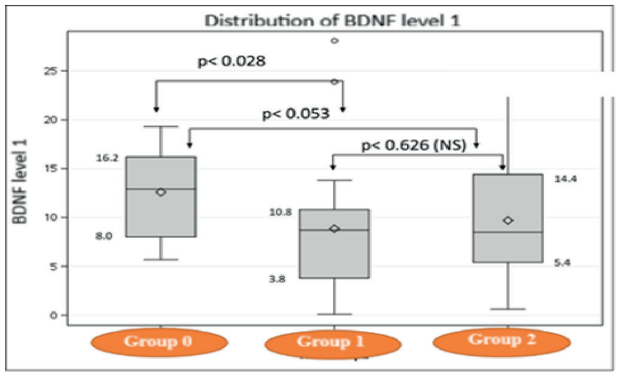

Fig. 2. Comparison of the BDNF concentration on the day the study was begun in groups 0, 1 and 2.

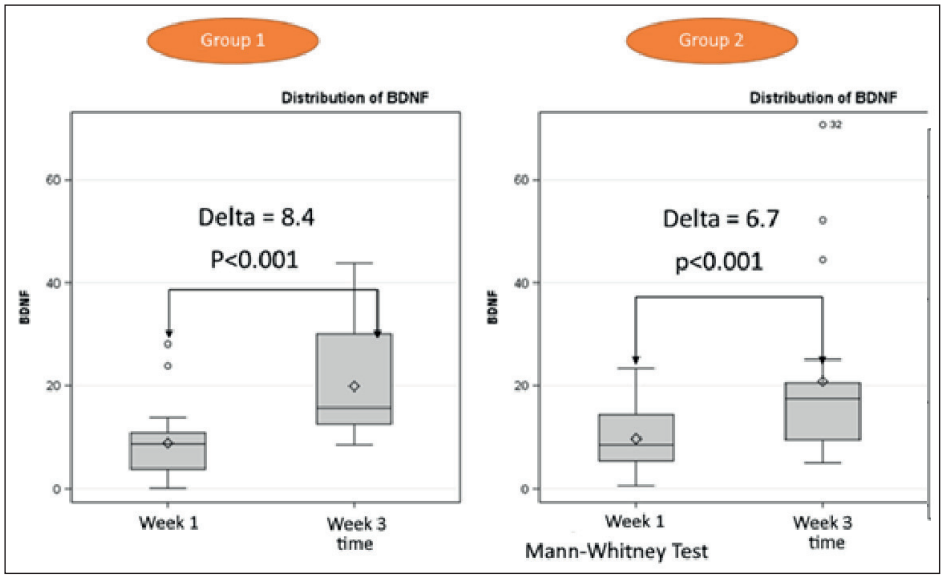

Fig. 3. BDNF concentration before and after the rehabilitation in Groups 1 and 2.

Comparison of the BDNF blood serum concentration in the study participants on the day of the commencement of physiotherapy with division into 3 groups (Fig. 2).

At the beginning of the study, a statistically higher BDNF concentration was found in the healthy patients (Group 0) than in each MS patients group recruited for the study. No statistically significant differences were detected in the BDNF concentration between MS groups (Groups 1 and 2).

Changes of the BDNF blood serum concentration in Groups 1 and 2 after a three-week rehabilitation (Fig. 3).

A statistically significant growth of the BDNF concentration was reported after the completed rehabilitation in both MS groups.

Comparison of the delta value for the BDNF blood serum concentration between groups of patients (Fig. 4).

Number of errors in the WSCT Wisconsin Card Sorting Test (Fig. 5).

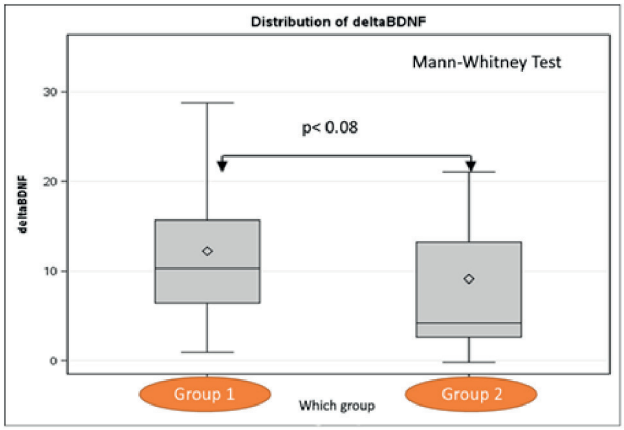

Fig. 4. Comparison of the BDNF growth between Group 1 and Group 2.

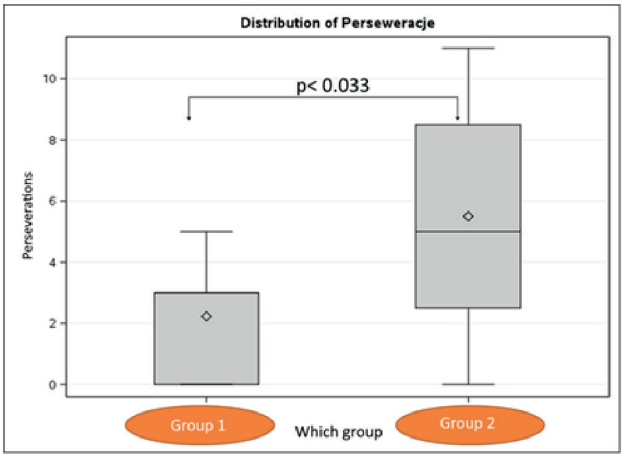

Fig. 5. Number of perseveration errors found in the WSCT in Groups 1 and 2.

A significantly (statistically) lower number of perseveration errors was found in the group of patients after rehabilitation including the use of sulphide baths (Group 1) as compared with the group of patients after kinesiotherapy only (Group 2).

DISCUSSION

Multiple sclerosis (MS) is a chronic, demyelinating and predominantly immune-mediated disease affecting the white matter tissue in the central nervous system (CNS). It is generally characterized by episodes of acute neurological dysfunction during the relapsing–remitting phase, leading to partial or full recovery. Its increasing incidence and prevalence globally make it one of the most common causes of neurological disability in young adults. Despite its prevalence and numerous studies conducted so far, the pathophysiology of MS development and the factors influencing its course are still not fully understood.

Modern treatment of multiple sclerosis is a comprehensive procedure, which includes, apart from currently available modern pharmacotherapy, also kinesiotherapy, physiotherapy, psychotherapy, and urological care. The need for multidirectional treatment of MS patients is caused by the lack of knowledge – despite all the progress of modern medical knowledge – of the etiological factor of the disease, its full pathogenesis, and the great diversity of disease activity.

Brain neurotrophic factor (BDNF) is a protein, member of the neurotrophin (NT) family, including the nerve growth factor (NGF), neurotrophin-3 (NT3), and neurotrophin-4 (NT4) [6].

The expression of BDNF has been documented in both central and peripheral nervous system (PNS) [7,8]. Furthermore, BDNF is produced by neurons and oligodendrocytes, but also platelets [8,9], cells of the immune system (i.e. T and B lymphocytes, monocytes/macrophages) [10]. Active muscles can also release BDNF, therefore representing the main reserve of BDNF at the peripheral level [11].

BDNF plays an important role in the development and maintenance of the structural integrity and function of neurons, influencing their growth, survival, and differentiation. [12]. It stimulates increase in the density of synaptic spines [12] and has several mechanisms-mediated neuro-protective activity [12]. It has also been shown to promote neuronal survival after experimental axotomy [13].

BDNF seems to exert its myelinating effect on the CNS via the TrkB receptor [10]. It is crucial for the proliferation, differentiation, activity and survival of oligodendrocytes [12]. Thus, its deficiency disturbs the aforementioned functions [12] as it is responsible for enhancing oligodendrocyte proliferation and myelination [14].

The role of BDNF in MS in not fully understood. The cause and consequences/pathophysiology of decreased BDNF levels in MS patients are not clear. It is postulated that decreased BDNF levels may be a consequence of increased protein absorption by the damaged nervous system. Simultaneously. there are hypotheses that alone, through its reduced concentration, it may contribute to CNS damage due to lack of its neuroprotective function [15, 16].

BDNF is believed to play a neuroprotective, remyelination and regenerative role in MS. The plasma/serum BDNF concentration can be used as an exponent of the cerebral level.

Data on the relationship between BDNF level and MS are still ambiguous. Reduced serum BDNF concentration in patients with MS was previously reported in the literature in the cerebrospinal fluid and in the serum [1, 16-19].

Karimi et al. [20] published in 2022 a metanalysis, which included thirteen studies with 689 patients with MS and 583 controls. MS patients had statistically significant lower plasma/serum levels of BDNF than controls: SMD [20].

Moreover, the disease duration and the proportion of males had a significant negative and positive correlation with BDNF levels, respectively. [20].

Yoshimura et al reported significantly higher serum brain-derived neurotrophic factor levels in MS patients than in healthy controls and patients with other neurological diseases, especially in younger patients with fewer relapses and mild disease [21].

On the other hand, there are papers which indicate decreased BDNF levels in MS patients [19].

The variability of the BNDF level in different phases of the disease was also observed – levels of BDNF increased

significantly after an MS relapse [17] but Yoshimura et al observed no variability of BDNF concentration during the relapse of the disease [21].

Yoshimura et al [21] suggested the influence of age and the duration of MS on BDNF levels – our study did not confirm such a correlation.

The results of our research are consistent with the majority of the hitherto carried out studies describing a decreased BDNF level in MS patients. We did not find any correlation with the age of the patients or the time which had elapsed since the diagnosis of the disease, nor differences related to the drugs administered.

REHABILITATION/EXERCISES

It has been postulated that factors which can potentially contribute to raising the BDNF level can result in slowing down the course of neurodegenerative diseases.

The influence of physical activity on BDNF in patients with neurodegenerative diseases was assessed, in the past, in a number of clinical studies, including studies on Parkinson's disease [22, 23]. Yet, the number of exercise-based RCT assessing the effects of exercise on BDNF levels in people with MS is still limited.

Ruiz-Gonzalez et al. published a meta-analysis including 18 randomized controlled trials in which they assessed the impact of physical exercise interventions including resistance exercise, aerobic exercise, combined exercise and and Tai chi on plasma BDNF levels in individuals with neurodegenerative disorders. (including 10 studies in patients with multiple sclerosis) [24]. The authors confirmed that physical exercise interventions increase plasma BDNF levels in patients with MS regardless of the exercise type [24].

Wens et al. reported that in patients with relapsing-remitting MS, the BDNF concentration increased by 13.9%± 8.8% following 24 weeks of exercise (a combined training programme, at a frequency of five sessions every 2 weeks) compared to the non-exercise MS control group. (rehabilitation included a cardiovascular part, consisting of cycling and treadmill walking or running, and the second part consisting of resistance training covering six exercises (leg press, leg curl, leg extension, vertical traction, arm curl and chest press; Technogym) [1].

A few studies (Liu et al. And Gonzales et al.) suggest that resistance exercises showed the largest effect size of all exercise types (a greater increase in plasma BDNF) followed by aerobic exercise and combined exercise [25-27].

Dinoff et al. (2016) found no differences between an intervention lasting less than 12 weeks versus 12 weeks or more [26].

Our results are in line with earlier studies and indicate that exercise in interventions are effective for increasing BDNF levels in multiple sclerosis.

BDNF levels have been positively associated with the cognitive function [27] and the hippocampal volume [28], and therefore our findings would support the previously reported benefits of exercise training on these markers in individuals with neurodegenerative disorders [29].

Sulphide baths are of proved importance in limiting both the activity of rheumatoid diseases of autoimmune origin and in reducing ailments reported by the patients affected. To our knowledge, there have never been studies evaluating the effect of sulphide baths on BDNF in patients with MS.

However, this study is not free of limitations. Therefore, further research is needed to fully understand the effects of exercise on BDNF levels and brain health in MS.

Finally, as a future perspective, it is worth considering that although the relationship between BDNF levels and symptoms of different neurodegenerative disorders is difficult to assess due to the multiple processes that regulate the amount of BDNF in tissues, it is necessary to clarify the detailed mechanisms underlying BDNF regulation in order to arrive at more effective therapeutic approaches to neurodegeneration.

Physical exercise appears to be an effective strategy in the regulation of BDNF and therefore most research has focused on whether exercise increases plasma levels of BDNF and whether there is a relationship between changes in BDNF and cognitive function in response to exercise.

CONCLUSIONS

A three-week rehabilitation, both in the form of kinesiotherapy and kinesiotherapy with balneotherapy (H_2S baths), contributes in a statistically significant way to increasing the BDNF blood serum concentration in MS patients.

Rehabilitation of MS patients based on kinesiotherapy enriched with sulphide and hydrogen sulphide baths) results in a higher (though on the verge of statistical significance) growth in BDNF than rehabilitation with the use of kinesiotherapy only.

Introduction of rehabilitation with the use of sulphide and hydrogen sulphide baths has a positive impact on selected parameters of cognitive, executive and affective functions in MS patients when compared with kinesiotherapy-based rehabilitation only.

The three-week standard rehabilitation does not have any statistically significant effect on the body composition (muscle and adipose tissue mass).

The standard rehabilitation applied does not affect in a statistically significant way the results of basic laboratory examinations.

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Dear colleagues,

On May 30, 2024, a scientific and practical conference with international participation "Organisational and Clinical Aspects of Patient-Centred Approach to Treatment and Rehabilitation in Modern Conditions" will be held.

The organisers of the conference are the State Institution of Science "Scientific and Practical Center of Preventive and Clinical Medicine" State Administrative Department, the National Academy of Medical Sciences of Ukraine, the Ukrainian Military Medical Academy and the Public Organisation "Ukrainian Association of Healthcare Management".

Publication of articles and abstracts in the professional journal "Clinical and Preventive Medicine" (SCOPUS) (Kyiv, Ukraine) (http://cp-medical.com/index.php/journal).

The programme issues of the conference:

1. Interdisciplinary aspects of medical and non-medical methods of rehabilitation of military personnel-combatants.
2. Topical issues of rehabilitation of civilians who have suffered as a result of the impact of stress and physical destructive factors of war.
3. Organisational and clinical aspects of the use of various rehabilitation types in modern practice of internal medicine.
4. Comorbidity in military personnel: the current state of the problem (topical issues of diagnosis, treatment and rehabilitation).
5. Theoretical and applied aspects of reflexotherapy in the complex rehabilitation of military personnel and civilians who have suffered as a result of war.
6. Features of the application of complex rehabilitation programmes in patients with acute cerebrovascular accident.
7. Modern approaches to the treatment and rehabilitation of patients with pathological changes caused by coronavirus infection (COVID-19).
8. Features of medical rehabilitation of patients with pain syndromes of different localisation.
9. Organisational and clinical aspects and perspective directions of medical rehabilitation after surgical interventions.
10. Clinical approaches to the treatment and rehabilitation of patients with mine-blast trauma.
11. Modern principles of perioperative management of patients and rational anaesthetic accompaniment in surgical practice.
12. Topical questions of rehabilitation at different stages and levels of medical care.
13. Problematic issues of interprofessional and long-term rehabilitation in primary health care.
14. The current state of integration of rehabilitation into primary health care.
15. Experience in implementing European training standards in the system of training medical personnel in the field of health care.

Media partners of the conference:

1. ALUNA Publishing House (Warsaw, Poland).
2. Journal "Clinical and Preventive Medicine" (SCOPUS) (State Institution of Science "Scientific and Practical Center of Preventive and Clinical Medicine" State Administrative Department, Kyiv, Ukraine).

ORIGINAL ARTICLE

Hypertonic saline inhalation therapy among patients with moderate asthma and functional dyspepsia commorbidity

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ABSTRACT

Aim: Dry powder hypertonic saline inhalation use possibilities evaluation in moderate asthma and functional dyspepsia patients.

Materials and Methods: 68 moderate asthma and functional dyspepsia patients were examined and treated according to the standard protocols, serum and erythrocytes membrane fatty acid levels were evaluated. The groups of patients with (n=35) and without (n=33) additional dry powder hypertonic saline inhalation use were compared after 1 month.

Results: After additional use of dry powder hypertonic saline inhalations vs only standard treatment the rate of well controlled asthma was 3 fold higher with significantly higher FEV1. We also observed positive dynamics of serum arachidonic and docosahexaenoic acids levels indicating resolution of inflammatory reaction with erythrocytes membranes linoleic acid level normalization (source of antiinflammatory cytokines synthesis) among patients with dry powder hypertonic saline inhalation use vs without it. Among patients who used only standard therapy compared to the control group, the erythrocytes membrane linoleic acid level remained decreased with high serum arachidonic and docosahexaenoic acids levels. Follow-up results (after 1 year) showed a significant decrease in exacerbations frequency among patients who underwent dry powder hypertonic saline inhalation vs only the standard treatment.

Conclusions: Among moderate asthma patients with functional dyspepsia use of dry powder hypertonic saline inhalation therapy additionally to the standard treatment allows to improve not only clinical and functional parameters but serum and erythrocytes membranes fatty acids spectrum as well leading to the systemic inflammatory reaction reduction and exacerbations prevention in remote period.

KEY WORDS: moderate asthma, functional dyspepsia, dry powder hypertonic saline inhalations, fatty acids

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INTRODUCTION

Asthma is one of the most common respiratory diseases that limits the patient's life in physical, emotional and social aspects. Despite the significant progress in asthma diagnosis and treatment, in many cases the disease is poorly controlled, especially in case of comorbidities [1]. Asthma and gastrointestinal diseases, especially functional dyspepsia (FD) association remains an important medical problem due to its high frequency – in about 21-75% of asthma patients [1] and mutual burden syndrome [2].

Lungs are one of the most vulnerable organs in terms of excessive lipid peroxidation (LPO) activation, as they are physiologically characterized by an increased intensity of free radical processes. The lungs directly contact both molecular oxygen, which initiates oxidation, as well as pro-oxidants contained in atmospheric air. Cell membranes are a nonpolar environment which dissolves oxygen so polyunsaturated fatty acids (PUFA) oxidation more often occurs in the membranes. The LPO products formation is a normal process with low level of LPO products presence in blood and body tissues [1-3].

Essential FAs, including ω-3 and ω-6 pulyunsaturated FAs (PUFAs) play an important part in the homeostasis maintenance, the same time, being pro- and antiinflammatory cytokines precursors, they affect inflammatory reactions. The changes in cell's membrane phospholipids fatty acid (FA) composition determine the course of pathological process in terms of pro- or anti-inflammatory cytokines production by immunocompetent cells [3].

Oxidative stress (OS) potentiates airways inflammation and can lead to poor adherence to the standard controller therapy in asthma patients. Since there's a chronic respiratory tract inflammation in asthma, a constant pro-oxidants in biological environments and body tissues production takes place. Hypoxia resulting from respiratory system insufficiency is the main factor that activates LPO processes and leads to disruption of the structure of biomembranes, modification of their phospholipid composition and changes in permeability [4, 5].

Primary links of oxidant homeostasis (i.e. FAs) investigations in case of comorbid respiratory and digestive system diseases are seldom. E.g., plasma and erythrocyte membranes selected FAs levels study in COPD with hepatobiliary lesions showed significantly more severe structural damage of erythrocyte biomembranes phospholipid layer in patients with COPD and comorbidities vs COPD without comorbidities indicating an importance of PUFAs levels investigation comorbid conditions and a necessity in additional correction of their changes [6] .

FD is one of the functional gastrointestinal diseases with a major pathogenetic link of gastrointestinal tract – brain interactions [7]. Nevertheless, OS is reported as one of important FD mechanisms as well [4]. Data regarding the primary links of oxidant homeostasis status in asthma with FD patients remain seldom and controversial.

Rehabilitation of asthma patients is commonly associated with control issues because quite often it's not possible to achieve good control in case of moderate asthma using only the standard controller therapy with inhaled glucocorticoids and long-acting beta2-agonists [1]. Since the majority of authors indicate an oxidant homeostasis violation in respiratory and digestive organs comorbidity, it is advisable to add antioxidants in the treatment complex [2].

For BA and FD patients, it is important to prescribe safe medicines without negative side effects on gastrointestinal tract. That's why there's an increased interest in non-pharmacological methods of asthma treatment, especially speleotherapy in the specific karst caves and salt mines microclimate. There are some publications regarding possible antiinflammatory effects of speleotherapy and possible impact on LPO process [8] that are seldom and not related to asthma and FD comorbidity so investigation of primary oxidative homeostasis links (FAs which are precursors of cytokines regulating an inflammatory reaction) can lead to good perspectives in moderate asthma with FD rehabilitation.

Since speleotherapy requires long-term acclimatization and is available for the limited number of patients leading to a necessity in artificial healing microclimate of salt mines reproduction, a dry powder hypertonic saline inhalation (HSI) method had been developed. Different investigations have confirmed its effect and showed that HSI is a pathogenetically based non-pharmacological method of asthma treatment. Special attention was paid to the HSI influence on inflammatory markers including some OS indicators [8, 9]. The same time, features of fatty acids membrane lipids spectra in moderate asthma with FD patients who underwent HSI course, remain underinvestigated.

AIM

Dry powder hypertonic saline inhalation use possibilities evaluation in moderate asthma and functional dyspepsia patients.

MATHERIALS AND METHODS

68 patients (mean age 44.1±4.0 years, 44% males and 56% females) with moderate asthma and FD in remission had been investigated according to the standard protocols considering international recommendations [1, 7]. Serum and erythrocytes membrane FAs levels were also evaluated. 21 relatively healthy individuals (mean age 42.4±7.4 years, 55% males and 45% females) were examined as a control group (control). The groups did not differ significantly in terms of age and gender. The study was conducted at the outpatient facilities of Uzhhorod, Ukraine.

Study inclusion criteria: age 18-65 years; singed informed consent for the study participation; moderate asthma remission; FD symptoms presence (epigastric pain, early satiety etc.) during the last 6 months for at least 3 months, absence of diagnosed organic, systemic or metabolic disorders that could explain dyspeptic symptoms. Exclusion criteria: failure to sign an informed consent for the study participation; mild or severe asthma; confirmed organic digestive and other systems diseases; use of antibacterial, antisecretory, bismuth drugs, antioxidants, systemic corticosteroids, pregnancy and lactation; severe decompensated internal diseases; neoplastic processes; mental illness.

FA spectrum of erythrocyte membranes and serum lipids was investigated using the chromatographic method for total fatty acid composition detection in biological fluids. The following FAs levels were determined: 2 saturated fatty acids (SFA) – palmitic acid (PA) and stearic acis (SA), a monounsaturated fatty acid (MFA) – oleic acid (OA), an ω3-PUFA – docosahexaenoic acid (DHA) and an ω6-PUFA – arachidonic acid (AA).

Before investigation all patients used combined controller (salmeterol and moderate dose of fluticasone) and reliever (salbutamol on demand) therapy. FD patients infected with Helicobacter pylori underwent eradication therapy and depending on PD variant, the proton pump inhibitors (omeprazole) and/or prokinetics (domperidone), symptomatic therapy with antacids was prescribed in standard dosing.

The patients were divided by 2 groups comparable in terms of age, sex and clinical, functional and laboratory parameters: group I (n=35) that were prescribed dry powder HSI additionally to the standard treatment according to the standard regimen (after three adaptation sessions lasting 15, 30 and 45 minutes, the main course of 17-19 60 minute' aerosol procedures had been performed, 20-22 sessions totally) and group II (n=33) who used only standard therapy and examined with the same interval (1 month). Follow-up results were assessed after one year. The statistical analysis was done using the Statistica 6.0 software package (StatSoft, USA). Results with $p<0.05$ were considered significant.

RESULTS

In group I (HSI additionally to the standard therapy) vs group II (only standard therapy) we revealed no patients with uncontrolled asthma vs 22% in group II ($p<0,05$) and a three fold higher rate of well controlled asthma (18% vs 6%) indicating a good clinical effect of HSI (Table 1).

Spirometry parameters dynamics (Table 2) showed a significant improvement in both clinical subgroups with FEV1 and FEV1/FVC normalization in group I vs incomplete compensation in group II. The significantly higher rates of FEV_1 and FEV1/FVC ($p<0,05$) after treatment in the group I (with additional use of HSI) comparing vs group II (only standard treatment) demonstrates better pulmonary function improvement in case of HSI utilization.

Assessment of the main FD symptoms demonstrated positive dynamics in both groups without significant difference. The intensity of epigastric pain decreased by (78.5±1.2)% in group I vs (76.2±1.3)% group II ($p>0,05$),

Table 1. Asthma control levels in moderate asthma with functional dyspepsia patients before and after treatment, %

Group	Well controlled asthma, n (%)		Partly controlled asthma, n (%)		Uncontrolled asthma, n (%)	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
I (n=35)	1 (3%)	7 (20%)	25 (71%)	28 (80%)	9 (26%)	0 (0%)*
II (n=33)	1 (3%)	2 (6%)	23 (70%)	24 (73%)	9 (27%)	7 (21%)

*Note: * – p<0,05 in group I (hypertonic saline inhalation + standard therapy) vs group II (only standard therapy).*

Table 2. Selected spirometry parameters of moderate asthma with functional dyspepsia patients before and after treatment (M±m), %

Index	Group I		Group II	
	Before treatment	After treatment	Before treatment	After treatment
FEV_1, %	85,6 ± 2,2	87,3 ± 2,4	86,5 ± 2,8	88,2 ± 3,7
FVC, %	63,2 ± 4,1	85,3 ± 4,3*+	65,4 ± 2,7*	75,8 ± 2,8*
FEV1/FVC, %	73,7 ± 2,7	92,4 ± 1,9*+	74,2 ± 1,2	85,8 ± 1,7*
FEF 25, %	63,3 ± 2,1	81,8 ± 2,3*	61,9 ± 2,2	78,7 ± 2,1*
FEF 50, %	62,4 ± 1,2	80,7 ± 1,7*	63,5 ± 1,3	76,4 ± 1,9*
FEF 75, %	68,2 ± 2,5	84,6 ± 1,8*	69,5 ± 1,5	81,8 ± 1,1*
FEF 25-75, %	67,8 ± 2,3	82,1 ± 1,5*	65,1 ± 2,1	80,3 ± 2,3*

*Note: *p < 0,05 after treatment vs before treatment; +p<0,05 in group I (hypertonic saline inhalation + standard therapy) vs group II (only standard therapy).*

Table 3. Dynamics of selected fatty acids levels in asthma with functional patients (M±m), μg/ml

Fatty acid	Control	Before treatment	After treatment
		Group I	
Membrane ALA	207,83±14,95	591,5±58,5+	456±53,65*
Serum PA	426,7±46,66	190,1±12,6+	146±13,3*
SA	139,8±11,6	367±35,1+	298±19,3*
OA	292,7±16,01	214,3±11+	148±10,9*
AA	141,1±12,18	77±8,32+	26±7,4*
DHA	27,8±0,29	591,5±58,5+	456±53,65*
		Group II	
Membrane ALA	207,83±14,95	161,75±14,56+	158,3±12,1+
Serum PA	426,7±46,66	591,5±58,5+	450,2±52,5*
SA	139,8±11,6	194±12,2+	154,2±13,1*
OA	292,7±16,01	369,5±36,5+	312±18,5*
AA	141,1±12,18	216±12+	193±11,6+
DHA	27,8±0,29	79±8+	56±7,2*+

*Note: *p < 0,05 after treatment vs before treatment; +p < 0,05 in asthma with functional dyspepsia patients vs control.*

of heaviness in epigastrium – by (82.4±0.8)% vs (85.3 ±1.1)% respectively (p>0,05). Patients did not complain of bloating in the epigastric area, heartburn, or nausea. Complaints were absent in 97% of patients of group I vs 97% in group II (p>0,05).

Levels of all investigated FAs (Table 3) normalized in group I while in group II ALA level remained decreased comparing to the control with increased AA and DHA levels probably indicating the inflammation persistence with compensatory activation of anti-inflammatory cytokines production.

Follow-up results showed a significant decrease in exacerbations frequency in group I (from 2.45±0.35 to 0.28±0.17 times/year, p<0.05) vs 2.75±0.41 times/year in group 2 during the same observation period, that was significantly higher compared to group I indicating good treatment effect improvement in use of HSI.

DISCUSSION

Asthma and FD comorbidity is very common causing mutual burden syndrome but there's a very little evidence in the literature about clinical, functional, laboratory features of such comorbidity. Previous clinical and observational studies have shown a significant pathogenetic role of OS and increased LPO in systemic inflammation, especially in asthma [1, 3, 6]. It had been reported that OS promotes insensitivity to inhaled corticosteroids in asthma patients [9, 10]. Some authors stated OS as one of important FD pathogenetic links as well [4]. Fatty acids composition of cell membrane lipids plays a crucial part in inflammatory response regulation as OS damage resistance factors and sources of pro-and anti-inflammatory cytokines [3]. However, primary oxidative homeostasis links (FAs) in asthma with FD patients remain underinvestigated with seldom studies reporting immune activation and FAs spectrum changes in case of FD [11]. Personalized management of such comorbid patients requires minimal treatment side effects risk in terms of possible allergy and gastric mucosa irritation, attracting an attention to non-pharmacotherapy methods with different mechanisms including OS reduction, e.g. SAT [7, 8] that is poorly described in asthma with FD patients. Thus we aimed to evaluate dry powder HSI use possibilities in moderate asthma and FD patients.

After treatment in group I who underwent HSI additionally to the standard treatment vs group II that used only standard therapy we revealed significantly better dynamics of asthma control with 3-fold higher rate of well controlled asthma and absence of uncontrolled asthma patients as well as FEV_1 and FEV_1/FVC normalization while in group 2 asthma remained uncontrolled in 21% with not full compensation of FEV_1 and FEV_1/FVC. Clinical and functional status improvement among moderate asthma patients receiving standard controller and reliever therapy was consistent with literature data regarding clinical and functional indicators dynamics [1]. Use of saline aerosol additionally to the standard therapy allows better control and normalization of spirometry parameters faster than in case of only standard therapy prescription accordant to similar studies [7, 8].

Normalization of the erythrocyte membranes ALA and serum PUFAs levels was revealed in patients who underwent HSI and standard treatment, while among patients who received only standard treatment, the ALA deficiency persisted as well as increased level of serum AA level. Considering that ALA is a source of DHA (antiinflammatory cytokines precursor) and AA is a precursor of proinflammatory cytokines [3], moderate asthma and FD patients after 1 month of standard therapy can be characterized by persistent inflammation with insufficient anti-inflammatory cytokines production increasing an asthma exacerbations probability. Therefore, HSI contributes to the normalization of ALA level restoring the other PUFAs reserves in moderate asthma patients with concomitant FD that helps in asthma exacerbation prevention.

Follow-up results (after 1 year) showed a significant decrease in the frequency of exacerbations among patients who underwent SAT while in the group using only standard therapy, the frequency of exacerbations during the same observation period was significantly higher indicating a relevant healthcare expenses reduction for asthma exacerbations management in young and middle-aged population.

CONCLUSIONS

1. In moderate asthma with functional dyspepsia patients who underwent dry powder hypertonic saline inhalation therapy additionally to the standard treatment vs only standard treatment use, a significant improvement in asthma control as well as normalization of FEV_1 and FEV1/FVC has been revealed, in combination with significantly higher FEV_1 after treatment (88.21±2.02% and 75.92±1.85%, respectively, $p<0.05$).
2. Fatty acid lipids composition of erythrocyte membranes and serum was normalized in patients who used dry powder hypertonic saline inhalations and standard treatment while among patients who received only standard therapy the deficiency of erythrocyte membranes α-linoleic acid and increased serum docosahexaoenic acid was persistent indicating active inflammation and insufficient anti-inflammatory cytokines production sources.
3. Follow-up results after one year showed a significantly lower frequency of asthma exacerbations in patients who received dry powder hypertonic saline inhalation therapy and standard treatment compared to patients who received only standard therapy.

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ORIGINAL ARTICLE

Assessment of the quality of life of patients after cardiac surgeries by means of the WHOQOL-BREF questionnaire

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ABATRACT

Aim: Comparison of the quality of life of patients after the procedures of coronary artery bypass grafting (CABG) and valve replacement (so-called small thoracotomy, i.e. a small incision under the breast).

Materials and Methods: The study group consisted of 144 patients (average age 68,36) of the State Medical Institute of the Ministry of Internal Affairs and Administration, after cardiac surgeries, who were subjected to physiotherapy for 3 years in the Cardiac Rehabilitation Department of the same hospital. Before and after the therapy, questions from the WHOQOL BREF Quality of Life Assessment Questionnaire were asked.

Results: In the patients-before rehabilitation, the average value of each domain variable, i.e. Somatic, Psychological and Social, is significantly lower than after the stay in the Cardiac Rehabilitation Department.

Conclusions: The implementation of rehabilitation in patients after cardiac surgeries had a positive impact on the values of each domain variable.

KEY WORDS: coronary artery bypass grafting (CABG), valve replacement, small thoracotomy, small incision under the breast, WHOQOL BREF

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INTRODUCTION

The quality of life is closely related to a person's capabilities and ability to meet their needs; the higher the degree of meeting the needs, the better the quality of life. In the 1970s, Quality of Life was introduced as an element of assessing the consequences of medical conditions. In 1949, the World Health Organization defined health as physical, mental and social well-being. Quality of life is not only related to health, but also refers to well-being, the health condition achieved by a sick person in relation to the conditio considered ideal. It is constantly changing under the influence of many external and internal factors. The patient evaluates and compares it by a pattern built on the basis of their own experiences and the adopted value system or by comparing it with the situation of other people.

Attempts to clarify the definition of quality of life have led to the creation of a new concept of quality of life suitable for use in medicine, i.e."quality of life conditioned by health" - HRQOL (Health Related Quality of Life). The concept was introduced by Schipper in 1990 and defined as the functional effect of the disease and its treatment, perceived and experienced by the patient. During the course of the disease, there is a loss of quality of life, decreased physical strength, lack of sense of security, inability to take any action, and inability to see and give one's life any meaning. In the 1990s, the quality of life of patients after an intensive therapy began to be assessed. In 1998, Heyland subjected them to substantive and methodological analysis. In the following years, further reports regarding research on quality of life and therapy appeared. Work to define measurement standards is still in progress.

The most frequently used scales to assess the quality of life are: Short Form Scale, Sickness Impact Profile, Spitzer's Quality of Life Index, Nottingham Health Profile -NHP, Quality of life questionarity C-30 and World Health Organization Quality of Life -100.

The SF-36: Short Form scale, developed at Medical Center Hospitals in Boston, assesses physical, emotional and pain condition, is simple and concise.

The SIP: Sickness Impact Profile scale, developed in the United States in 1972, enables self-assessment of health condition and the impact of the disease on physical and psycho-social functioning and the category of independent activities. It contains 136 questions divided into 12 categories, and the results are expressed in scores from 1 to 100.

Spitzer's Quality of Life Index: Constructed in the 1980s, in the first version it was a questionnaire that was completed by a doctor based on his knowledge about the patient, then it was used as a self-assessment scale to be completed by the patients themselves. The index differentiates patients depending on the disease.

The Nottingham Health Profile (NHP), created by Hunt and McEwan (1986) and divided into two parts. The first part contains 38 data on areas such as: life energy, professional work, pain, emotional reactions, sleep, social isolation and physical activity. The second part contains questions about housework, social life, personal relationships, sex life, interests and the ways of spending holidays and free days.

QLQ C-30 (Quality of life questionarity C-30) developed by EORTC

(European Organization for Research and Treatment of Cancer). Researches the quality of life in the aspect of physical, emotional and social functioning in patients with cancer.

WHOQOL-100 (World Health Organization Quality of Life -100) questionnaire, created in the early 1990s by a team appointed by the World Health Organization. It covers 6 areas: physical health, mental health, aspects of functioning, independence, social relations, environment and religion, as well as overall quality of life and self-assessment of health.

WHOQOL-Bref contains 26 questions and allows you to obtain a quality of life profile in four areas: physical, mental, social and environmental functioning. The mentioned areas include:

a) in the physical domain: activities of daily life, dependence on medications and treatments, energy and fatigue, mobility, pain, discomfort, rest, sleep, ability to work,

b) in the psychological area: appearance, negative and positive feelings, self-esteem, spirituality, religion, personal faith, thinking, learning, memory and concentration,

c) in social relationships: personal relationships, social support and sexual activity,

d) in the environment: financial resources, freedom, physical and mental safety, health and health care, its availability and quality, home environment, opportunities to acquire new information and skills, opportunities and participation in recreation and leisure, physical environment (pollution, noise, traffic, climate), transport.

The numerical result in each domain of quality of life corresponds to the individual perception of the quality of life in each area. Scores for those areas are determined by calculating the arithmetic mean of the items included in individual domains.

Each item contributes equally to the domain numerical score (score range 1-5).

The transformation of the results allows for comparison with the results obtained by means of WHOQOL-100.

AIM

Comparison of the quality of life of patients after the procedures of coronary artery bypass grafting (CABG) and valve replacement (so-called small thoracotomy, i.e. a small incision under the breast).

MATERIALS AND METHODS

The research was conducted at the State Medical Institute of the Ministry of Interior and Administration. The study group consisted of 144 patients (average age 68,36) of the Cardiac Rehabilitation Department, all former patients of the Cardiac Surgery Department of the same hospital. Each patient was consulted and subjected to a physiotherapeutic assessment. During the stay in the Department, daily gymnastics adjusted to the patient's abilities and walking training were conducted, anti-swelling exercises were taught, and additional lectures were given on the need for physical exercises, their impact on the body, safe mobility of limbs until the sternum heals, postoperative wound care, the need for proper coughing and coughing up, ability to return to daily activities and interests. The WHOQOL-BREF questionnaire was also used, with 26 questions analyzing four areas of life, asked before starting the treatment in the Rehabilitation Department and the day before the end of physiotherapy, and then compared. The assessment was correlated with age, length of stay, type of surgical procedure and location of the postoperative scar.

RESULTS

Statistical analysis performed on the entire study group with calculation of means and confidence differences. Tests were performed at a significance level of $p < 0.05$. A correlation analysis (Pearson's r) was performed to test the existence of a relationship between the duration of rehabilitation and Change in the Somatic, Psychological and Social Domain ($p < 0.05$). Somatic Domain: in people before rehabilitation, the average value of the variable is significantly lower (equal to 19.993) than after rehabilitation (equal to 25.227). $p < 0.001$. Statistical analysis showed no differences in the mean values in people with a split sternum and without a split sternum ($p = 0.2750$), the correlation analysis showed that there is no relationship between the time spent on rehabilitation and the Somatic Domain Change ($r = - 0.15$; $p = 0.081$). Psychological Domain: in people before rehabilitation the average value of the variable is significantly lower (equal to 19.097) than after rehabilitation (equal to 24.313). $p < 0.001$. In the group Without a cut sternum the value of the Psychological Domain is 4.26, and in the group with a cut sternum its value is significantly higher, equal to 5.41; $p = 0.0432$. Correlation analysis showed a slightly negative correlation between the time spent on rehabilitation and the Change of Psychological Domain ($r = - 0.20$; $p = 0.023$). Social Domain: in people before rehabilitation, the average value of the variable is significantly lower (equal to 40.47) than after rehabilitation (equal to 49.45) $p < 0.001$. Statistical analysis showed no differences in means in people with a split sternum and without a split sternum ($p = 0.7201$), correlation analysis showed that there is no relationship between the time spent on rehabilitation and the Change of the Social Domain ($r = - 0.12$; $p = 0.189$).

DISCUSSION

Developing research tools enabling an assessment of the universal quality of life or an assessment of the quality of life conditioned by health condition, depending on specific determinants resulting from past or current diseases, therapies or disabilities, also in older people, is difficult [1, 2]. It is important that the results are useful and comparable in assessing the effectiveness of treatment. WHOQOL-BREF turns out to be the most useful but constantly being modified [3-5]. The scale was used to analyze the quality of life of healthy and sick people, deaf people, refugees, people living in urban and rural areas, young and old people, sick people and people taking care of them [6-15]. Research conducted in many countries on various aspects

of the quality of life of people of different ages, including geriatrics, used different means to measure individual aspects of the quality of life.

There are different versions of WHOQOL-BREF, for the population and culture of the country, e.g. Norwegian, Spanish, French, Brazilian and Polish [4, 14, 16-19]. Research with the use of the test included the analysis of people at working and post-working age, in connection to gender, marital status, education and income, reading and writing skills, and treatment in various places intended for them [3, 11, 20-23]. Coronary artery bypass graft surgery (CABG) is a serious cardiac surgery procedure that involves cutting the sternum and working on an open chest. It also requires cardiac arrest and extracorporeal circulation. The material for creating the bypass is the great saphenous vein, taken from the patient's lower leg or the radial artery taken from the forearm. After the surgery, the patient has a large scar on his chest and, depending on where the material was taken, additionally on his lower or upper limb. The replacement and repair of the valve is performed using a minimum access (without cutting the sternum or by partially cutting the sternum). The patient has smaller scars, and the one under the breast in women is almost invisible. A significant number of patients are satisfied with undergoing the procedure, their mental condition improves however, short-term post-traumatic stress disorder occurs. Examination of the quality of life should be part of the therapeutic process in people after a cardiac surgery, especially in the case of a long-term therapy. Cardiac rehabilitation is an essential element of the treatment of these patients. Differences in disease experience and mood were examined between the patients undergoing cardiac rehabilitation after coronary artery bypass graft (CABG) and after valve replacement (VR). It is concluded that anxiety and depression influence the genesis of ischemic, not valvular, diseases, but little has been known yet about the psychological profile of cardiac patients after surgery. Psychosomatic concerns were analyzed, the results showed their more frequent occurrence in CABG than in VR patients. After adjusting age, gender, education, marital status, disease belief scores and psychosomatic concerns were higher in CABG patients and denial scores were higher in VR patients. However, anxiety and depression scores did not differ between the groups. During cardiac rehabilitation, it is suggested to differentiate psychological support in the treatment of anxiety and depression for both VR and CABG patients [24].

CONCLUSIONS

The values of each Domain variable increased significantly after the stay in the Cardiac Rehabilitation Department. In the group with a cut sternum, the value of the Psychological Domain was significantly higher in comparison to the group without a cut sternum; correlation analysis showed a slightly negative correlation between the time spent on rehabilitation and the Change in the Psychological Domain.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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ORIGINAL ARTICLE

Restoration of the act of swallowing and rehabilitation of patients with tumors of the oral cavity

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ABSTRACT

Aim: To assess the restoration of the act of swallowing in patients with cancer of the oral cavity and oropharynx using an objective method - ultrasound examination of the contraction of the muscles involved in the act of swallowing in complex treatment.

Materials and Methods: The study was conducted in 76 patients (58 (76.3%) men and 18 (23.7%) women, mean age 58.05±12.31 years) with tumors of the oral cavity and oropharyngeal mucosa of stages II-IVa, with the possibility of surgical removal, without distant metastases. Patients are divided into two groups depending on treatment and postoperative analgesia. The act of swallowing and its restoration were studied using the ultrasound method of research for 1 and 10 days.

Results: During the study, it was found that the difference in the indicators of contractions of the muscles of the oral cavity on day 10 in the main group almost corresponded to the initial indicators before the operation and the proposed treatment. This indicates that patients with cancer of the oral cavity and oropharynx in the postoperative period resumed the act of swallowing on the 10th day and such patients could switch from zonal to self-feeding. That is, on the 10th day, a nasogastric tube can be removed from them. And in the patients of the comparison group, on the 10th day, the indicators of muscle contraction decrease. Therefore, the nasogastric tube was removed for 12-14 days, depending on the volume of removed muscles.

Conclusions: The developed ultrasound study of the act of swallowing is of practical importance as an objective research method with a mathematical justification of the functional activity of the muscles. Combined treatment contributes to the rapid recovery of swallowing, which is confirmed by ultrasound examination of the contraction of the muscles involved in the act of swallowing.

KEY WORDS: oral cancer, dysphagia, swallow, reconstructive operations, ultrasound

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INTRODUCTION

The act of swallowing is a complex reflex process that ensures the transport of food and fluids from the oral cavity to the stomach. It is made up of three main phases: oral, pharyngeal, and esophageal. During the oral phase, there is a movement of food through the tongue to the pharynx. The pharyngeal phase involves closing the nasopharynx with the soft palate, elevating the larynx, and closing the glottis to prevent food from being aspirated into the airways. During the esophageal phase, there is a movement of the food lump through the esophagus towards the stomach due to the peristalsis of its muscles [1, 2].

Swallowing requires coordinated work of more than 25 pairs of muscles in the mouth, pharynx, soft palate, larynx, and esophagus [3, 4]. These muscles are innervated by the glossopharyngeal, vagus and hypoglossal nerves. The regulation of the act of swallowing occurs with the participation of the respiratory, salivary and taste centers of the brain stem [5].

Swallowing disorders (dysphagia) can occur in a variety of diseases, including neurological (stroke, Parkinson's disease), muscular (myasthenia gravis, scleroderma), as well as tumors of the oral cavity, oropharynx, pharynx, larynx and esophagus [6, 7]. Dysphagia is especially common in patients with malignant tumors of the oral cavity (cancer of the tongue, floor of the oral cavity, tonsils), which worsens in the postoperative period.

Various methods are used to objectively assess the act of swallowing. Clinical examination of swallowing includes medical history (complaints of choking, food stuckness, pain during swallowing), examination and palpation of the muscles of the oral cavity, assessment of the motor function of the tongue. Video fluoroscopy makes it possible to visualize in real time the stages of movement of the contrast agent during swallowing. Fiber-optic swallowing endoscopy involves inserting a flexible endoscope through the nose into the pharynx to directly observe swallowing. Electromyography makes it possible to assess the bioelectrical activity of the muscles involved in the act of swallowing. These methods make it possible to determine which phases of swallowing are impaired, the location and degree of impairment [6, 8-10]. However, the use of these methods in the postoperative period in the presence of edema, wound and pain is not always possible. Therefore, we have proposed a non-invasive and objective method for examining the contraction of the muscles involved in the act of swallowing, such as ultrasound examination of the act of swallowing. Where several indicators for the study are displayed [11].

Restoration of swallowing function in patients with oral tumors is extremely important. After all, adequate nutrition is the key to successful treatment of these patients, both surgically and by radiation or chemotherapy methods. In addition, swallowing disorders significantly worsen the quality of life of patients, leading to social isolation and depression. Therefore, in the early postoperative period, when conventional nutrition becomes impossible, we use artificial nutrition through a nasogastric tube. And when the act of swallowing is resumed, the nasogastric tube is removed.

AIM

The aim of the study to assess the restoration of the act of swallowing in patients with cancer of the oral cavity and oropharynx using an objective method - ultrasound examination of the contraction of the muscles involved in the act of swallowing in complex treatment.

MATERIALS AND METHODS

The study was conducted in 76 patients (58 (76.3%) men and 18 (23.7%) women, mean age 58.05±12.31 years) with tumors of the oral cavity and oropharynx, who were treated in the department of head and neck tumors of the Podilsky Regional Center of Oncology of Vinnytsia Regional Council in the period 2021 to 2022 inclusive.

The study included patients with locally advanced cancer of the oral and oropharyngeal mucosa of stages II-IVa, with the possibility of surgical removal, without distant metastases. Exclusion criteria: refusal of the patient to participate in the study, other malignant neoplasm in anamnesis, severe comorbidity, patients of stage IV with the presence of distant metastases who required only palliative treatment. In all cases, the diagnosis was verified histologically.

The main group included 39 patients who underwent a preoperative course of radiation therapy, followed by surgical intervention (removal of the tumor with plastic surgery with local tissues (56%) and regional, removed arteralized flaps (44%)) and the appointment of complex clinical enteral nutrition (Peptamen and the amino acid complex Glutargin), with combined anesthesia (long-term postoperative conduction anesthesia and non-steroidal anti-inflammatory drugs) in the postoperative Period. The second group consisted of 37 patients who underwent a preoperative course of radiation therapy and surgery (with plastic surgery with local tissues (74%) and regional and removed flaps (26%)) followed by nasoesophageal nutrition and postoperative anesthesia with non-steroidal anti-inflammatory drugs.

Clinical observation of patients and their subjective sensations of the ability to take a sip was carried out on days 1 and 10 of the postoperative period.

Ultrasound examination in B- and M-mode was performed on days 1 and 10 after surgery in combination with the proposed supportive treatment. The following parameters were measured, before and after surgery: chin-hyoid distance, longitudinal length of the suprahyoid muscle group and the length of the anterior abdomen of the digastric muscle on the side without a tumor and with a tumor in lateral projection.

Statistical processing of the obtained data was performed using a mathematical statistical method on a PC using Excel software from Microsoft Office 2003, STATISTICA 5.5 (owned by CNIT VNMU named after MI Pirogov, licensed № AXXR910A374605FA) according to Student's criteria. Differences between groups were considered statistically significant at $p<0.05$ [11].

RESULTS

According to clinical observations and subjective sensations, patients of the main group, where long-term postoperative conduction anesthesia was performed, could swallow movements and swallow saliva painlessly as early as 3 days. And patients in the comparison groups, where non-steroidal anti-inflammatory drugs were used for pain relief, had swallowing problems, which are associated with pain and salivation. On the 7th day, a similar picture was observed in the subjective sensations of patients, where patients of the main group made swallowing movements painlessly, and in patients of the comparison group, swallowing is painful and impossible, there is constant salivation, which leads to maceration of the skin and edges of the wound, which complicates the course of healing. It is easier for such patients to spit saliva than to swallow. On the 10th day, patients of the main group made swallowing movements painlessly and could even drink water freely. Patients in the comparison groups indicated the possibility of taking a sip with effort, noted mild pain during the act of swallowing.

For an objective study of the dynamics of restoration of the functional activity of the muscles of the oral cavity and oropharynx, the possibility of the act of swallowing, we have chosen the 10th day of the postoperative period, taking into account the clinical manifestation, subjective sensations of patients and regenerative capabilities of tissues.

During the ultrasound examination of the act of swallowing, a decrease in muscle contraction was observed in both observation groups. A more significant decrease in indicators occurred on the side of surgical intervention. However, when comparing the indicators between the groups, a positive trend was found in the approximation of the indicators of the act of swallowing after surgery to the initial indicators of the patient in the main group (Fig. 1-6).

DISCUSSION

Ultrasound examination of the act of swallowing revealed a decrease in the amplitude of contraction of the muscles of the supragastric group in the longitudinal projection in patients with cancer of the oral cavity and oropharynx of both groups before surgery and amounted to 31.6 % and 32.3 %, with the normal act of swallowing - ≥40 %. On the 10th day, this indicator was reduced, but in the main group it was 30.9%, and in the comparison group - 27.7%. When analyzing the data of the indicator «length of the anterior abdomen of the digastric muscle in lateral

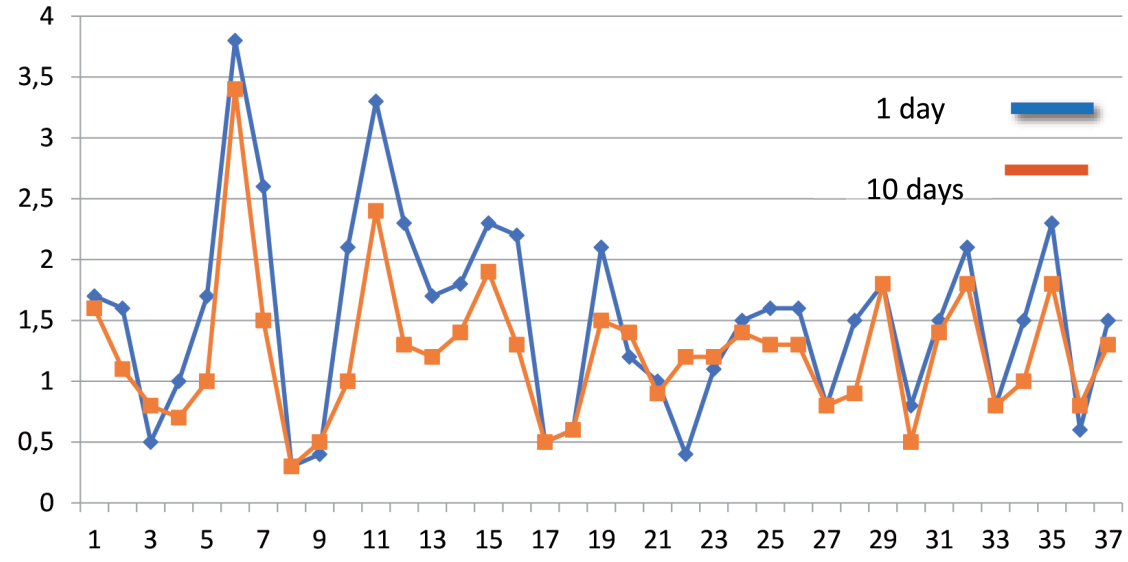

Fig. 1. Length of the anterior abdomen of the digastric muscle in lateral projection on the side without tumor (control group).

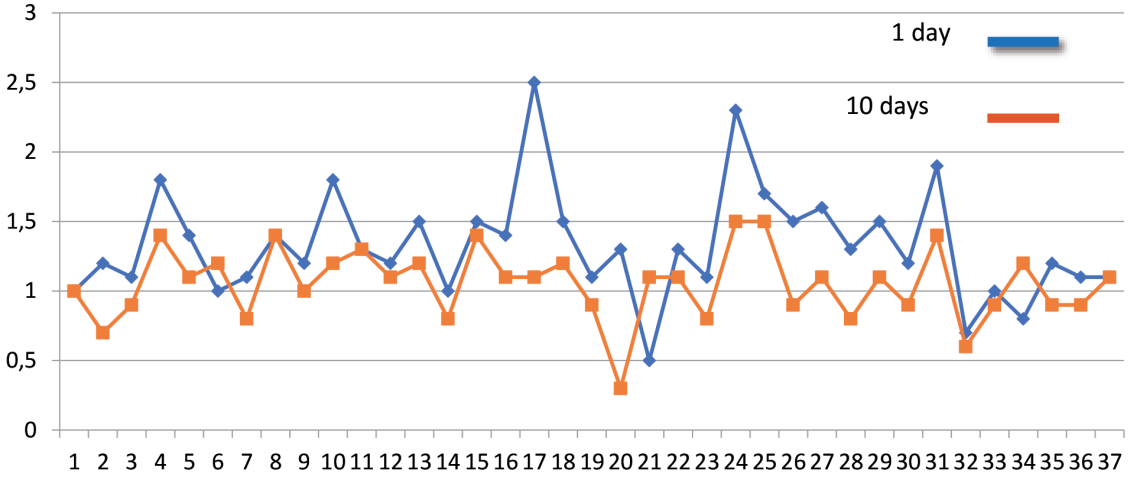

Fig. 2. Length of the anterior abdomen of the digastric muscle in lateral projection on the side with the tumor (control group).

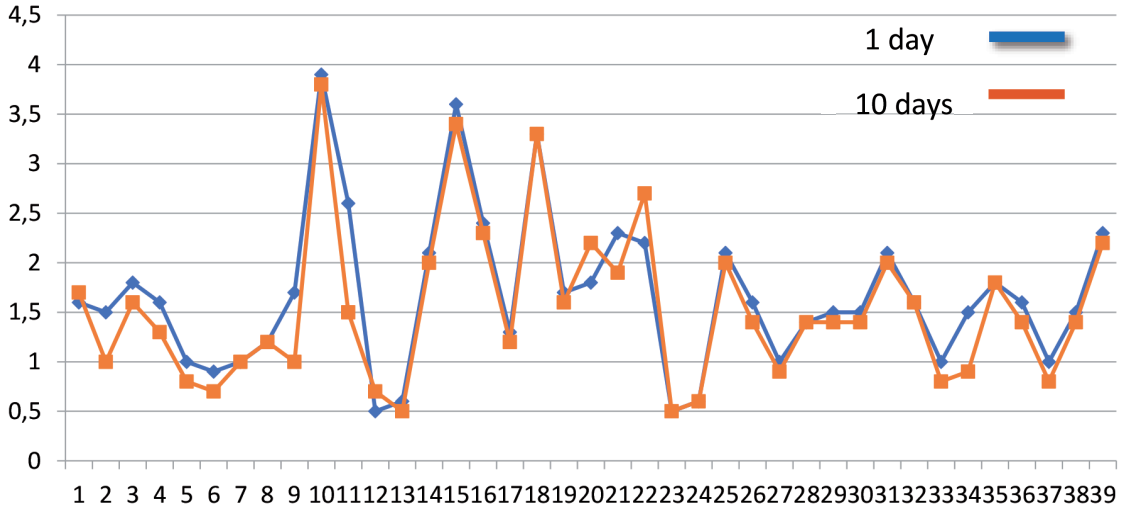

Fig. 3. Length of the anterior abdomen of the digastric muscle in lateral projection on the side without a tumor (main group).

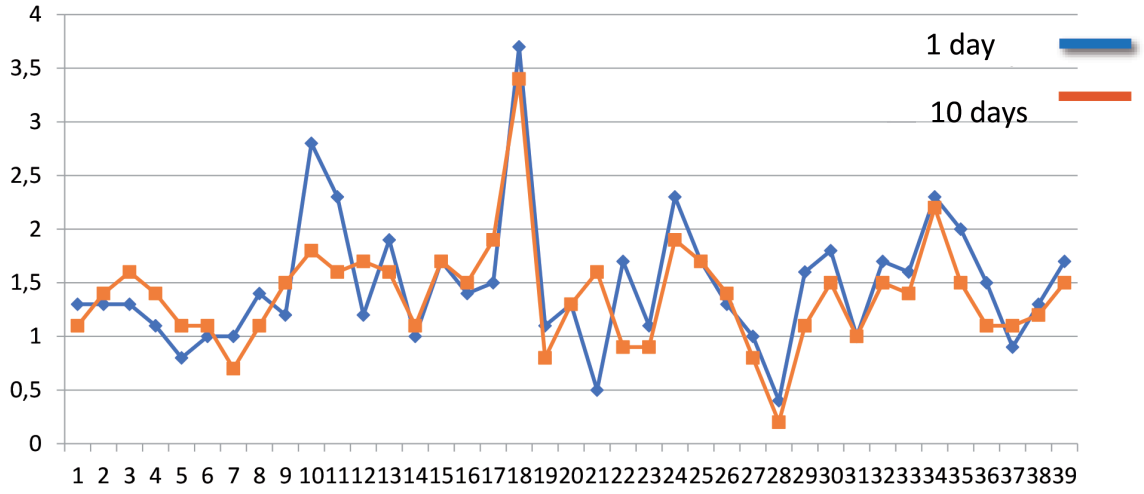

Fig. 4. Length of the anterior abdomen of the digastric muscle in lateral projection on the side with the tumor (main group).

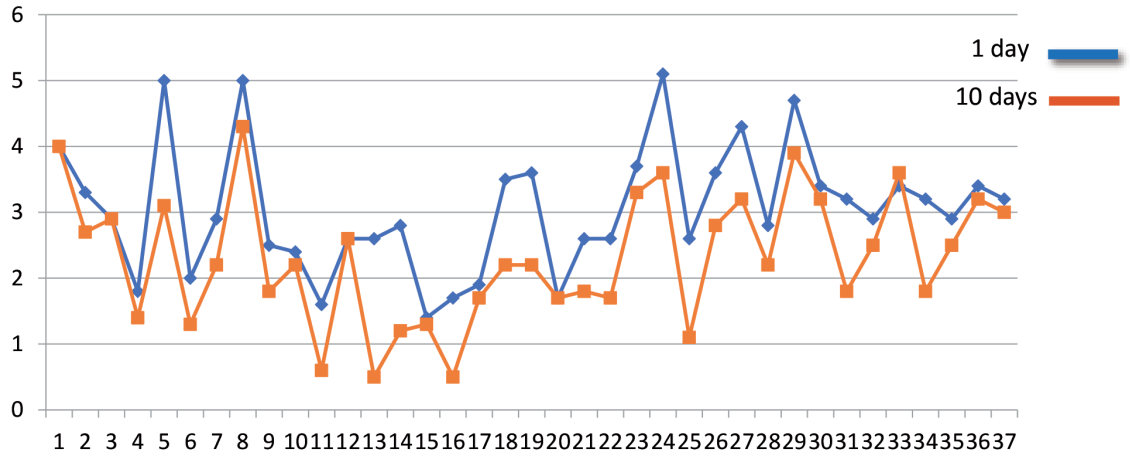

Fig. 5. The difference in the reduction of the indicator, the length of the suprahyoid muscle group in the longitudinal projection in dynamics (control group).

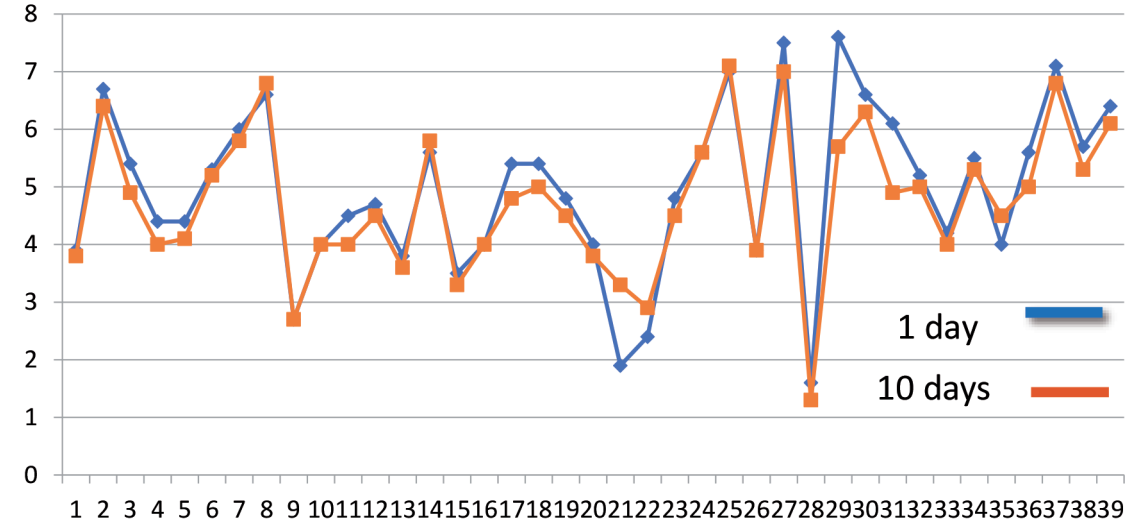

Fig. 6. Difference in the reduction of the indicator, the length of the suprahyoid muscle group in the longitudinal projection in dynamics (main group).

projection on the side without a tumor» before treatment, a decrease in muscle contraction was also found in both groups of the study and amounted to 14.5% and 15.5%. With the normal act of swallowing, the percentage of contraction was ≥20%. This indicator continued to decrease in patients of the comparison group in the postoperative period (12.7%), in contrast to the indicators of patients in the main group, where it did not change from the initial indicators – 14.5%. The indicator «length of the anterior abdomen of the digastric muscle in lateral projection on the side with the tumor» before treatment was also reduced and amounted to 12.7% in the main group and 13.6% in the comparison group. However, pronounced changes in this indicator were observed on day 10 in the main group, where muscle contraction is 13.6%, although a decrease in indicators in absolute numbers was detected compared to the initial data. And in patients of the comparison group, this indicator did not recover to the initial data, but, on the contrary, almost halved (7.3%).

Thus, the difference in the indicators of contractions of the muscles of the oral cavity on day 10 in the main group almost corresponded to the initial indicators before surgery and the proposed treatment. This indicates that in patients with cancer of the oral cavity and oropharynx in the postoperative period on the 10th day, the act of swallowing was restored and such patients could switch from zone nutrition to independent nutrition. That is, on the 10th day, it is already possible to remove the nasogastric tube from them. And in patients of the comparison group on day 10, the indicators of muscle contraction are reduced. Therefore, the nasogastric tube was removed for 12-14 days, depending on the volume of the removed muscles.

Thus, objective indicators of the effectiveness of muscle contraction were derived, at which the act of swallowing is possible. They represent ≥20% in the longitudinal contraction of the suprahyoid muscle group and ≥13% in the contraction of the anterior abdomen of the digastric muscle in lateral projection. Readings below the percentage reduction data indicate the inability to swallow.

Therefore, timely diagnosis and adequate correction of swallowing disorders in patients with oral and oropharyngeal cancer can prevent severe complications such as aspiration pneumonia, nutritional deficiency, and also significantly improves their quality of life.

CONCLUSIONS

1. The developed ultrasound examination of the act of swallowing is of practical importance as an objective method of research with mathematical substantiation of the functional activity of muscles.
2. With the restoration of the act of swallowing, the range of motion of the hyoid bone with a reference measurement along the edge of the chin of the lower jaw is from 20 to 25%, the contraction of the suprahyoid muscle group by ≥35% in the B-mode and ≥40% in the M-mode, and the range of contractions of the anterior abdomen of the digastric muscle in the lateral projection during swallowing reached ≥17-20%.
3. Combined treatment promotes rapid recovery of swallowing, which is confirmed by ultrasound examination of the contraction of the muscles involved in the act of swallowing.

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ORIGINAL ARTICLE

Evaluation of the impact of a comprehensive psychiatric rehabilitation program on the improvement of cognitive functions in patients of the Mental Health Support Centre in Tarnowskie Gory using the Wisconsin Card Sorting Test

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ABSTRACT

Aim: The purpose of our study was check to how a 3-month program of physical, cognitive and social rehabilitation affected the cognitive functions of patients of the Mental Health Support Centre in Tarnowskie Gory by using the Wisconsin Card Sorting test

Materials and Methods: The Wisconsin Card Sorting Test (WCST) was conducted twice among patients of the Mental Health Support Center in Tarnowskie Gory, who were undergoing a 3-month rehabilitation program that included physical, cognitive, and social rehabilitation. The test was conducted at the beginning and after the participation in the rehabilitation program.

Results: The rehabilitation program led to a significant decrease in patients' perseverative responses compared to the initial study. Other indicators were also assessed in the Wisconsin Card Sorting Test (WCST). There were no statistically significant differences between the results of the first and second studies.

Conclusions: After completing the rehabilitation program, patients showed a significant decrease in perseverative responses, indicating improved speed in responding to changing task conditions. Cognitive flexibility, including the ability to respond to changing environmental conditions, is a key skill that enables adequate and adaptive actions.

KEY WORDS: psychiatric rehabilitation, Wisconsin Card Sorting Test, cognitive functions

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INTRODUCTION

Environmental psychiatry is currently recognised as the best psychiatric aid model as well as a support system alternative to the traditional model, which is limited to the personal contact between the doctor and the patient. It is focused on multidirectional therapeutic interactions performed in a manner suited to the needs of the patient. In its foundations it utilises the locally-operating multidisciplinary systems, institutions and people dedicated to mental health assistance. The primary objective of environmental psychiatry is to strengthen the self-reliance in the day-to-day life of patients suffering from mental disorders and to support their general functioning in the local communities [1]. It has been proven that the described form of patient care reduces the number of hospitalizations, shortens their time and improves the quality of life while simultaneously reducing the costs of treatment [2, 3]. It ensures social assistance, which is an important element missing among the recipients of exclusively formal psychiatric services [4].

One of the potential goals of rehabilitation programmes improving the self-reliance of patients suffering from mental disorders is to strengthen the cognitive functions such as attention, memory, executive functions, social cognitive functions, metacognitive functions and linguistic functions. Seemingly simple activities in the patient's everyday life may require complex coordination of cognitive processes, which is why their smooth functioning is so important. For example, executive functions facilitate important life decision-making, effective planning, recognition of losses against profits, smooth interpersonal communication or cooperation during personal therapy [5]. Cognitive flexibility is essential in adapting to the constantly changing requirements of the environment, as it determines the ability to mentally switch between principles, strategies and tasks [6]. Scientific literature informs that cognitive impairments are an element of the clinical image for many disorders, however, each disease entity is defined by a differing combination of such [7, 8]. Improvement of mental processes can be achieved in many scientifically proven ways. Physical exercise through the inducement of neurogenesis and the inhibition of neuron apoptosis was proven as a method of neurocognitive disorder prevention and improves cognitive functioning in people of all ages [9, 10]. Furthermore, in the scientific literature, reports appear on the potentially beneficial influence of regular use of art therapy methods on psychosocial functioning of people experiencing mental disorders through e.g. the improvement of patient's emotional expression, self-esteem

and self-awareness as well as the short-term and working memory [11, 12]. Growing interest in using computer programs to train neurocognitive functioning has also been observed. It has been proven that the dynamic and multisensory stimulation they provide influences, among others, the attention selectivity, cognitive flexibility, short-term memory functioning, and is one of the most effective methods of cognitive training [13]. Efficiency in improving the neurocognitive functioning was also proven for many different non-pharmacological therapeutic methods. Every stimulation which compromises existing cognitive schemes and requires greater involvement of mental processes, performed systematically in appropriate doses and for an adequate length of time, can be a perfect method of cognitive flexibility enhancement. The more complex, attractive and adapted to the patient's level, the more potentially effective [6].

Due to the growing interest in environmental psychiatry, Mental Health Support Centre (Centrum Wsparcia Zdrowia Psychicznego, CWZP) was established in 2019 in Tarnowskie Gory. As a part of this project, health-promoting endeavours were planned, meant to maintain, restore and improve the mental health of people experiencing mental disorders. The patients of CWZP took part in a 3-month rehabilitation programme based on cognitive rehabilitation with the use of specialised computer programs (CogniPlus, Neuroforma and RehaCom), social rehabilitation with group therapy participation as well as movement rehabilitation with a physiotherapist (general fitness group exercises, breathing exercises and relaxation with elements of body awareness exercises). Detailed description of our program can be found in our previous publications [14, 15]. Reports on the efficiency of numerous therapeutic methods in supporting the psychosocial functioning of patients with mental disorders inspired the authors of this study to evaluate the influence of multi-domain interactions on the improvement of cognitive functions, and the subsequent improvement of self-reliance in everyday life.

AIM

The aim of this study was the evaluation of the influence of multi-domain rehabilitation interactions on the improvement of cognitive functions among the patients of the CWZP.

MATERIALS AND METHODS

The Wisconsin Card Sorting Test (WCST) was carried out among the patients of the CWZP who had undergone the rehabilitation programme on the turn of 2020 and 2021. Qualified to the project were the patients who met the criteria of inclusion in the programme, such as: being over 18 years old, psychophysical state allowing safe use of interactions offered as well as an informed consent for participation in the project. The exclusion criteria consisted of: addiction to alcohol or other psychoactive substances with the inability to maintain 3-month abstinence or the violation of abstinence during the project, withdrawal of consent for participation in the project or deterioration of health preventing further use of rehabilitation interactions.

The Wisconsin Card-Sorting Test (WCST) is a neuropsychological diagnostic tool for the measurement of working memory and executive functions.

It consists of four model cards depicting figures differing in shape, quantity and colour, as well as 128 answer cards. In front of the person subjected to the examination, from their left to their right side, are placed four model cards presenting the following: a single red triangle, two green stars, three yellow crosses and four blue circles. The examinee's task is to match each of the four subsequent model cards with a single answer card from the set. The examiner then informs the examinee whether or not the cards were matched correctly, however, without explaining the valid sorting criterion. The examinee who manages to discover the sorting rule in place is allowed to place the cards correctly and then the sorting criterion changes. Each time the examinee needs to discover the new sorting criterion using the information from the examiner about the correctness of the task performed.

During the test numerous indicators are assessed: Number of Attempt, Number of Correct Answers Total, Number of Errors Total, Error Percentage, Perseverative Answers, Perseverative Errors, Non-perseverative Errors, Conceptual Answers, Number of Credited Categories, Attempts Until First Category Credit, Failure to Maintain Mindset, Learning to Learn. Low results of WCST indicate disturbances in abstract thinking, inflexibility in thinking and inability to adjust the mindset as a response to rapidly changing stimuli from the environment [16].

Numerous scientific studies identify that the decreased WCST indicators are observed, inter alia, among people suffering from focal brain damage (mainly within the frontal lobes), schizophrenia, attention deficit disorders, depressive disorders [16, 17].

The patients were examined using the Wisconsin Card Sorting Test carried out by psychologists qualified in this field. The test was conducted twice, once prior to participants beginning the project, and then again after a minimum of 6 weeks since the first test.

STATISTICAL ANALYSIS

The data collected was developed with the Statistica 13.3 program, which is licensed by the Medical University of Silesia in Katowice. The normality of variable distribution was verified using the Shapiro-Wilk test. The comparison of results achieved by the patients in the WCST in the first and second examination was performed using the Student's t-test for dependent samples for variables with normal distribution and the Wilcoxon test for the variables differing in distribution from the normal distribution. $P<0,05$ was assumed as statistically significant.

RESULTS

From among the patients participating in the project the result analysis was performed for a representative sample consisting of 26 people, 18 women and 8 men in the ages of 24 through 86 years, with diagnoses from the circle of psychotic disorders (6 patients), affective disorders

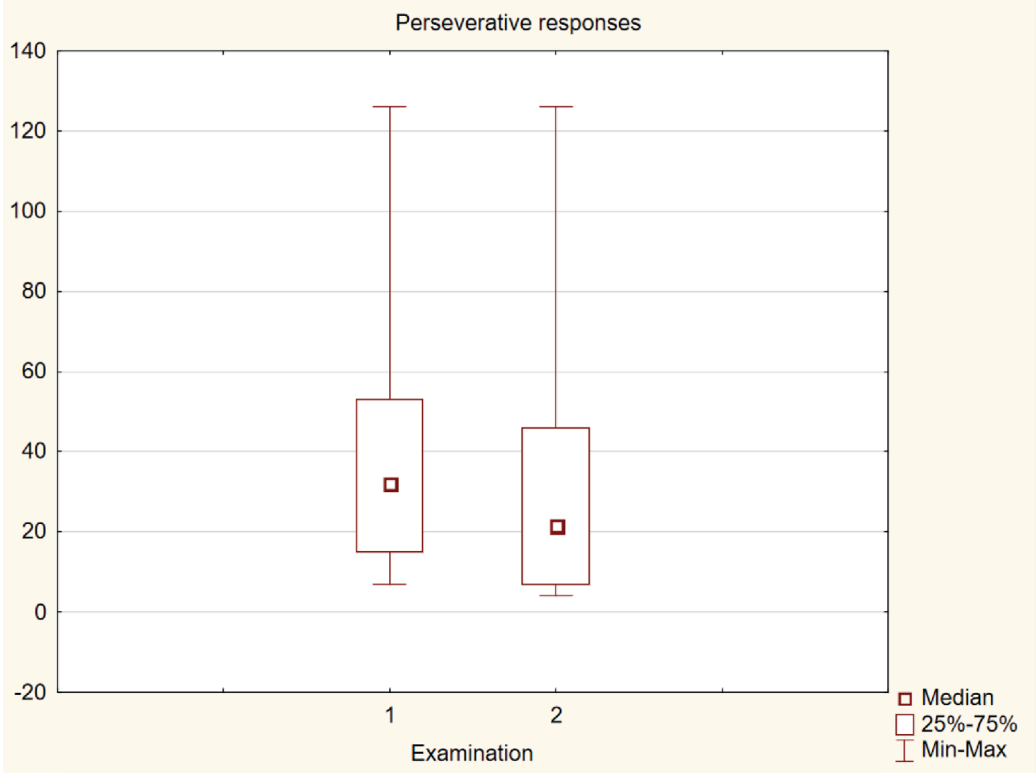

Fig. 1. Number of perseverative answers in the first and second examination.

(7 patients), anxiety disorders (8 patients) and organic mental disorders (5 patients).

The second examination saw a statistically significant decrease in the number of perseverative answers provided compared to the first examination (p<0, 05). Those results were presented on the chart (Fig. 1).

No statistically significant changes were observed among the remaining variables (number of correct answers total, number of errors total, perseverative errors, conceptual answers).

DISCUSSION

Existing scientific studies indicate that physical and cognitive social rehabilitation has a positive influence on psychological functioning, especially among the patients suffering from mental disorders as well as the elderly people [14, 15]. Several studies have reported changes in brain under the influence of cognitive rehabilitation [18-21]. Cognitive training is often used in elderly people, especially with mild cognitive impairment (MCI) to prevent the progression of dementia. Modern neurocognitive rehabilitation methods that stimulate neuroplasticity of the brain include: neurofeedback, musical and abacus training, computerized cognitive training programs, aerobic and resistance training, brain-computer interface technology, transcranial non-invasive brain stimulation (NIBS), Strategic Memory Advanced Reasoning Training (SMART) [18-21]. Some researchers point to the benefits of combining computerized cognitive training with pro-cognitive medication [22]. In addition to typical pro-cognitive drugs, vortioxetine (antidepressant) also shows this beneficial effect.

It seems that virtual reality may be an important element that should be introduced into the neuropsychological rehabilitation of patients with mental disorders. Studies on the rehabilitation of patients using this method indicate improvement in WCST results after rehabilitation using virtual tools. Among others in the research [23] a decrease in perseverative answers was found in the group of examined patients. In our study, a decrease in this area was also observed after rehabilitation based on physiotherapeutic and social interventions, as well as classic tasks supporting cognitive functions. In the study by Marques et al., using VR methods, results were also improved in terms of WCST measures such as number of errors, persistent errors and categories [23]. This suggests that the introduction of VR into the rehabilitation of patients with mental disorders may significantly support the rehabilitation of cognitive functions based on classical interventions.

Currently, in order to ensure adequate rehabilitation specialised facilities are being created in the form of day care departments and mental support centres. Analysed in our research were the changes of cognitive ability assessed using the Wisconsin Card Sorting Test carried out among the patients suffering from mental disorders such as psychotic disorders, affective disorders, anxiety disorders and organic disorders. In the field of cognitive ability a positive change was observed in the area of perseveration. A statistically significant decrease in the number of perseverative answers was noted. It indicates that improvement was achieved in

the swiftness of adaptation to the changing conditions of the task. The flexibility of cognitive functioning, including the ability to react to the changing environmental conditions, is one of the crucial abilities enabling adequate and adaptive actions. No statistically significant differences in the other characteristics assessed in the Wisconsin Card Sorting Test were observed. The lack of observable disparities in this field between the first and the second examination might be a result of the research limitations, including the small size of the sample group as well as its heterogeneous nature in socio-demographic characteristics. At this point, attention must be paid to various age of the patients, as well as to different mental disorders in the subjects (psychotic disorders, affective disorders, anxiety disorders and organic mental disorders).

CONCLUSIONS

Social, cognitive and physical rehabilitation has a beneficial effect on improving the quickness of response to changing task conditions in patients with mental disorders.

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ORIGINAL ARTICLE

Method of physical improvement of higher education students by means of functional training in the aspect of health-preservation

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ABSTRACT

Aim: To justify and experimentally verify the modern method of physical improvement of higher education students by means of functional training, taking into account the individual capabilities of student age in the aspect of health-preservation.

Materials and Methods: 264 students of the 1st-2nd years of the specialties: «Physical therapy, occupational therapy», «Technologies of medical diagnosis and treatment», specialty «Secondary education. Physical culture» and «Physical culture and sport. Sport» took part in the study. They attended physical education classes and extracurricular functional training classes during 2020-2022 in three stages: theoretical and diagnostic stage; analytical and research stage; experimental and generalizing stage. Students were from the Educational and Scientific Institute of Physical Education and Sports of the State Institution «Luhansk National University named after Taras Shevchenko», the Communal Institution «Kharkiv Humanitarian and Pedagogical Academy» of the Kharkiv Regional Council. Research methods: theoretical, empirical, methods of statistical data processing.

Results: The survey of the tested contingent showed that 60% of respondents want to increase muscle mass, increase strength – 30%, correct the figure – 10%. Among the forms of classes, 46% students consider independent classes to be the best, physical education classes – 40%, personal and group classes – 14%.

Conclusions: An experimental method of physical improvement of students of higher education institutions using functional training exercises has been developed. A feature of the developed methodology is the individualization and integral combination of traditional teaching methods with innovative ones with gradual complication of the content of classes.

KEY WORDS: technique, physical improvement, students of higher education, quality of training, means of functional training, health-preservation

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INTRODUCTION

The concept of physical education in the education system of Ukraine focused attention on the development of scientific research on the problems of physical education in institutions of higher education: development of the concept of the development of science in the field of physical education and sports, programm and normative foundations of physical education of young people, taking into account the criteria for assessing health, maintaining a healthy lifestyle, and physical self-improvement [1].

Scientists [2-4] and others note that in today's conditions there is a negative trend of increasing the number of students of special medical groups as among first-year students, as well as in the process of learning in institutions of higher education, which arises due to the reduction of credits for «physical education», the deterioration of the state of health of students, the peculiarities of the organization of the educational process in institutions of higher education during the Pandemic-2019 and martial law period.

Following scientists have studied the influence of health fitness on various body systems [5-9]. Some aspects of functional training in the physical education system of female students were considered by [10], functional training as a form of extracurricular sports mass work in a higher educational institution [11], features of functional training using the «TRX Functional Loops» simulator [12].

Considering this problem in European scientific space, scientists drew attention to: Characteristics of morphofunctional state of paratrooper cadets in the process of crossfit training [13]; Dynamics of students' fitness level while differentiating physical education classes in accordance with their health and nosology of diseases [2]; Physical Development by Means of Fitness Technologies as one of General Aspects of Student's Health [14]; Methodical System of Using Fitness Technologies in Physical Education of Students [15]; Checking of the Methodical System Efficiency of Fitness Technologies Application in Students' Physical Education [7]; System of Preparation of Future Fitness Coaches' for Health-Improving Activity in the Conditions of Rehabilitation Establishments [16]; Dynamics of the Functional State of Students in the Process of Powerlifting in Higher Education [17]; Leisure and recreational activities of student

youth in the context of healthpreservation [18]; Modern approaches to the formation of professional readiness of future specialists in physical rehabilitation in the context of restoring the health of athletes [4]; Analysis of the Current State of Training of Future Specialists in Physical Culture and Sports in the Conditions of Distance Learning [19]; Study of the State of Physical Fitness of Students of Medical Institutions of Higher Education by Means of Crossfit in the Process of Physical Education [3]; The influence of taebo on the development of motor potential of students of medical and pedagogical specialties and its efficiency in the process of extracurricular activitiesh [20].

It should be noted that for the prevention of deviations in the state of health, physical exercises aimed at strengthening health and creative activity are necessary. Increasing work capacity and active longevity is associated with certain difficulties caused by the low level of knowledge of the impact of physical exercises on the human body, the peculiarities of individualization of health-oriented physical programs, the use of exercise equipment depending on functional and physical fitness. Therefore, one of the main tasks of physical education is to ensure the optimal level of motor activity, which allows to achieve the highest level of functional capabilities and vitality of the body. Therefore, we proposed a modern method of physical improvement of students of higher education by means of functional training in the aspect of health-preservation.

AIM

The aim of the study is to justify and experimentally verify the modern method of physical improvement of higher education students by means of functional training, taking into account the individual capabilities of student age in the aspect of health-preservation.

MATERIALS AND METHODS

264 students of the 1st-2nd years of the specialties: «Physical therapy, occupational therapy», «Technologies of medical diagnosis and treatment», specialty «Secondary education. Physical culture» and «Physical culture and sport. Sport» took part in the study. Students were from the Educational and Scientific Institute of Physical Education and Sports of the State Institution «Luhansk National University named after Taras Shevchenko», the Communal Institution «Kharkiv Humanitarian and Pedagogical Academy» of the Kharkiv Regional Council. They attended physical education classes and extracurricular functional training classes during 2020-2022 in three stages: *theoretical and diagnostic stage* (2020); *analytical and research stage* (2021-2022); *experimental and generalizing stage* (2022).

At different stages we have used such *set of research methods*:

– *theoretical* – methods of conceptual and comparative analysis, which compared the existing theoretical approaches on the basis of generalization of philosophical, methodological, psychological, pedagogical, educational literature and video materials; method of structural-system analysis and modeling;
– *empirical* – methods of collecting information (questionnaires, surveys, pedagogical testing), analysis of learning outcomes, interviews, methods of expert assessment, self-assessment, generalization of independent characteristics; ascertaining, formative, and control stages of pedagogical experiment, methods of clarity;
– *methods of statistical data processing* – for processing experimental data, their quantitative and qualitative analysis. They were used to identify the reliability of the difference between the studied indicators, the correct processing of the results, reflecting them in graphical and tabular forms, conducting experimental testing; descriptive statistics, determination of the statistical significance of differences between groups by correlation analysis by Pearson's method.

The Ethics Commission of the Luhansk Taras Shevchenko National University has no comments on the methods used in this study.

RESULTS

In the educational and scientific institute of physical education and sports of the State institution «Luhansk National University named after Taras Shevchenko», teachers actively introduce following into the educational process: health-preserving technologies, modern methods and the latest technologies in the conditions of mixed learning, the Internet is widely used, modern multimedia software, a student-centered approach aimed at individual personality development, enjoyment of classes. Tasks of students' health-preservation in higher education are solved in the process of teaching the following disciplines: «Musical and rhythmic education and the basics of health fitness», «Gymnastics with teaching methods», «Technologies of physical culture and health activities for training people with special needs», «New technologies and modern methods of teaching physical culture in educational institutions», «Recreation in physical culture of different population groups» and others.

Young men demonstrate an increase in the popularity of such types of fitness as strength training with simulators (36%), crossfit (25%) and functional training (27%), while girls prefer exercises performed to music, like dance aerobics (21%), step aerobics (19%), functional training (14%). Respondents consider endurance, strength and flexibility to be the most important qualities for an active life. In order to correct those, most students are ready to devote 3 hours a week or more to functional training.

When performing various fitness exercises and functional training exercises, the highest heart rate (HR) occurs when performing exercises that include large groups of muscles, of a strength nature or performed at a large amplitude. There is a linear relationship between heart rate and work intensity within 50-90% of maximum load tolerance.

So, as a result of systematic training, such changes occur that ensure an increase in the body's oxygen consumption during muscle work. The strength of respiratory muscles increases. The total volume of the lungs and the vital capacity

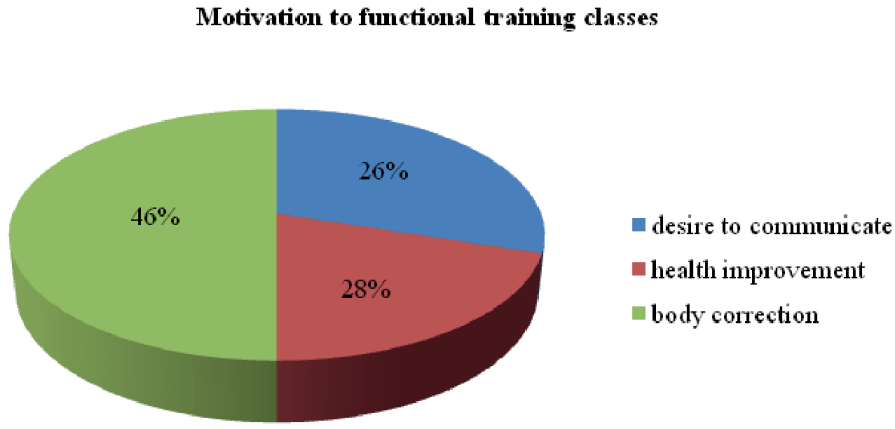

Fig. 1. The leading motives of higher education seekers for engaging in functional training, %.

of the lungs increases, the number of blood vessels in the lungs increases, which makes it possible during work for a larger amount of blood to be saturated with oxygen and get rid of carbon dioxide in a shorter time.

Thus, systematic classes of functional training make it possible to acquire a good sense of well-being, improve health, and are gaining more and more popularity among young people. As a result of studying the motives and interests of functional training, it was found that the most pronounced motive is to increase the functional capabilities of the body and the desire to improve one's appearance – 46%. The next leading internal factor that affects the motive among the surveyed students of the 1st-2nd years is strengthening one's health – 28%. This is followed by the possibility of relieving emotional tension, the desire to look good in one's own eyes and the desire to communicate – 26% (Fig. 1.).

The survey of the tested contingent showed that 60% of respondents want to increase muscle mass, increase strength – 30%, correct the figure – 10%. Among the forms of classes, 46% students consider independent classes to be the best, physical education classes – 40%, personal and group classes – 14%. To the question: «Are you able to independently select exercises for functional training» – only 29.8% answered «yes». The vast majority of respondents (70.2%) answered «no».

During the entire experiment, the subjects did not have any serious illnesses or injuries. The subjects noted a gradual improvement in their well-being, an increase in the general working capacity of the body. Particularly significant changes were observed in persons with a low level of physical condition. As a result of the experiment, the resting heart rate of the participants slightly decreased, on average by 4.05 beats per minute (bpm). The reaction of the heart to standard physical exercises (functional tests) improved. This was manifested in a smaller increase in heart rate when performing loads of the same power and in a more intense recovery of this indicator, on average by 10 seconds. Arterial pressure at rest during the entire experiment in all subjects was stable and within normal values. There was only a slight tendency to its decrease, on average by 5.48 mm Hg. As a result of the classes, there were significant changes in the functional state of the muscular system. Skeletal muscle strength determined by dynamometry increased by an average of 2.86 kg.

The effectiveness of the methodology of functional training consists in the complex physical development of the body immediately in the following directions: high performance of the cardiovascular and respiratory systems, general and strength endurance, strength, power, speed, balance, accuracy, flexibility, coordination, as well as quick adaptation to changes in load. When conducting classes, on the recommendation of D. Pyatnytska, O. Shkola gradually made the content of classes more difficult: the first level involves mastering individual exercises without using movements, combining them into «chains»; the second level involves the sequential combination of several «chains» to form a complete «connection» of the exercise; the third level of difficulty includes exercises performed with different movements.

In the process of the experiment (taking into account the recommendations of scientists and practitioners), a basis was developed for the creation of experimental methods of physical improvement of students of higher education institutions (Table 1) and experimental methods of physical improvement of students of higher education institutions using functional training exercises (Table 2).

We improved the methodology, which included: the structure of the class at the stage of learning functional training exercises, which differed in that the emphasis was placed on increasing general physical fitness, building endurance, teaching the technique of performing special exercises with gradual complication of the content of classes. In our teaching methodology, 15-20% of the total time of the lesson was allocated to the preparatory part of the lesson. In the preparatory part, they performed various types of running, general development and gymnastic exercises, a combination of running with «push-ups», jumping on a rope. Up to 30-40% of the total class time was allocated to the main part of the class. In the main part, they performed a series of strength, aerobic and mixed exercises using the circular training method. Circular training increased motor and emotional density, made classes more diverse

Table 1. The basis for the creation of experimental methods of physical improvement of students of higher education institutions

Purpose and tasks			
Primary		**Secondary**	
Comprehensive physical development of the body in aspect of health-preservation	Physical improvement	Relaxation exercises	Resting
Increase in general physical fitness. Quick adaptation to load changes	High performance of the cardiovascular and respiratory systems. General and strength endurance, strength, power, speed, balance, accuracy, flexibility, coordination	Coordination exercises and stretching exercises	Breathing and psychoemotional exercises
Use of various types of motor activity			
Means			
Learning the technique of performing special exercises			
Varieties of running, general development and gymnastic exercises. Jumping with a rope	Functional strength and aerobic exercises. Aerobics, dance exercises	Imitating real movements. Exercises in balance. Stretching	Breathing exercises. Art therapy

Table 2. Experimental method of physical improvement of students of higher education institutions using functional training exercises

DISTRIBUTION OF EXERCISES BY LEVEL OF DIFFICULTY		
Basic level program	**Intermediate level program**	**High level program**
– basic elements of functional training; – learning the correct exercise technique and safety techniques.	– demonstration of the main elements of functional training with an explanation of the exercises at the teacher's expense and accompanied by music.	– teaching the technique of performing special exercises; – combination with other types of motor activity; – increasing the speed of performing exercises; – performance of functional training without pauses.
RESULTS OF TRAINING		
1. Training in accordance with the level of physical fitness of students of higher education for the purpose of health-preservation. 2. The sequence of learning functional strength, aerobic and jumping exercises with gradual complication of the content of classes. 3. Complex physical development with the use of additional exercises: general developmental, gymnastic, dance, breathing, psycho-emotional exercises, stretching, art therapy. 4. Improving the content of academic disciplines: «Musical and rhythmic education and the basics of health fitness», «Gymnastics with teaching methods», «Technologies of physical culture and health activities for the training of persons with special needs», «New technologies and modern methods of teaching physical culture in educational institutions», «Recreation in physical culture of different population groups».		

and interesting for students, giving space to individual opportunities and personal initiative, thereby increasing motivation to engage in physical culture. In addition, dance steps were included: gallop step, polka, waltz step, various snakes, jumping exercises. Exercises on the short rope included: jumps with a double rotation; jumps with a 180° turn; jumping with movement, including handwork; jumping in place for 30 seconds without stopping, jumping in place for 1 minute, without stopping, at an average pace. Only 5-10% of the total class time was allocated to the final part of the class. The content of the final part included exercises for the abdominal muscles 3-4 sets of 15-25 times, stretching exercises and art therapy.

The main content of the developed methodology is theoretical, practical, sectional and independent classes in leisure activities. It also included forms of physical exercise control and self-control, taking into account individual, differentiated, systemic and gender approaches.

Functional training classes were offered, the program and method of their application consisted of 2 blocks:

1. A block of exercises using: skipping ropes – gymnastic sticks – bodybars – fitballs – rubber balls of different diameters.

2. Block of exercises using: step platform – platform slide – Airex Balance Pad.

Simulators produced by Kettler were also used in the classes: strength training center «HAMER»; multifunctional

simulator «ULTRA»; multifunctional simulator «BASIC»; step simulator «STEP»; bicycle ergometer «TX-1» (equipped with a cardio sensor); treadmills «PROFORM» and «TUNTURY» (equipped with a cardio sensor).

Functional training included exercises with dumbbells and a barbell, which allowed many more varieties of one exercise, to change the angle of inclination and amplitude of movements. Exercises were performed for several muscle groups at the same time (complex exercises), which provided more effective training. Natural movements were the basis, that allowed to improve coordination of movements and develop the ability to maintain balance.

The selection of rational means of physical education for health-oriented classes was carried out taking into account the age and physical condition of the participants. Functional training classes were held 2-3 times a week for 60-90 minutes. Exercises on the cycle ergometer, treadmill, step trainer were cyclic in nature, performed at a uniform pace and occupied 60% of the training time in persons with a low and below average level of physical condition and 40% of the time in persons with an average and above average level of physical condition. Subjects with a low level of physical condition performed cyclic exercises at a heart rate of about 130-140 bpm. At a higher level of physical condition, the heart rate was maintained at the level of 140-160 bpm. The results of the survey are presented in Table 3.

So, on the basis of the presented questions, we can come to the conclusion that the introduction of the functional training method had a positive effect on the attitude of 1-2 year students to their own health and motivation for classes.

The regularity of physical exercise classes for students of 1-2 courses as part of their own physical self-improvement is specified in Table 4.

So, as we can see from the table, almost half of girls and boys do not do physical exercises. During the research, general scientific methods were used: observation, description, comparison, analysis, synthesis, generalization, classification.

The generalized quantitative results of the initial level of adaptation of students of 1-2 courses to physical education classes by means of functional training and health-preserving technologies of EG and CG are shown in Table 5.

DISCUSSION

Scientists noted that in the physical education of students of higher education, the main focus is traditionally on the development of motor skills and sports and technical readiness (mastering the techniques of various sports). Education of the need for physical improvement, taking into account individual characteristics, in the practice of physical education teachers is mostly carried out episodically [3, 7, 9, 21-26]. Among the external factors of the formation of the need for physical self-improvement are: personality of the teacher, content of training and teaching methods, condition of sports facilities, availability of sports equipment. Among the internal ones are: motives, interests, value orientations, level of development of personal qualities, self-assessment of the state of health and physical fitness. The results of the analysis of practice and numerous scientific studies show that the process of formation of the need for physical self-improvement

Table 3. The results of the survey of students of 1-2 years

Questions and answers in the survey	November 2021 (%)		November 2022 (%)	
	EG	CG	EG	CG
Your attitude towards functional training classes:				
I do it with great desire	20%	18%	68%	22%
Satisfactory	44%	46%	20%	50%
Indifferently	24%	23%	9%	20%
I don't have time for training	12%	13%	3%	8%
Do you have missed lessons?				
Rarely, only for a good reason (illness, etc.)	56%	50%	28%	44%
Often, for no good reason	24%	26%	8%	26%
I visit regularly	20%	24%	64%	30%
How does functional training affect your health?				
Positively	52%	53%	76%	60%
Negatively	12%	14%	8%	10%
Hard to answer	36%	33%	16%	30%
What types of physical activity do you like to do?				
Athletics	20%	23%	16%	22%
Gymnastics	24%	20%	18%	17%
Sports games	36%	40%	22%	38%
Functional training	20%	17%	44%	23%

Table 4. Table of the regularity of physical exercises of students of higher education within the framework of their own physical self-improvement

Regularity of classes	Boys, %		Girls, %	
	Beginning	End	Beginning	End
5-6 times a week	6.4%	14.2%	5.0%	12.5%
3-4 times a week	20.4%	28.5%	18.4%	25.3%
1-2 times a week	26.2%	40.5%	20.2%	38.2%
Do not perform	47.0%	16.8%	56.4	24.0%
Including those who are taking classes:				
With an instructor or a teacher	22.8%	43.2%	12.4%	35.4%
Independently	30.2%	40.0	31.2%	40.6%

Table 5. Initial level of adaptation of students of 1-2 courses to physical education classes by means of functional training and health-preserving technologies (%)

Group	Levels, %					
	High		Medium		Low	
	Beginning	End	Beginning	End	Beginning	End
Experimental group	9.8	22.4	35.6	53.6	54.5	26.0
Control group	10.2	12.0	32.5	38.0	57. 3	50.0

among students of higher education consists of a number of interrelated directions: fostering a positive attitude towards physical education and sports; mastery of knowledge and awareness based on them of beliefs in the need for systematic physical exercises; formation of relevant abilities and skills; involvement of student youth in daily physical education classes [21-22].

We agree with S. Sychev's opinion that self-improvement is most often motivated by the desire to surpass the current self, to achieve higher results, to improve one's skills, to acquire important personal qualities. This is constant work on oneself with the aim of positive change, getting closer to a certain ideal «Self», realization of the tendency towards personal growth, towards professional development, self-discovery and self-determination [22]. In our study, we will physically improve students of 1-2 courses by means of functional training, which are part of fitness classes in the process of physical education and extracurricular activities.

Fitness is, first of all, a healthy lifestyle, a chance to change the quality of life without excessive effort; the most advanced training system to date, which includes all the most effective methods of «body education» [5-7, 19, 27]. Fitness is classified by following main categories:

1) *cardio programs*, aimed at the development of the cardio-respiratory system, which include all types of aerobics, namely: basic, health, sports, applied, step aerobics, dance aerobics, interval, spinning, tai-bo, kick aerobics, boxing aerobics, slide aerobics, aqua aerobics;

2) *strength training programs*, which are aimed at developing the strength of all muscle groups of the body with the use of various sports equipment, namely: dumbbells, body bars, a special barbell-pumps, stuffed balls, etc.;

3) *fitness programs of recreational gymnastics*: classes in yoga, pilates, fitball, calanetics, stretching, etc.);

4) *functional training*, that is, complex fitness programs that provide an opportunity to simultaneously develop strength, flexibility, balance, and dexterity. Functional training is carried out both as a separate training and as an additional load to traditional strength training.

As points out, modern popular functional programs include crossfit training, the Tabata protocol and TRX loops. Complication of training occurs due to special equipment, in particular core platforms, bosu (rubber hemispheres), fitballs (rubber gymnastic balls), TRX loops, etc. [12].

Next, we will consider the concept of «functional training» according to different authors (Table 6).

We agree with that the features of functional training are [11]: a wide range of physical exercises (with or without objects, on equipment, simulators, etc.); functional connection of motor activity with music, high emotionality of classes; wide variability in the use of methods and methodological techniques; opportunities for creative self-expression, getting pleasure from performing various motor actions; improvement of movement capabilities, improvement of movement culture; acquisition of special knowledge and self-control skills.

S. Oger notes: «At the beginning, in functional training it is quite enough to use only the weight of one's own body. Then you can add various additional equipment: rubber shock absorbers, unstable platforms, balls, free weights, body bars, etc. But it is fundamentally important to first learn how to technically perform the basic exercises, and only after that you can add additional resistance or elements of instability (unstable platforms, bosu, TRX, etc.)». The author suggested using hanging loops, thanks to which

Table 6. Definition of the concept of «functional training» according to different authors

Author, year	Definition
V. Biletska, E. Petrenko, I. Bondarenko, 2012	«Functional training» is aimed at learning motor actions, education of physical qualities (strength, endurance, flexibility, speed and coordination abilities) and their combination, improvement of physique, i.e. what can be defined as «good physical condition», «good physical shape», «athletic appearance» [10].
N. Dovgan, 2017	«Functional training» is a process of sports training aimed at strengthening health, developing motor skills, increasing the level of physical fitness, which is determined by the components of physical, mental, spiritual and social states; is a very promising innovative technology that expands students' opportunities for physical self-improvement, diversity of the training process, providing individual coloring and showing one's own individuality [11].
A. Miroshnikov, 2013	«Functional training» is primarily movement training, not muscle training. Only a strengthening effect is exerted on the muscles in the process of functional training [23].
Y. Tatura, 2006	«Functional training» (in the narrow sense) – training aimed at developing coordination (balance). Functional training contributes to the harmonious development and improvement of the body, increases the level of physical development, the formation of the need for motor activity, the achievement of physical improvement, strengthening health by determining the presence of the necessary strength, speed, endurance and dexterity, a wide variety of motor skills and abilities [24].
S. Oher, 2019	«Functional training» is a combination of exercises used in functional training classes, that contribute to the improvement of all physical qualities, psychologically relieve the body, and increase emotional mood [12].

you can change the load individually to suit yourself and your level of physical fitness [12].

In turn, V. Biletska, E. Petrenko, I. Bondarenko noted that the most popular directions of functional training are training using step platforms, Core platforms, Bosu (rubber hemispheres), fitballs (rubber gymnastic m cages), Airex Balance Pad balancing pillows (pillows made of soft «foam» material), jump ropes, gymnastic sticks, rubber balls, body bars [10].

For the purpose of physical improvement, functional training helps students of higher education to adapt to all the variety of physical loads that they have to face every day in everyday life. The main principle of functional training is adaptation to loads that determine the manifestation of general aerobic endurance, speed endurance, power endurance, speed-power endurance, speed, dynamic muscle strength, functional strength, flexibility, stability, balance and coordination [25-27]. We also note that in many European countries, functional training is a global program aimed at strengthening the health of the nation.

Analysis of the classifications of existing health-preserving technologies used in the educational process of higher education institutions made it possible to distinguish the following types [6]: *health-preserving technologies*, which create safe conditions for the education of students and solve the tasks of rational organization of the educational process (taking into account age, sex, individual characteristics and hygienic norms), compliance of educational and physical loads with the capabilities of the student; *health technologies*, aimed at solving the tasks of strengthening the health of student youth and increasing health resources, which include hardening, health gymnastics, massage, phytotherapy, music therapy; *health-preservation education technologies* – hygiene training, formation of life skills (emotion management, conflict resolution), injury prevention and substance abuse, sex education; *education of health culture* – education in students of personal qualities that contribute to preserving and strengthening health, forming ideas about health as a value, strengthening motivation to lead a healthy lifestyle, increasing responsibility for personal and family health.

According to the analysis of literary sources, the use of health-preserving technologies in physical education in higher education institutions allows expanding the reserves of physiological functions, restoring the body's ability to self-regulate. It is necessary to ensure a comprehensive approach to the harmonious formation of all components of health, improvement of physical and psychological preparation for an active life and professional activity, especially in conditions of martial law; use of various forms of motor activity and means of physical improvement [11, 13, 20]. So, the health-improving effect of fitness training is associated with increasing the functional capabilities of the cardiovascular system. It consists in economizing the work of the heart at rest and increasing the reserve capabilities of the circulatory system during muscle activity.

Scientists point out that adolescence is the period of completion of growth processes, an important stage in the formation of physical development indicators, which begins in high school age and passes into the first period of adulthood in the last courses of study at a higher education institution [28]. The anatomical and physiological «tension» of this age is explained by a sharp change in the place of residence, climate, social conditions, daily routine, nutrition, physical and mental load. Most often, the reason for these changes is graduation from a general secondary education institution and entry and study at a higher education institution.

Then comes the «stress stage» of physical, psychological and social development. At this age, it is recommended to do physical exercises at least 3 times a week for 2 hours with an additional health-improving and recreational effect [28].

An important role in the preparation of individual programs is played by the test results, which determine the expediency of using simulators, allow you to determine the time of exercise, the pace and the amount of resistance of the simulator. Determining a low level of physical condition gives reason to include cyclical exercises on the «treadmill», «cycle ergometer», and «stepper» in classes. Lag of strength indicators from normative values serve as a basis for using exercises with weights [2, 15, 16]. Therefore, with the complex use of simulators, the sequence of using various means in health training should be followed. A positive effect from exercises is observed if the training process first achieves the goal of increasing general endurance, then speed-strength and speed qualities. When selecting exercises on the simulators, it is also important to follow the optimal sequence and include the muscle groups of the legs, back, abdomen, arms and trunk in the work.

CONCLUSIONS

Therefore, the level of adaptation of higher education students to physical education classes by means of functional training and health-preserving technologies increased significantly in the experimental group and remained almost unchanged in the control group.

Based on the analysis of scientific and methodological literature, we have developed an experimental method of physical improvement of students of higher education institutions using functional training exercises. The peculiarities of the methodology of conducting functional training classes, which provide for the implementation and conduct of general and special training of students of higher education, taking into account the individual characteristics of physical development and physical fitness, have been revealed. A feature of the developed methodology is the individualization and integral combination of traditional teaching methods with innovative ones with gradual complication of the content of classes.

Physical improvement can be based only on a personal and individual approach, taking into account the physical capabilities of each student. Physical self-improvement is a set of methods and types of life activities that determine and regulate the position of a person in relation to his physical development, physical fitness and state of health.

The health-improving effect of functional training classes is associated with increasing the functional capabilities of the cardiovascular system and consists in saving the work of the heart at rest and increasing the reserve capabilities of the circulatory system during muscle activity. Therefore, systematic classes are aimed at good health and health-preservation. In the future work, the differentiation of training in functional training classes will be carried out.

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REVIEW ARTICLE

Balneotherapy in urology

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ABSTRACT

Aim: This article aims to analyze the scientific understanding of the role of balneotherapy in the treatment of numerous urological conditions based on the latest research and clinical findings.

Materials and Methods: A review of literature from PubMed and Google Scholar databases published between 2000 and 2023 on the use of balneotherapy for urological conditions was performed. The literature data was analyzed to identify the most common urological conditions such as chronic pelvic pain, urinary incontinence, urolithiasis, rehabilitation after prostatectomy and overactive bladder syndrome in which this field of physical medicine is applicable. Publications containing the following keywords were selected for analysis: balneology, urology, cpp, OAB, urolithiasis, post-prostatectomy treatment. Out of 90 papers, 26 sources containing key information related to the topic of the paper were selected.

Conclusions: While the potential of balneotherapy in urology appears promising, it is crucial to approach these findings with cautious optimism. Many studies are in their early stages, and larger, multicenter, randomized, controlled trials are essential for a solid understanding of the role of balneotherapy in urology. In addition, it is essential to establish standard protocols to ensure patient safety and treatment efficacy. As our knowledge deepens, balneotherapy, with its rich history, may become a cornerstone of modern urologic care.

KEY WORDS: urology, CPP, OAB, incontinence, urolithiasis, balneotherapy

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INTRODUCTION

The field of urology has witnessed significant advances and diversification of therapeutic methods over the past few decades. Among them, balneotherapy – the time-honored practice of using mineral waters and muds for treatment – has emerged from the annals of historical remedies and has become the focus of modern scientific research. Although historically rooted in anecdotal evidence and tradition, the 21st century has seen an increase in research efforts to demystify its therapeutic mechanisms and potential applications in urological conditions. This review seeks to gather and analyze existing knowledge on the subject, from mechanism studies to clinical trials, offering a comprehensive understanding of balneotherapy's place in modern urology. During this exploration, it becomes necessary to consider both its therapeutic potential and the challenges it poses, preparing the ground for its integration into evidence-based medical practice [1].

AIM

This article aims to analyze the scientific understanding of the role of balneotherapy in the treatment of numerous urological conditions based on the latest research and clinical findings.

MATERIALS AND METHODS

A review of literature from PubMed and Google Scholar databases published between 2000 and 2023 on the use of balneotherapy for urological conditions was performed. The literature data was analyzed to identify the most common urological conditions such as chronic pelvic pain, urinary incontinence, urolithiasis, rehabilitation after prostatectomy and overactive bladder syndrome in which this field of physical medicine is applicable. Publications containing the following keywords were selected for analysis: balneology, urology, cpp, OAB, urolithiasis, post-prostatectomy treatment. Out of 90 papers, 26 sources containing key information related to the topic of the paper were selected.

REVIEW AND DISCUSSION

The therapeutic efficacy of balneotherapy in urological conditions can be attributed to a number of biochemical and physiological mechanisms. First of all, the mineral components of the medicinal waters, including sulfates, bicarbonates and trace elements, have shown anti-inflammatory, analgesic and muscle relaxing effects [2]. Moreover, balneotherapy helps improve microcirculation and promote tissue oxygenation, which is crucial for healing and regeneration [3]. Studies have also shown its potential to modulate the immune response by affecting the synthesis and release of certain cytokines, which play a key role in urological conditions such as interstitial cystitis [4]. The thermal aspect of balneotherapy offers additional benefits: it improves vascular dynamics, relieves pain and promotes relaxation, which can be particularly important in conditions characterized by pelvic floor dysfunction or pain [5]. While the exact mechanistic

pathways are still being clarified, there is no doubt that the interplay between the chemical, thermal and hydrostatic properties of balneotherapy offers a multifaceted approach to treating a range of urological conditions.

BALNEOTHERAPY AND ITS THERAPEUTIC BENEFITS IN CHRONIC PELVIC PAIN

Chronic pelvic pain (CPP) is a multifactorial and often debilitating condition that poses significant diagnostic and therapeutic challenges. Emerging research highlights balneotherapy as a promising adjunctive or alternative treatment for CPP. The mineral-rich waters used in balneotherapy have shown profound anti-inflammatory properties, alleviating the inflammatory cascades often associated with the pathogenesis of CPP [6]. Moreover, the heat associated with many balneotherapeutic practices serves not only to increase blood flow and tissue oxygenation, but also to relax the hypertonic pelvic floor muscles that often contribute to CPP [7]. Recent randomized controlled trials indicate a significant reduction in pain and improvement in quality of life among CPP patients receiving balneotherapy compared to standard care [8]. Moreover, the holistic nature of balneotherapy includes psychosomatic aspects, potentially alleviating psychological comorbidities often associated with CPP. As our knowledge deepens, balneotherapy may become an important tool in the multifaceted treatment of CPP, offering a synthesis of physiological and psychological benefits.

BALNEOTHERAPY AND ITS THERAPEUTIC EFFECTIVENESS IN URINARY INCONTINENCE

Urinary incontinence, a common urological condition, negatively affects the quality of life and psychosocial well-being of affected individuals. Balneotherapy is emerging as a potential therapeutic modality that offers promise for addressing the multifactorial etiology of incontinence. The mineral components of the therapeutic waters, particularly magnesium and sulfate, have been shown to have neuromuscular regulatory properties, potentially helping to restore detrusor muscle function and increase pelvic floor reactivity [9]. The heat of balneotherapeutic baths plays a dual role: it promotes blood flow and oxygenation of genitourinary tissues and facilitates muscle relaxation, potentially reducing episodes of incontinence [10]. Moreover, the hydrostatic pressure inherent in balneotherapy sessions supports pelvic floor muscle training, a cornerstone of incontinence treatment [11]. Recent studies have shown a significant reduction in incontinence episodes and improvement in urodynamic parameters among patients undergoing balneotherapy as an adjunct to conventional treatments [12]. Although more extensive controlled studies are needed, preliminary evidence suggests that balneotherapy is a potential boon in the treatment of urinary incontinence, offering physiological restoration combined with improved patient well-being.

BALNEOTHERAPY AS A METHOD OF REHABILITATION AFTER PROSTATECTOMY

Rehabilitation after prostatectomy is a key aspect of patient care, aimed primarily at restoring urinary function and improving overall quality of life. Balneotherapy has begun to gain popularity as a promising complementary therapy in this context. The therapeutic waters used in balneotherapy, which are rich in elements such as magnesium, sulfur and selenium, show potential anti-inflammatory properties that can accelerate the healing of surgical wounds and alleviate perioperative inflammation [13]. Additionally, the thermal properties of balneotherapeutic treatments may increase local circulation, promoting tissue repair and potentially alleviating postoperative complications [14]. There is also preliminary evidence suggesting that the hydrostatic pressure of balneotherapy may help strengthen pelvic floor muscles, which are key to regaining continence after prostatectomy. A recent cohort study found that patients undergoing balneotherapy after prostatectomy showed a faster return to baseline urinary function and reported better quality of life compared to their counterparts without balneotherapy [15]. While these results are indeed encouraging, larger randomized trials are needed to establish the role of balneotherapy in rehabilitation after prostatectomy. Nevertheless, the current data underscore the potential of balneotherapy as a holistic, patient-centered approach in postoperative care.

POTENTIAL OF BALNEOTHERAPY IN THE TREATMENT OF UROLITHIASIS

Urolithiasis, characterized by the formation of stones in the urinary tract, remains a common and recurrent urological condition. Emerging evidence highlights the potential benefits of balneotherapy as an additional therapeutic strategy for patients with urolithiasis. Mineral waters, particularly those enriched with magnesium and bicarbonates, have been shown to modulate urinary pH, potentially preventing crystallization of certain stone-forming salts [16]. In addition, the diuretic effect promoted by many balneotherapeutic sessions can facilitate the flushing out of smaller stone fragments and crystals, thus helping to expel stones and reducing the incidence of recurrence [17]. Increased blood flow and tissue oxygenation resulting from the thermal components of balneotherapy may also promote healing of renal tissue after stone injury [18]. A recent observational study showed that patients with urolithiasis who underwent regular balneotherapy sessions reported fewer episodes of recurrent stones and improved renal function compared to those who received only standard care [19]. Although these results indicate the positive implications of balneotherapy in the treatment of urolithiasis, further controlled studies are needed to solidify its role and optimize protocols. However, preliminary observations suggest a promising frontier for balneotherapy in the holistic care of patients with.

THE ROLE OF BALNEOTHERAPY IN THE TREATMENT OF OVERACTIVE BLADDER SYNDROME

Overactive bladder (OAB) syndrome, characterized by symptoms such as urinary urgency, frequent urination and nocturia, places a significant burden on sufferers. Balneotherapy is increasingly being explored as a therapeutic option for OAB, with intriguing results. Specific mineral

constituents of medicinal waters, particularly magnesium, have shown neuromodulatory effects that may play a role in stabilizing excitability of the detrusor muscles, and consequently reducing urinary urgency and frequency [20]. Furthermore, the warm temperatures characteristic of balneotherapeutic practices may increase blood flow to the pelvic area, potentially promoting tissue healing and reducing bladder hypersensitivity [21]. The hydrostatic pressure experienced during balneotherapy may also play a key role in strengthening the strength of pelvic floor muscles, thereby indirectly helping to relieve OAB symptoms. A recent randomized controlled trial highlighted the potential of balneotherapy, showing that OAB patients receiving balneotherapy along with standard treatment showed greater symptom reduction and better bladder diary parameters compared to the control group [22]. While these results are encouraging, further research is needed to define standard balneotherapy protocols for OAB. Nevertheless, current evidence points to balneotherapy as a viable and complementary

The resurgence of balneotherapy in modern urology offers compelling insight into the diverse benefits of this age-old therapeutic modality in a range of conditions. In patients with chronic pelvic pain (CPP), balneotherapy appears to counteract inflammatory pathways and relieve musculoskeletal discomfort, providing tangible symptomatic relief [23]. Promising results from balneotherapy have been reported in the incontinence arena, particularly after prostatectomy, with evidence suggesting improved pelvic muscle reactivity and potential restoration of detrusor muscle function [24]. Patients with overactive bladder (OAB), when introduced to balneotherapy, showed reduced urinary frequency, likely attributed to the neuromodulatory effects of mineral-rich waters [21]. Rehabilitation after prostatectomy, an area of great clinical importance, may benefit from the anti-inflammatory and restorative properties of balneotherapy, potentially accelerating recovery and improving functional outcomes Meanwhile, treatment of urolithiasis can be aided by the diuretic effect of balneotherapy, facilitating the expulsion of stone fragments and its ability to modulate urinary pH [25].

CONCLUSIONS

Balneotherapy, a centuries-old therapeutic practice that utilizes the healing properties of mineral-rich waters, has renewed interest in modern urology. From chronic pelvic pain to overactive bladder syndrome, its multifaceted benefits suggest profound implications for a variety of urological conditions. The mineral components, particularly magnesium and sulfate, appear to exert a variety of physiological effects, ranging from neuromuscular modulation to anti-inflammatory effects. Moreover, the thermal properties inherent in balneotherapy not only promote tissue oxygenation and blood flow, but may also promote neuromuscular relaxation, a key factor in conditions such as overactive bladder and recovery from prostatectomy[26]. The hydrostatic pressure experienced during balneotherapy sessions, as indicated in several studies, can also improve pelvic floor muscle training, increasing the utility of this method for conditions such as incontinence.

However, while the potential of balneotherapy in urology appears promising, it is crucial to approach these findings with cautious optimism. Many studies are in their early stages, and larger, multicenter, randomized, controlled trials are essential for a solid understanding of the role of balneotherapy in urology. In addition, it is essential to establish standard protocols to ensure patient safety and treatment efficacy. As our knowledge deepens, balneotherapy, with its rich history, may become a cornerstone of modern urologic care.

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REVIEW ARTICLE

Methodological potential of phenomenology and hermeneutics in research on valeological, rehabilitation and physiotherapeutic activities

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ABSTRACT

Aim: The aim of the study is to investigate the methodological potential of hermeneutics and phenomenology in modern specific scientific research on valeological, rehabilitation and physiotherapeutic activities, highlighting the substantive and functional features of phenomenology and hermeneutics in rehabilitation practice.

Materials and Methods: The basis of scientific research is the method of historical-philosophical analysis. In working with texts, the general methodological basis was the acquisition of historical-critical and systemic-structural approaches. Also, the interdisciplinary approach played a leading role in the work, which within the scope of the study involves the synthesis of not only the norms of scientific research of primary sources, but also theoretical ideas and principles that determine the directions of the object's research.

Conclusions: It was established that hermeneutics and phenomenology have significant methodological potential in valeological, rehabilitation and physiotherapeutic research. It has been proven that the problem of understanding is of particular importance in rehabilitation activities. With the help of hermeneutics, it is possible to create a bridge for effective communication between the rehabilitation doctor and the patient.

KEY WORDS: hermeneutics, phenomenology, methodology, valeology, rehabilitation, physiotherapeutic activity

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INTRODUCTION

Hermeneutics and phenomenology are one of the leading directions of modern philosophy that emerged at the turn of the 19th and 20th centuries. as a reaction to the crisis of European humanity and an attempt to theoretically substantiate the ways out of the crisis. Nowadays, phenomenology and hermeneutics have gained high authority in the scientific community [1].

Hermeneutics and phenomenology, as a philosophical theory and as a method of understanding and interpreting the text, with the development of knowledge and practices, acquires special relevance and wide application. Thus, hermeneutics can be considered as a foundation for solving the problem of understanding in valeological, rehabilitation and physiotherapeutic activities. It should be noted that hermeneutics is a method used for understanding between the patient and the doctor, where the patient is a source of information about his own state of the body, and the doctor as a subject is called to understand and is the foundation of communication between the doctor and the patient. Thus, interpretation and understanding, as the basis of hermeneutics, are necessary for the dissemination of medical knowledge and successful rehabilitation of the patient, and in general, for the development of the medical culture of society. Understanding is also the basis of compliance with ethical and deontological norms in medicine [2-5].

The development of philosophical hermeneutics in the XXth century. went far beyond the limits of German philosophy, overcoming the philological orientation as well. In general, modern philosophical hermeneutics, as before, faces a number of numerous challenges and temptations that constantly encourage philosophers, in the words of Alain Badiou, to «tailor» to the problems and discourse of some related disciplines and procedures of truth. For philosophical hermeneutics, these are forms and means of interpretation that are widespread in religious exegesis (with which hermeneutics is often equated), philology, and psychoanalysis. The latter is also a specific theory and technique of understanding and interpretation, but without that metaphysical basis, which at one time was the basis of the formation of hermeneutic ideas. Modern psychoanalysis has long been performing the role of a general humanitarian methodology, which tries to absorb hermeneutic procedures, to reinterpret the metaphysical core of philosophical hermeneutics within the limits of a specific reductionist discourse. Many hermeneutics are

aware of this, for example, P. Ricker in his work «The Conflict of Interpretations» devotes almost half of the book to psychoanalysis and does not perceive the psychoanalytic paradigm as something threatening [6-8]. But the word «conflict» still leads to certain thoughts.

AIM

The aim of the study is to investigate the methodological potential of hermeneutics and phenomenology in modern specific scientific research on valeological, rehabilitation and physiotherapeutic activities, highlighting the substantive and functional features of phenomenology and hermeneutics in rehabilitation practice.

MATERIALS AND METHODS

The basis of scientific research is the method of historical-philosophical analysis, which made it possible to trace the context and conditions of the emergence of philosophical hermeneutics and phenomenology, as well as the dynamics of its interpretations in various research methods and rehabilitation practice. In working with texts, the general methodological basis was the acquisition of historical-critical and systemic-structural approaches.

The leading role in the work was also played by the interdisciplinary approach, which, within the framework of historical-philosophical research, involves the synthesis of not only the norms of scientific research of primary sources, but also theoretical ideas and principles that determine the directions of object research. Also, the interdisciplinary approach played a leading role in the work, which within the scope of the study involves the synthesis of not only the norms of scientific research of primary sources, but also theoretical ideas and principles that determine the directions of the object's research.

REVIEW AND DISCUSSION

From a method that was called, in fact, to serve historical-philological and religious discourse, hermeneutics turned into an independent philosophical discipline that reflects the very essence of metaphysical problems. First of all, such a change is associated with the development of the phenomenological tradition, especially with the works of Heidegger, who managed to free hermeneutics from the excessive influence of language theories and put it at the basis of metaphysical inquiry. This, of course, does not mean that the language itself was in philosophical oblivion, it is only about a change in emphasis and research attitudes [1].

The ideas of creators of hermeneutic theories of the 19th century are quite relevant against the background of modern challenges (F. Schleiermacher, F. Ast, V. Dilthey), in which ideas about spiritual culture as a determining force of social development and individuality as a prerequisite for any existence were further developed [6]. In the end, these theories formed the basis of German hermeneutics and its approaches to interpretation, connected above all with the rejection of the understanding of hermeneutics as an auxiliary tool and its transformation into the most complete and perfect humanitarian methodology. Such is the philosophical hermeneutics of V. Dilthey in connection with his idea of historical knowledge. In the teachings of the philosopher, hermeneutics is not a separate component, but the essence of historical knowledge, which is based on the procedures of understanding and interpretation. It was this approach that later became the basis for the development of hermeneutics and its approaches to the interpretation of complex spiritual formations and contributed to the expansion of the methodological basis of humanitarian knowledge [6-7].

F. Brentano's philosophy of language and the doctrine of intentionality in connection with the development of hermeneutic ideas within the phenomenological school, as well as the relationship of this concept with representatives of various linguistic theories of the late 19th and early 20th centuries, are of fundamental importance for the understanding of modern hermeneutic studies. The concept of intentionality is presented as a key element in the process of understanding and interpretation. Also, understanding can be interpreted as the formation of a special intentional object, more broadly, a secondary intentional structure that creates lines of communication with the source text. Intentionality is considered as a primary model that creates meaning and the very possibility of hermeneutic interpretation [1, 4].

In the 20th century hermeneutic discourse was reflected in the writings of representatives of the phenomenological school of E. Husserl, M. Heidegger, as well as thinkers who in a certain sense worked in the problematic field created by phenomenology, such as A. Meinong and A. Marty [1, 2, 6, 7].

The development of German philosophical hermeneutics was logically completed in the hermeneutic project of H.-G. Gadamer as the final phase of the development of the circle of ideas of German philological hermeneutics of the 19th-20th centuries. The philosophy of language and the doctrine of understanding and interpretation are studied in connection with the development of hermeneutic ideas within the phenomenological school. The relationship between Gadamer's position and representatives of various linguistic theories of the beginning of the 20th century is quite debatable. The concept of understanding is presented as a key element of the hermeneutic process [2, 4].

Romanticism as an artistic and philosophical direction understands the practice of interpretation as a kind of creation of meanings, radically bringing interpretation and artistic creativity closer together. It is in romanticism that the concept of a genius recipient, that is, a reader or viewer, who, in order to understand a work of art, must be no less artistically gifted than the author, arises. This concept, or rather, a romantic fantasy, played a double and not only a positive role in the history of hermeneutics. Hence all the numerous romantic formulas about the fact that there are as few real readers as there are real writers, that reading is a special artistic skill that is difficult to learn, and, finally, that the reader must penetrate the soul of the author, live his life through emotional deepening his experience. This romantic fantasy is also far removed from the reality of language and its understanding, as well as from the experience of hermeneutic interpretation.

This attitude can only harm the understanding and put a reliable barrier to the meaning of any work of art. Indeed, can we be sure that this particular reader or viewer is as talented as the artist? This is impossible by definition, as it blurs the boundary between art and reality, between the work and its recipient. This is all the more impossible because, in fact, we still do not understand what the artist's genius consists of, not to mention that the artists themselves do not understand the essence of genius. In the period preceding romanticism, the reader was not considered as a participant in the process of understanding and interpretation. In the further development of hermeneutics and interpretation procedures, the recipient was introduced as a creative agency, but not at all as the romantics saw it. All the more so because we can say with full confidence that romanticism appeared in Germany as an intellectual environment within which it became possible to form the circle of ideas of philosophical hermeneutics. This school is also associated with the gradual liberation of hermeneutics from the influence of theology, which is particularly noticeable in the earlier period. Hermeneutics emerged from the romantic tradition and, along with its formation, radically changed the latter [8-10].

The second important intellectual field in which philosophical hermeneutics was formed was classical philology. It was the work on the publication of ancient classics, commentaries and attempts to understand the ancient heritage that stimulated the development of appropriate methods and theoretical understanding of the need to create a general theory of interpretation.

It is important to see modern philosophical hermeneutics in the context of ideas about the transformation of discursive practices and their influence on the formation of philosophical theories. Hermeneutics as a theory of understanding and interpretation is itself a family of discursive strategies conditionally combined into a single whole, and a new type of communication with the original source of philosophical knowledge, which is fundamental for understanding its individual components. It is very important to be aware of the relationship between philosophical hermeneutics and the philosophy of language and the theoretical uncertainty of the most important elements of hermeneutic discourse.

We are guided by the understanding that each significant philosophical theory, not to mention philosophical directions, produces and establishes a new, own style and even order of discourse, and it is philosophical hermeneutics that is this new order, which was present in one way or another in all directions without exception philosophy of the 20th century – phenomenology, existentialism, analytical philosophy, Marxism, psychoanalysis, etc. This interpretive discourse penetrated the essence of modern philosophy, and is its quintessence and main motive. Therefore, the hermeneutic logos is as if «splashed» in many theories, despite their often fundamental differences [9, 11].

This problem is not just one of the research tasks facing science, but the very essence, the meaningful core of hermeneutics. It can be said differently: the totality of meaning and situations of meaning-making and interpretation are necessary conditions for the constitution of hermeneutic discourse. At the same time, hermeneutics itself, together with its procedures, is the order of discourse, which establishes the main theoretical paradigm of modernity.

In our study, we develop ideas about the general nature of philosophical hermeneutics, that its very existence is a natural continuation of metaphysical questioning of the world. Hermeneutics, understood in this way, is the ideal of philosophical knowledge, suffered by the entire history of Western European metaphysics.

Adhering to this theoretical position, we note that in the German philosophy of the last two centuries, a special form of discourse, a problem field, a field of tasks, and even a special style were created, which in general we denote as a hermeneutic space. Despite all the metaphorical nature of such topological fusions, they have taken root in modern philosophy. Yes, we are talking about the space of discourse, the semantic horizon, the mechanisms of interpretation, and this does not cause us mental rejection. In each such case, it is important to realize the degree of convention of such turnovers, and perhaps their fundamental inadequacy [8].

We record the presence of meaning in our utterances as something that goes beyond meanings and grammatical forms. This primary given of meaning is an anthropological and psychological fact, and, among other things, also a mental event, a form of inner representation and experience. In other words, the meaning is not simply perceived, but also constantly transformed, turning into a series of events, into what is happening, which can be recorded in memory and subjected to analysis and interpretation. It is this mental horizon of events, or noematic horizon, if we use Husserl's terminology, that constitutes, in our opinion, the problematic field of philosophical hermeneutics [2].

It is also necessary to consider how the innumerable meanings with which a person operates turn into a coherent whole, forming his life world, keeping consciousness in a state of meaningful activity, purpose, and perspective. Perhaps the solution lies in intentionality, a special property of all mental processes and formations of the psyche without exception. However, in our opinion, intentionality is only the first step on the way to the formation of meaning structures, a technical condition of meaning formation, an imaginary orientation, an indication that any meaningful activity has an objective nature by definition.

To reveal the multi-level structure of meaning-making, it is necessary to analyze the structure of the theoretical structure of philosophical hermeneutics, conduct a critical analysis of its basic concepts, and this is possible only within the framework of understanding the evolution of the phenomenological school in its relation to the hermeneutic discourse, the necessity of phenomenology for the further development of philosophical hermeneutics.

The thesis about the decisive role of phenomenology in the creation of modern philosophical hermeneutics is relevant. First of all, we are talking about paying attention to the essential characteristics of consciousness and its role in creating the noematic horizon. It is consciousness that creates the possibility of meaning and its interpretation,

a conditional window of such possibilities. A kind of «exclusion of the world», which occurs within the framework of a consistent phenomenological reduction, is also of fundamental importance. In contrast to scientific, scientistic reductionism, which tries to reduce consciousness and its products to certain natural processes and functions, phenomenological reduction leaves out of parentheses the question of the «real» existence of things, thus opening up space for the hermeneutic interpretation of any meaning-making of consciousness [1, 4, 6, 9].

This procedure is very technical at first glance, in fact it creates a certain theoretical barrier in the way of physicalism and reductionism, indicating philosophical hermeneutics its rightful place among philosophical theories. So, philosophical hermeneutics is understood and positioned as a metaphysical theory that is able to combine both the traditional domain of metaphysical discourse – ontology and epistemology and problem fields that were actualized already in the 20th century – phenomenological theory of consciousness and phenomenological philosophy of language.

In our work, the historical-philosophical plane of research meaningfully and conceptually intersects with the internal structure of the hermeneutic field, that which is generally subject to interpretation. The structure of being is considered in its correlation with the structures of perception and sensory experience and with the mental picture of the world. Procedures and results of meaning-making, noematic activity, as well as the world of intersubjective interaction – all this is the field of discourse of modern philosophical hermeneutics.

It is possible to raise the question, where in this general scheme is the place of art and the understanding of its meanings, where is the place for everyday communication, and in general, does philosophical hermeneutics have anything to do with these significantly important forms of life. These questions can be answered from two different positions.

First, hermeneutics, which positions itself as a philosophical discipline, must by definition provide a general outline of reality and indicate fundamentally significant and integral components of meaningful activity and its understanding. Should aesthetics, for example, as a philosophical discipline follow every artist, pointing out, instructing and interpreting the creative process and its results. Art history and criticism, which are certainly based on certain aesthetic principles, deal with this in one way or another. In the same way, philosophical hermeneutics is, in relation to art, a general program of interpretation, a call to constantly delve into essential, eidetic issues, without losing the specificity of meaning and its factuality, which is inherent in art [8, 9].

Secondly, as in art itself, we see in hermeneutics a certain element of variability, ambiguity, multiversity, which is determined by the very nature of meaning-making, the essence of meaning as such, which is never complete, once and for all formed and formulated and, in addition, it has no usual localization. Not only do we not place meaning in physical space, which is understandable, but it is also not in consciousness itself, it cannot be found in works of art either, from a certain point of view, meaning is a meonic formation, it is a kind of nothing, because it is nowhere and «splashed» in the conventional space between the creator, his creative product and the viewer, interpreter, recipient, more precisely – between all possible recipients. Such infinity of meaning makes it a very inconvenient object of research, but it is meaning understood in this way that is the main object of philosophical hermeneutics.

It is hermeneutics that acts as a theory and a general methodology for understanding everything that forms the basis of a person's spiritual life. In our work, we will defend the thesis that hermeneutics, according to its nature, constantly gravitates towards metaphysics in the sense that M. Heidegger put into this term, as well as towards idealism, since it is impossible or very difficult to engage in the interpretation of spiritual, ideal, meaningful formations, not recognizing their fundamental autonomy and difference from other nature [1].

A separate problem can be considered the question of the possibility of the existence of hermeneutics within the limits of materialism or in modern scientific methodology. With regard to materialism, we can mention Marxist anthropology, in which the concept of alienation, which goes through certain stages – from simple economic appropriation to the transformation of the spiritual state of a person, plays a key role. It is the interpretation of the latter within the framework of the theory of alienation and loss of spiritual characteristics by man and misunderstanding of himself that makes Marxism, if not hermeneutics in the full sense, then a kind of theory of understanding.

The specificity of Marxism and neo-Marxism is that they are almost entirely social. They always had a noticeable lack of both ontological and epistemological constructions, as well as primary, archaic interpretations of the life world. It is not surprising that if Marxism is «completed» to the level of ontology, then it risks turning into its opposite. Inattention to individual consciousness, to mental phenomena and to their uniqueness, which is characteristic of Marxism in general, makes it not a very suitable environment for the creation of philosophical hermeneutics. Although some of the works of modern Marxists, in particular Guy Debord or F. Jamieson, could be like that [1, 2, 6].

A person is able to understand only what he is now, moreover, precisely at each such moment, but this is also a rather widespread and complex illusion - the creation and understanding of meaning in relation to himself. We simply do not think about words and believe that any experience or mental manifestation, any thought is guaranteed to have meaning.

As shown by the experience of phenomenological interpretation, first by E. Husserl, then by M. Heidegger in his analysis of Dasein, a person has only a vague, uncertain experience of being himself, and without the use of special forms of hermeneutic discourse, he is unable to find his true meaning. From Husserl's point of view, we are in the so-called «life world» (Lebenswelt), which consists of the sum of immediate data that determine forms of orientation and behavior. Such obvious phenomena in a logical sense

are the primary layer of any consciousness, the basis, the condition for the possibility of the individual's conscious acceptance of theoretical attitudes. These possibilities coincide with the realm of well-known ideas that have the character of worldview automatisms, unconscious origins of meaning-making [1, 2, 8, 10].

Every person really experiences difficulties when he wants to subject this entire phenomenal series to phenomenological reflection. At the same time, these are her personal states that belong only to her, and only she can be an expert in their interpretation. But this primary interpretation is not clear enough, it requires additional mechanisms, the sequential implementation of all stages of phenomenological reduction in order to find meaning as a certain result, and not to start with it as a reliable phenomenological source. If people could so simply say what they know, instantly and effortlessly find meaning in their immediate experiences, then the very conversation about the need for hermeneutics would be redundant.

We can lose this necessity only by losing our individuality. Actually, it is also in world culture, for example, in Buddhism, where there is no reason to wonder whether my personal enlightenment is similar to Buddha's enlightenment or is it somehow different, maybe he was more enlightened, and my enlightenment is not real, fake. In this context, any individuality is a fiction, a myth, this opinion is quite popular in modern culture. But we are generally not inclined to use the word «myth», which has recently turned into nonsense and began to replace the phrase «anything». In addition, none of those who like to use this word have ever explained what the mythological nature of my experiences, my consciousness or mathematics, for example, consists of. In general, not every abstraction, idealization or just fiction can be a myth. We believe that a myth is not a phenomenon that can be pointed at, most likely, it is a function inherent in certain phenomena under certain circumstances. For example, Greek myths were them in ancient Greece, but now they do not fulfill this function and, strictly speaking, are not myths. For most people, these are just sometimes funny and sometimes boring stories, at best, with some ethical or historical background. It is also possible that, like language, a myth cannot be purely individual, personal, that is, I can of course come up with something that resembles a language, I can make my notes on it or even begin to reason with it, but it will always be something insufficient [7].

The same with the myth. Any fictions and fantasies, no matter how much a person himself believes in them, will remain only nuances of his own psyche. Each person has a lot of absolutely incredible fantasies (especially in so-called altered states of consciousness), long ago framed in some system, but the difference between them and myth is clearly visible, as a function of social and cultural discourses. Even a person who cannot tolerate any community, sociality, is still not autonomous and cannot create his own culture, mythology, and language in himself and for himself. There is something ant in human culture in general, we are either the worker ants of the culture or its soldiers, but no one, not even Plato or Shakespeare, are its producers. In other words, language, myth, culture do not have a creator – the people do not create their mythology and their culture, they arise together with it.

It is fundamentally insufficient to rely on an ordinary understanding of hermeneutics in order to be able to interpret mythology or that which can perform the functions of myth. Myth functions not only in the realm of poetry or in any kind of social discourse. Fundamental to the understanding of myth is that it functions only or almost exclusively in the taboo system.

Unlike Husserl, M. Heidegger has his own vision of a pre-phenomenological or «pre-hermeneutic» subject. In his ontology, it is important for Heidegger to contrast the concept of Dasein with the concept of subject in the new European sense, since Dasein in its ontological definition is not yet a thinking substance, it is only an essential prerequisite of subjectivity. The philosopher points out that Dasein somehow and with some clarity understands itself in its being. It is characteristic of this being that with its being and through it, this being is revealed to itself. The intelligibility of being itself is the essential determination of this-being. That is, the conditions and intellectual content of Dasein's existence includes ontology or the concept of being. And this ontological thinking of oneself is not achieved in the experience of existence, but is initially present in a ready-made form, as an inheritance: «This being (Dasein) in all its way of being, and therefore also with its essential content, grew into the inherited interpretation of this – existence and grew in it. From it, it constantly understands itself in the closest way and in the known sphere. This darkness unlocks the possibilities of his existence and controls them. His own and this always means his «generation» – the past was behind the here-being, but it always goes ahead of him» [1, 2].

With these words, Heidegger, following Husserl, decisively breaks with the Enlightenment concept of consciousness in the form of a clean tablet (tabula rasa). Any consciousness is always historical, determined by the past. In this position, one can see the advance of Cartesian «thought» (cogito) towards Kant. In the sense that the way of thinking and the organization of the unity of thinking, as a variety of places of thinkable things, contain a priori and are rooted in the past. These a priori, according to Heidegger, «open up the possibilities» of thinking and give it directions and ways of movement [1, 2].

Heidegger first recreated what M. Foucault later called the «hermeneutics of the subject» [10]. He understands the relationship between ontological and hermeneutic issues, the point of intersection of which is the concept of Dasein. Heidegger establishes the need for hermeneutics to understand the very essence of human existence and the essence of philosophical discourse. It was Heidegger who completed the theoretical work that was done during the 19th and 20th centuries. and enabled the formation of basic concepts of philosophical hermeneutics. His discovery is that the hermeneutic position is naturally embedded in the structure of Dasein and its further specification and

finding. This approach makes philosophical hermeneutics a fundamental ontological theory. This is the fundamental difference between hermeneutics and other methodological approaches [1].

So, philosophical hermeneutics is a natural continuation of the development of European metaphysics, its traditional problems in the field of a complex multi-level structure of meaning and meaningful activity. The realm of meaning existence and meaning creation is, by definition, a new vision of ontology, its new content and the meaning of the existence of hermeneutics as a general philosophical methodology. A general outline, or a general outline of the development of modern hermeneutics and its problems, can look like this. At the first stage, hermeneutics plays the role of an auxiliary discipline from a set of practices and techniques of interpretation in the field of theology, and later also in classical philology. In this period, the first attempts to define the essence of hermeneutics appear, to find its place among other sciences and to give hermeneutics a philosophical sound for the first time. The gradual development of humanitarian knowledge, first of all philology and history, as well as the rapid development of psychology, which at that time quickly gained weight and popularity, led to the appearance of numerous projects of theories of interpretation in these areas, as well as numerous mutual influences and theoretical borrowings, which only contributed to the general development of hermeneutics. Among such influences, we note the theory of language and the philosophical vision of culture by V. von Humboldt, who for the first time gave the theory of language a truly philosophical status [4, 7, 9].

The new stage of the development of hermeneutics is connected with the development of phenomenological philosophy, which gave philosophical hermeneutics a new and fundamentally important impetus for development. Since then, hermeneutics deals with the consideration of the structures of consciousness, primarily the structures of sense-making and meaning itself and its functioning in the realm of intersubjectivity. This task is still relevant for philosophical hermeneutics, which is why it is still a descendant of the phenomenological method. Modern hermeneutics does not need to go «back to Husserl», it is already constantly receiving the ideas of the creator of phenomenology.

The next step taken by philosophical hermeneutics is related to the work of two thinkers who each saw the role and task of hermeneutic discourse in their own way, but were united by the relationship of legal succession. Of course, we are talking about M. Heidegger and his student H. G. Gadamer, without whom philosophical hermeneutics would not have such importance, and our research would not make sense at all. We will dwell on the theories of these thinkers in more detail in the relevant sections, and now note that the last, phenomenological stage of the development of philosophical hermeneutics led, in our opinion, to the formation of hermeneutic philosophy and even to the creation of the hermeneutic paradigm of the entire modern philosophy, to which almost all its directions range from Marxism to psychoanalysis and even analytical philosophy [1, 2].

So, until now, hermeneutics has gone through three stages of its development: formative, methodological and technical maintenance of the humanities, and phenomenological, when it turned into a universal metaphysical theory that meets the urgent problems and demands of modern philosophy.

Understanding and correct interpretation of what is understood is the hermeneutic method of acquiring humanitarian knowledge in general. In rehabilitation activities, the problem of understanding is of particular importance. With the help of hermeneutics, it is possible to create a bridge for effective communication between the rehabilitation doctor and the patient, connected, respectively, with the effectiveness of achieving the goal of such communication – the recovery of the patient. For example, if we talk about research that examines the effect on heart rate variability indices in athletes depending on training status, different types of physical exertion, gender and age, presented in both cross-sectional and longitudinal studies [8].

Or about evaluating the impact of inspiratory muscle training on exercise tolerance and functional indicators of the respiratory system in patients with heart failure who are involved in cardiorehabilitation [9]. Obstacles often arise. These obstacles are problems for qualitative and adequate analysis of problems and understanding of the patient, the problem of understanding medical terminology (related to the rapid development of medical science, the emergence of new methods of diagnosis and treatment, new medicines); the problem of understanding in the relationship between the doctor – the rehabilitation specialist and the patient (violation of ethical norms, lack of tolerance for the individual characteristics of the patient (religion, nation, age, character), lack of empathy for the patient.

In order to eliminate the obstacles that arise in the way of effective communication between the rehabilitation doctor and the patient, it is advisable to follow the practical recommendations developed in the modern literature on optimizing the communication between the doctor and the patient [8, 9].

CONCLUSIONS

In other words, our interpretations, which reach a certain level, always run into a certain barrier. We are not inclined to mystify this phenomenon and believe that these limitations have a very rational explanation. Highlighting the formation, development and substantive and functional features of phenomenology and hermeneutics, their status in the system of modern philosophical knowledge, in-depth study of phenomenological and hermeneutic heritage, familiarization of future specialists with the main traditions and approaches to the essence of phenomenological and hermeneutic, which together with information obtained from other courses, will contribute to the integrity of the knowledge of the theory of cognition and methodological activity.

And the further development of this issue will allow us to exploit the methodological potential of hermeneutics and phenomenology in modern specific scientific research on valeological, rehabilitation and physiotherapeutic activities. And also, elimination of problems in the system of understanding the relationship between the doctor and the patient.

The practical significance of this article lies in the further development of this problem, which will allow to exploit the methodological potential of hermeneutics and phenomenology in modern specific scientific research on valeological, rehabilitation and physiotherapeutic activities. And also, in order to eliminate problems in the system of understanding and mutual relations between the doctor and the patient, we suggest introducing a corresponding module in the discipline «Theory of Cognition and Methodology of Scientific Activity» for students of higher educational institutions.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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REVIEW ARTICLE

Characterization of humic substances in waters and their therapeutic applications – a review

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ABSTRACT

Aim: In this review, the authors characterise bioactive ingredients of humic waters, the chemical structure of humic acids and their properties, methods of their analysis and isolation. The aim of the study is also to review the application of humic waters and humic acids in different fields such as medicine and balneology.

Materials and Methods: A literature review was done based on the available PubMed bibliographic database from 1994-2023. Articles in Polish and English were included. During the search the keywords such as humic waters, humic acids, peloids, balneotherapy and balneology were used. The authors also used other sources for the search, such as books and internet websites.

Conclusions: Humic acids have a very high sorption capacity and a variety of biological properties including anti-inflammatory, antioxidant, antibacterial, antiviral, which can be successfully applied in different fields of medicine: dermatology, gastrology, diabetology and balneotherapy. The multitude of biological properties of humic waters and humic substances raises the question of whether or not they should be considered natural medicinal resources.

KEY WORDS: humic water, humic acids, peloids, balneotherapy, medicine

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INTRODUCTION

Humic substances have drawn the attention of water and soil chemists for more than two centuries. Despite intensive studies on this organic matter, the exact knowledge about them is still limited. The formation process of humic substances is also a subject for long-term and continued research [1]. Water with high concentration of humic substances is often called humic water, but also "brown water" or "black water". Humic substances are natural organic polyelectrolytes constituting 60-80% of the total mass of organic matter present in waters. They are found in some surface waters and in groundwater, brown waters, especially from Tertiary aquifers – Miocene [2]. The average content of humic acids (HA) in Polish surface waters is 3.9-4.9 mg/l and in groundwater 2.1-3.0 mg/l [3]. The importance of humic substances in water chemistry is not only attributable to their ubiquity but also their reactivity. Humic substances that are most commonly identified with brown organic material occur also in soils. They are also present in all of the suspended and bottom sediments of river, lakes and estuaries [4]. Humic compounds including HA – forming as a result of plant humification – occur mainly in peat, peat soils and also in brown coal [5]. The presence of humic substances in soils have been widely detected, even in the Antarctic continents where the humification process is very specific [1]. In general, they can be defined as a group of relatively high-molecular-weight, brown to black substances formed by secondary synthesis reactions. Among humus substances derived from soil, except HA, some non-specific substances can be distinguished, such as carbohydrates, amino acids, tannins, fats and lignins [6].

There are different theories relating to the humic substances origin process, such as lignin theory, polyphenol theory and sugar-amine condensation theory. The lignin theory holds that lignin is incompletely utilized by microorganisms and the residuum becomes part of the soil humus. Modification in lignin includes the loss of methoxyl (OCH_3) groups with the generation of orto-hydroxyphenols and the oxidation of aliphatic side chains to form carboxyl (COOH) groups. The modified material is then a substrate for further unknown modifications to yield the first HA and then fulvic acids [6, 7]. In the polyphenol theory, phenolic aldehydes and acids released from lignin during a microbiological attack undergo an enzymatic alteration to quinones, which polymerize in the presence or absence of amino compounds to form humic-like macromolecules. According to the sugar-amine condensation theory, reducing sugars and amino acids, formed as by-products of microbial metabolism, undergo nonenzymatic polymerization to form brown nitrogenous polymers of the type produced during dehydratation of certain food products at moderate temperatures. However, the major limitation of this theory is that the reaction proceeds rather slowly at the temperatures found under normal soil conditions [7]. At present, many researchers assume that humic substances originated in lignin.

AIM

In this review, the authors characterise bioactive ingredients of humic waters, the chemical structure of HA and their properties, methods of their analysis and

isolation. They also review the application of humic waters and humic acids in different fields such as medicine and balneology.

MATERIALS AND METHODS

A literature review was done based on the available PubMed bibliographic database from 1994-2023. Articles in Polish and English were included. During the search the keywords such as humic waters, humic acids, peloids, balneotherapy and balneology were used. The authors also used other sources for the search, such as books and internet websites.

REVIEW AND DISCUSSION

BIOACTIVE INGREDIENTS OF HUMIC WATERS

The colour of humic waters is determined by the presence of humic substances [8, 9]. They are comprised of HA, which are macromolecules with different chemical composition and can be classified according to their solubility in various solvents [1]. HA are divided differently depending on the researchers into: humic (the name of the fraction is the same as the general definition), fulvic, hymatomelanic acids [10] or humic, fulvic acids and humins [6, 11]. The chemical structure of HA varies according to geographical origin, age, climate and biological conditions, which causes difficulties in the full characterisation of these substances [8]. Humic waters are usually characterised by a low content of calcium, magnesium, sulphates, potassium and metaboric acid. The main cationic component is sodium ion, while the dominant anion is bicarbonate or chloride ion.

In Poland, humic waters occur zonally in Miocene formations. The concentration of humic substances in Miocene waters from the Brown-Coal Formation sometimes reaches several hundred g/m^3, giving them a colour above 4100 mg Pt/dm^3 [12].

In a study by Górski et al., the colour and other physicochemical properties were determined in four samples of brown water from the Wielkopolska region (collected from Brączewo, Poznań, Mosina, Sepno) in Poland. The results showed the intensive colour of all the waters (> 1000 mg Pt/l), conductivity in the range of 907-1890 µS/cm, pH in the range of 6.99-7.54, high oxidisability (in the range of 60-650 mg O_2/l), chloride content (ranging from 120.5 to 354.5 mg/l) and relatively low hardness (ranging from 4.2 to 4.4 mval/l) [2, 13].

In another study by Górski et al., the authors examined the occurrence, genesis and chemical properties of 42 samples of water with a colour above 80 mg Pt/l. Their studies confirmed the complex occurrence pattern and it is an effect of paleo-hydrogeological conditions of water circulation in the environment of Miocene formation enriched with organic substance of plant origin dispersed with sand sediments. Waters with constant colour and the content of HA above 50 mg/l were considered to be especially valuable for balneotherapy. Some of these water samples are characterised by their colour stability even after being heated up to 80°C and following intensive aeration [13].

CHEMICAL STRUCTURE AND PROPERTIES OF HA

The knowledge of chemical composition of HA is required for a full understanding of the role and function of these constituents in the environment. However, due to the complexity of the chemical structure, including multiplicity of component molecules of which they are composed together with the numerous types of linkages that bind them together, accurate structural formulas are unachievable. Some authors indicate that humic substances have a high affinity for actinide and lanthanide metal ions and have a strong influence on the distribution of these metal ions in the terrestrial and aquifer system [11].

HA can be subdivided into three separate classes based on their solubility. Due to their amphiphilic character, HA form micelle-like structures, called pseudo-micelles, in neutral to acidic conditions. Humic acid is not soluble in water under pH < 2 conditions but is soluble at a higher pH. Fulvic acid is a fraction soluble in water under all pH conditions. Humins are insoluble under alkaline conditions. Some authors also highlight hymatomelanic acids, which are soluble in alcohol and insoluble in aqueous solutions with a pH < 2 [10, 14].The aqueous behavior of humic substances is highly dependent on the presence of carboxylic and phenolic groups, which principally define their acidity. These substances have intrinsic surfactant-like tendencies, e.g. reducing the surface tensions of aqueous solutions and solubilising organic molecules in colloidal aggregates.

In a study by Swiech, the authors examined commercially available HA (which are a mixture of different HA) sampled from Sigma-Aldrich and reported that it was possible to isolate „solubility fractions" based on differential solubility in deionized water under near-neutral pH conditions. They fractionated by sequential dissolution in deionized water and obtained 4 fractions: two water-soluble products and two water-insoluble residues. Sophisticated analytical methods, such as small-angle X-ray scattering (SAXS), thermogravimetric analysis (TGA), solid state NMR and atomic force microscopy, were used. Soluble fractions contain more oxygen with increased carbonyl functionality and phenol groups. They also contain a greater aromatic/aliphatic carbon ratio and a lower polysaccharide C-O content. One of the sub-fraction behaved as hydrophylic anionic colloid. These results were in agreement with an earlier „polymer model" in which humic substances were considered ionic polymers [15].

HA are mixtures of various heterogeneous particles or aggregates that contain different functional groups the amount of which varies and depends on the geographical origin, age, climate and environmental conditions of extraction and production of HA. Among chemical groups, the majority are these with labile protons such as carboxylic and phenolic functional groups, which are responsible for weak acidic behaviour of these substances. It is probable that these groups contribute to the biological activity of HA, such as anti-inflammatory and antiviral properties. These moieties are able to bind protons and metal ions, which affect the geochemistry of natural systems and also

regulate buffer capacity of such waters [16]. They can also complex heavy metals. HA can also have amine groups in their structures. Some of them include enolic groups, sugars and peptides as well. Besides that, the presence of quinones can be linked with antioxidant, antimutagenic and fungicidal/bactericidal activity of HA. Apart from their hydrophilic character (attributable to hydroxyl groups), HA have a hydrophobic part, which consists of aliphatic chains and aromatic rings [8]. The molecular weight of HA ranges from 2.0 to 1300 kDa.

When it comes to elemental composition, it is quite constant that HA contain approximately 50% C, 35% O and 5% H with the remaining percentage distributed between N and S [8].

The reactivity of HA is directly related with their structure [6]. HA have a high sorption capacity and buffering properties. Due to the strong sorption properties of humic substances, when combined with heavy metals, pesticides, phthalates and other compounds present in water, they form stable and hardly degradable complexes [3].

Difficulties in defining the exact structure of HA are linked to their continuous and dynamic change. The chemical structure, molecular weight and functional groups of HA differ depending on the compounds' origin and age. This is mainly due to the ongoing humification process of organic matter. Their chemical structure contains aromatic rings, heterocycled and condensed rings with heteroatoms, side aliphatic chains and numerous functional groups: carboxylic, phenolic, alcoholic, amino, amide, metoxylic, quinonic and ketonic. The hypothetical structure of HA is presented in Fig. 1 [6].

The full structural characterisation of complex mixtures, such as humic acid extracts, has been elusive because of insufficient compound dissolution with conventional techniques [17]. In case of HA, interesting results have been achieved by applying electrospray ionization coupled with Fourier transform ion cyclotron resonance mass spectrometry and laser desorption/ionization time of flight [1, 17].

In the study on the influence of thermal and chemical processes on the content and the structure of HA, the authors showed that elevated temperature (60°C) of mud water macerates did not affect their concentration of HA. The addition of NaOH and Na_2CO_3 increased the content of HA. An elevated temperature and the addition of mineral compounds (NaOH, Na_2CO_3) together allowed for the optimal use of the studied peat raw material. The IR spectra obtained showed that the thermal and chemical processes used did not significantly affect the humic acid content [18].

Fulvic acids belong to a fraction of humus compounds with overall solubility in the entire pH range. Their colour varied from light yellow to yellow-brown. They are rather characterised by a low molecular weight (ranging from 300 to 6000 Da) in comparison to HA. They contain less organic carbon and nitrogen and more oxygen in the chemical structures [6]. Fulvic acids contain more functional groups of acidic nature, particularly -COOH. The total acidity of fulvic acids (900-1400 mmol/100g) is considerably higher than for HA (400-870 mmol/100g) [1]. They have a very high cation exchange capacity and a strong acidic character [6].

Humins are a fraction of specific humus substances that is less understood and studied, mainly due to a problem with their extraction and analysis. Their colour is rather black. They cannot be isolated with alkaline solutions. They are not chemically reactive and are unlikely to take part in significant soil processes [6]. The chemical changes of humic substances are presented in Table 1.

In a study by Cory et al., the authors characterised fulvic acids isolated from Arctic waters. Fulvic acids in this area are generally derived from two classes of precursor organic material, i.e. decomposed plant material and soils of terrestrial origin (allochthonous) and organic material produced by algae and bacteria (autochthonous). Fulvic acids were isolated using XAD-8 chromatography and then characterised using NMR and UV-VIS spectroscopy. The authors identified differences between the chemical structures of fulvic acids obtained from various sources. In the obtained ^{13}C-NMR and ^{15}N-NMR spectra, fulvic acids from Arctic streams had higher aromatic contents, higher

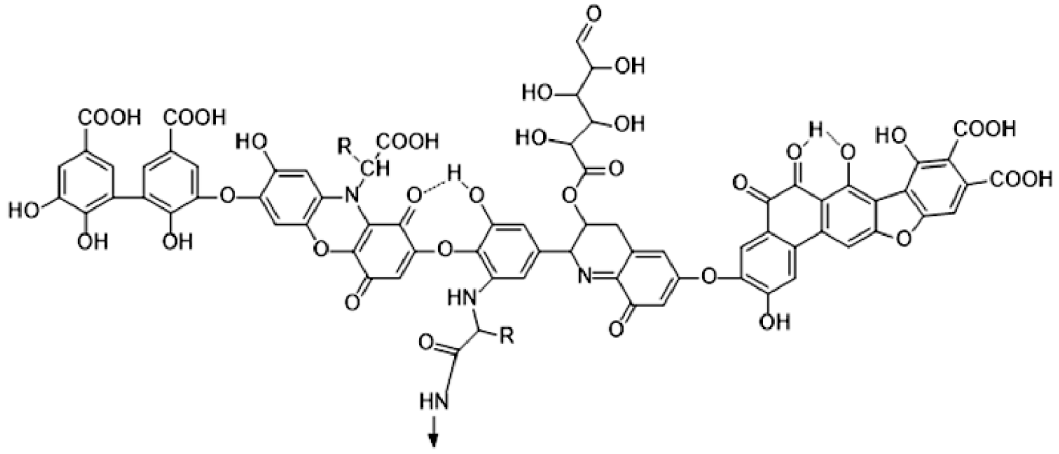

Fig. 1. The hypothetical structure of HA.

Table 1. Changes in the chemical properties of humic substances

	Humic substances		
Property	**Fulvic acids**	**Humic acids**	**Humins**
Intensity of colour	+	++	+++
Degree of polymerization	+	++	+++
Molecular weight	+	++	+++
Carbon content	+	++	+++
Oxygen content	+++	++	+
Solubility	+++	++	+

+, ++, +++ - *means gradation of property.*

specific absorbance values, a lower nitrogen content, lower amino acid-like fluorescence, and were more depleted in δ15N relative to fulvic acids isolated from lake and coastal surface waters. Many of the initial differences in the fulvic acid chemical characteristics across the gradient of water residence times were consistent with the changes observed in fulvic acid photolysis experiments. The results of the aforementioned study suggested that photochemical processes predominantly control the chemical character of fulvic acids in Arctic surface waters. The authors found that hydrological transport in addition to biogeochemical alteration of the organic matter must be considered in order to predict the ultimate fate of Arctic dissolved organic matter [19].

METHODS OF HA ISOLATION AND ANALYSIS

Various methods have been used to investigate the chemical structures of humic substances, such as nuclear magnetic resonance spectrometry, gas chromatography-mass spectrometry, liquid chromatography-mass spectrometry, spectroscopic analysis, chromatography and other (elemental analyses, metal complexation). In spite of such powerful techniques, the structural characteristic of HA at molecular level is still unsuccessful [11].

One of the methods used to study humic substances, e.g. in various soil and humic water samples, is absorption spectroscopy in ultraviolet–visible (UV-VIS) light with the use of derivative functions [20]. The flow of the procedure of isolating the acid fractions of humic compounds from peat using selective alkaline, acid and alcohol extraction, keeping the same peat/extractant ratios and solvent concentrations according to Beer [21, 22] is shown in Fig. 2.

The results of existing works indicate that HA in aqueous solutions follow the Lambert-Beer law in the concentration range of 0.005-0.2%. Therefore, any quantities obtained by dividing the absorbance values at different wavelengths do not depend on the concentration. In a study by Miklewska and Gołębiowska, the authors obtained HA from soil samples. Three replicate extractions with sodium pyrophosphate and successively three replicate extractions with sodium hydroxide (NaOH) were performed. HA were precipitated in each repetition. The precipitate of HA was centrifuged, the filtrate was discarded, and the precipitate was redissolved in sodium pyrophosphate or NaOH. Two types of HA (KH) were thus obtained: labile- KH pyro and bound KH-NaOH. The spectra were recorded in the UV-VIS range (230-380 nm) at a film thickness of 1 cm and in the visible range (360-700 nm) at a layer thickness of 1.99 mm. Following the methods used in protein studies, it was decided to make a fourth derivative. The spectra were taken off by recording the absorbance every 1 nm. Subsequent derivatives were determined by an analytical method after fitting a polynomial of appropriate degree at each point of the curve. The approximation by polynomials smoothed the analyzed curves at the same time. The obtained spectra of fourth derivative absorption in the UV-VIS range had richer structure than the untreated ones. The position of the main maxima in the spectra of the fourth derivatives in the UV range (λ= 295 nm and λ=325 nm) corresponded to the position of the bands in the fluorescence excitation spectrum [23].

Studies by Martinez-Villegas et al. included determination of metals in peloid extracts using an inductively coupled plasma optical emission spectrometer ICP-OES. For labile metal concentration, 0.5 g of peloid samples were digested using 5 ml of $HClO_4$ (60%) and 10 ml of HNO_3(65%). After digestion, samples were filtered through a 0.45 µm Millipore nitrocellulose membrane and diluted to 50 ml with Mili-Q water. Final extracts were analysed using ICP-OES [24].

In a study by Suarez-Munoz M. et al. peloids from San Diego de los Banos extracted from the estuary of San Diego River were analysed. Total carbon, hydrogen, nitrogen and sulfur contents were determined using a LECO CS2000 analyser and the results were expressed as a dry weight percentage. Total metal contents were also determined using the extraction procedure and ICP-OES method [25].

According to Berger et al., the structure of acids isolated from peat change depending on the sample drying method (nitrogen, air, freeze drying), as well as the order and type of solvents used in the process of their extraction [20, 26].

In a study by Drobnik and Latour, HA were isolated from miocene water, mud and brown coal samples from Poland [18]. Three mud samples obtained from a depth of 0.6-1.0 m from different regions of Poland were collected and air dried under the same temperature conditions (22 ± 1°C). Peloid crushed in mortar was sieved through sieves. One gram of dry material with a diameter of ≤ 0.25

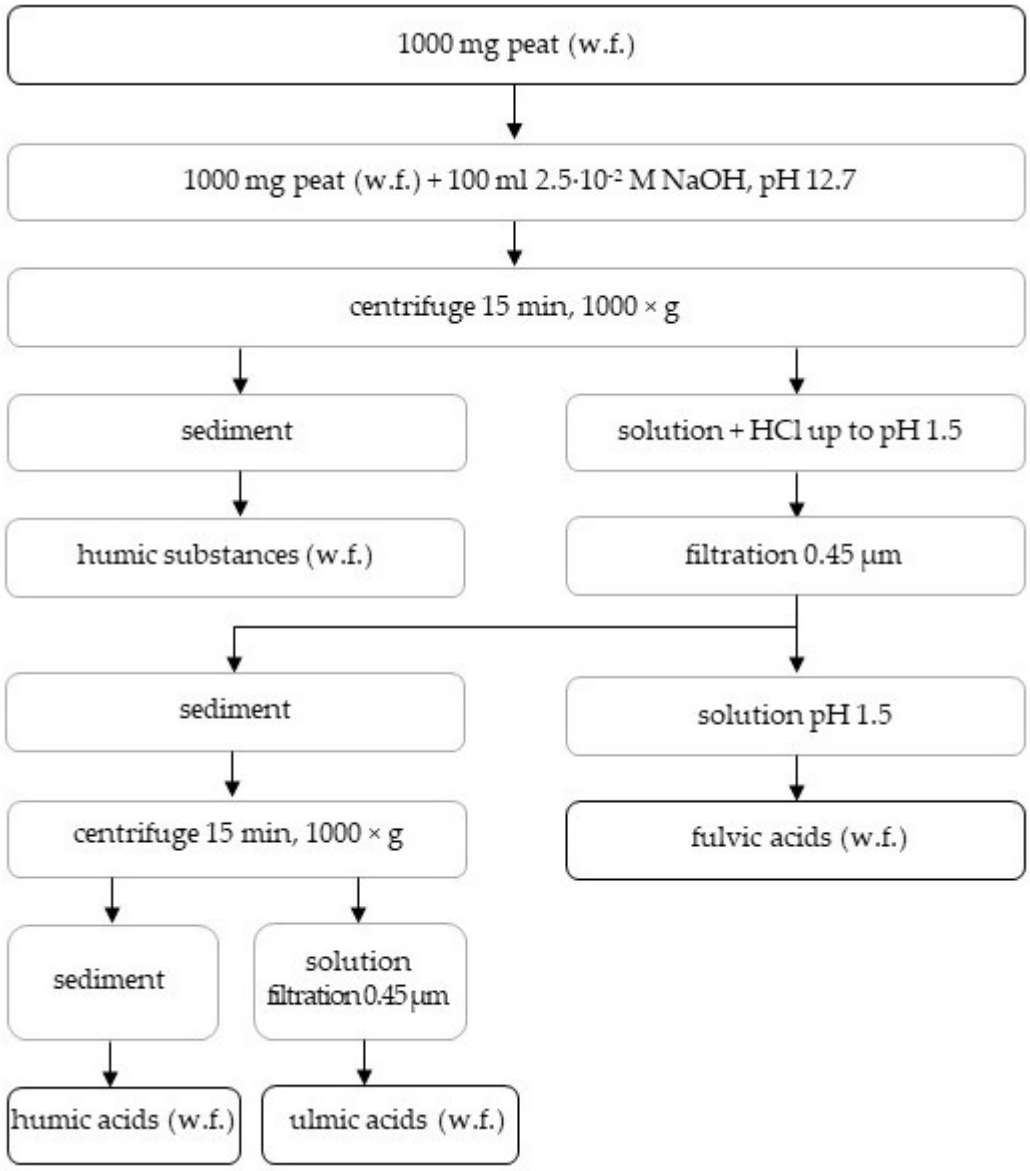

Fig. 2. The procedure of HA isolation from peat according to Beer [21] (w.f. means water free).

mm was taken for analysis. A sample of dry brown coal derived from coal mine KWB "Bełchatów" was crushed and sieved. Groundwater from aquifers was used to study Miocene deposits layered with brown coal. The flow chart of obtaining the fractions of HA, fulvic acids and hymetomelanic acids is shown in Fig. 3. Continuous flow observation shot, more than 100 m deep, located in Brączewo (Greater Poland Voivodeship); within the Warta valley. Spectrograms of the isolated acids were performed continuously in the range of 250-800 nm using Hitachi UV-VIS spectrophotometer model U-1800 with the following operating parameters: scan speed 400 nm/min, spectral width 4 nm slit, wavelength accuracy ± 0.5 nm, reproducibility of wavelength setting ± 0.3 nm. Fourth degree differentiation of real spectra of absorption was done by the numerical method using the UV Solutions spectrophotometer computer software. For the comparison of the test results, the absorption spectra of humic and fulvic acids and hymatomelanic acid (after previous isolation) were also performed [18]. Humic, fulvic and hymatomelanic acids occurring in Miocene water and peat have similar peaks of different sizes at specific wavelengths in differential absorption spectra. In the spectra of fulvic acids, especially HA obtained by means of extraction of brown coal, there are no characteristic peaks in comparison with the other studied raw materials. In hymatomelanic acids, there is a greater number of peaks than in humic water and peat. There were different amounts of particular types of HA in the raw materials studied.

THE APPLICATION OF HUMIC ACIDS IN DIFFERENT FIELDS MEDICINE AND BALNEOLOGY

HA have a wide variety of properties, such as antioxidant and anti-inflammatory activity. In a study by Aeschbacher et al., the authors characterised the antioxidant properties

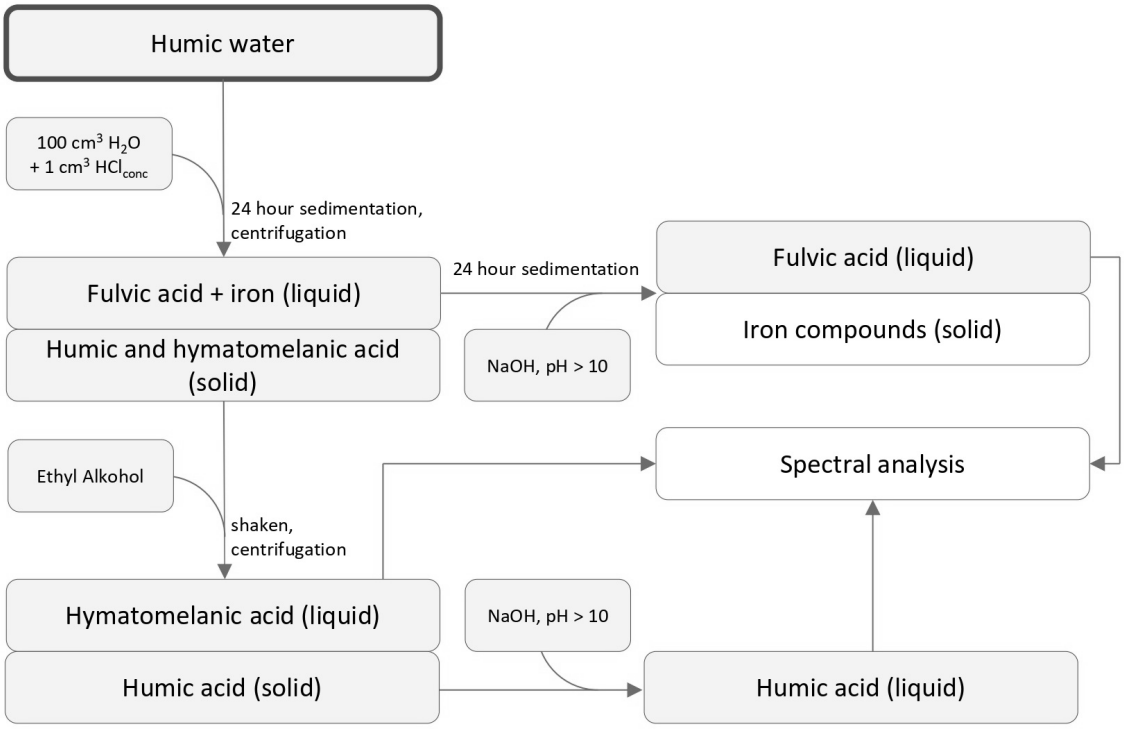

Fig. 3. The flow chart of HA isolation [2].

of humic substances as a function of redox potential (Eh), solution pH, and their origin to gain an insight into the reactivity of the electron donating moieties in humic substances. The results showed that humic substances contain a wide variety of moieties that are oxidized at different potentials and that, upon oxidation, release protons and undergo irreversible follow-up reactions. At a given pH and Eh, the electron donating capacities (EDCs) of humic substances correlated well with their titrated phenol contents suggesting phenolic moieties as major electron donating groups in humic substances. Comparing the EDCs of 15 humic substances to their electron accepting capacities (EACs), aquatic humic substances had higher EDCs and lower EACs than terrestrial humic substances of comparable aromaticities. These results indicate that the oxidative transformation of these compounds in the environment results in a depletion of electron donating phenolic moieties with antioxidant properties relative to the electron accepting quinone moieties [27].

HA also inhibit the expression of complement receptor one (CR1) and three (CR3) in the lipopolysaccharide (LPS)-induced human umbilical vein endothelial cells (HUVECs) through the inhibition of the nuclear factor kappa B (NF-kB) activation [5, 28]. These surface molecules play an important role in the inflammation process.

The immunomodulatory effect of humic substances was demonstrated by the course administration of HA isolated from pine-sphagnum-cotton sedge peat. It was observed that they reduce the general anaphylaxis reaction in mice and guinea pigs immunized with ovalbumin and they decrease serum content of IgG1 and IgE in mice. Antiallergic activity of HA is also probably due to the stabilization of mast cell membranes, which leads to inhibition of the pathological reactions associated with the production and release of allergy mediators [29, 30].

The antibacterial and antiviral properties of HA enable their application in medicine. Different studies showed HA' activity against human immunodeficiency virus type 1 (HIV-1), type 2 (HIV-2), cytomegalovirus (CMV), vaccinia virus as well as against herpesviruses [31]. In the experiments focused on HA' antiviral mode of action, it was shown that with most viruses they act specifically against an early stage of virus replication. In the study by Gilbert et. al. on SP-303, a humic acid-like polymer isolated from Euphorbiaceae shrub, the authors revealed that the SP-303 partially inactivates viruses by direct interaction with virus or host cell lipid memebranes [32]. Clinical studies have shown that difficult viral respiratory illnesses common in children were resolved with fulvic acid dietary supplementation [1].

In a study by Górski et al., the authors analysed brown water from the Wielkopolska region collected from five selected wells. Their study revealed that brown water containing humus substances amounting to over 200 mg/l and showing high colour stability following their collection from the water-bearing layer was especially useful for balneotherapeutical purposes [2, 13]. Such humic waters used in the study on animals (per os administration) had a positive effect on the fat, protein and carbohydrate metabolism as well as the motor activity of the intestines [2]. Peloids that contain high amounts of HA are already applied in balneotherapy. Balneotherapy

is officially recognized in many countries such as Italy, France, Spain, Hungary, Poland, Germany and Russia and is dependent on some specific geological, geographic, and meteorological preconditions. The therapeutic activity of natural medicinal resources, such as natural medicinal waters and peloids, is widely known.

Clinical studies have shown that a humic acid preparation significantly accelerated the healing of gastric ulcers induced in rats [1, 5, 33]. In the study of Veryho et al., the authors explore the influence of humic water on the process of hepatic cell regeneration in patients with toxic liver damage. The study group consisted of 28 patients with alcohol addiction treated at the Addiction Treatment Unit, who additionally underwent humic water drinking treatment. The results of the study showed that hepatic parameters (AST, ALT, GGTP, and bilirubin), elevated at the beginning of the treatment, decreased in a statistically significant manner. A statistically significant reduction in the liver size in the midclavicular line was observed by an ultrasound (USG) examination. During the medical examination, none of the patients reported disturbing side effects of the therapy. The patients observed and reported a significant improvement and reduced incidence of symptoms from the digestive tract. The obtained results suggest the possibility of humic water use in hepatic disorders [34].

In a study by Szot et al., the authors investigated the effect of humic water on endothelial cells under hyperglycemic conditions. Hyperglycemia affects the activation and stimulation of endothelial cells, leading to a disruption of multifactorial balance provided by these cells. In their study, the authors used cultures of endothelial cells (HUVEC line) with the addition of 30 mM/L glucose in the culture medium. The cells were derived from human umbilical veins by the enzyme method using collagenase. The addition of a proper volume of humic water to the culture medium caused a reduction of inflammation by a significant decrease in inflammatory cytokines, such as TNFa and IL-6, and also led to enhanced cell proliferation. It appeared that the adverse effects of hyperglycemia on vascular endothelial cells may be corrected by the addition of humic water [35].

Lately, HA were introduced to the market as oral diet supplements which can influence the concentration and composition of colonic microbiome. Swidsinski et al. conducted a clinical study on fourteen healthy volunteers, which took orally HA supplements for 45 days. The authors observed that mean bacterial concentration increased from 14% to 41% in patients after 45 days of supplementation. However, the studies revealed that the product did not affect patients'microbial diversity [36].

Topical treatment of different types of dermatitis and psoriasis has been used in balneotherapy and treatment medicine. Also, the topical application of mud and peat extracts alleviates the symptoms of patients suffering from rheumatoid arthritis, eczema, psoriasis and wounds [5]. On the other hand, some peloids, such as Dead Sea black mud, have bactericidal effects on potential skin pathogens. This fact might be related with the therapeutic action of this mud in skin diseases, such as acne. For example, Matz et al. undertook a review which cites the effects of balneotherapy and mud therapy on different dermatological diseases, mainly psoriasis and atopic dermatitis. The authors concluded that special places for balneotherapy are the Dead Sea in Israel, the Kangal hot spring in Turkey, and the Blue Lagoon in Iceland, but they do not distinguish between balneotherapy and mud therapy [37, 38].

OTHER FIELDS

Humic substances have found application in the production of plastics, especially as dyes for colouring Nylon 6 or PVC. They can be used in the paper industry too [1].

Due to their amphiphilic character, HA form micelle-like structures, called pseudo-micelles, in neutral to acidic conditions. This property has been explored in terms of its use in pollution remediation and increasing water solubility of hydrophobic drugs [8]. Being rich in carboxyl and phenolic–hydroxyl groups, humic substances can also be applied in the remediation of soils contaminated with heavy metals, especially cadmium and arsenic. These toxic and carcinogenic elements pose a threat to the quality of environment [39]. In a study by Bi et al., the efficiency of Cd and As removal with humic substances was tested in three types of contaminated soils: red soil, black soil and fluvo-aquic soil in China. Single washing with humic substances for twelve hours at pH 7 resulted in the removal of 88.1% of Cd and 44.2% of As from the red soil. A twelve-hour wash of fluvo-aquic soil with humic substances cause 75.1% Cd reduction and 57.4% As reduction. A single six-hour wash of black soil reduced Cd content by 68.2% and As by 49.9% [40]. The results of the study showed that humic substances, which are cheap, have a high potential to remediate soils contaminated by heavy metals.

Humic waters are also used in the food industry. However, due to their colour and organic substance content, they cannot be classified as natural mineral waters. Bottled black water is considered a beverage and offers an alternative to other products available on the food market.

CONCLUSIONS

Humic substances are widespread, natural complexing ligands occurring in nature. They are regarded as purely biological products, which promote nature. Although humic substances were at first used to boost plant growth, over time, it turned out that they can be applied in agriculture, industry, environment and biomedicine as well as in the treatment of many diseases. Nowadays, people are interested to combine their conventional medicinal therapies with natural supplementation. Despite multiple research studies, the level of knowledge about the exact role and chemical structure of HA is still insufficient. However, it seems that humic water is a new natural medicinal source and can be used in the treatment of various diseases.

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CONFLICT OF INTEREST
The Authors declare no conflict of interest

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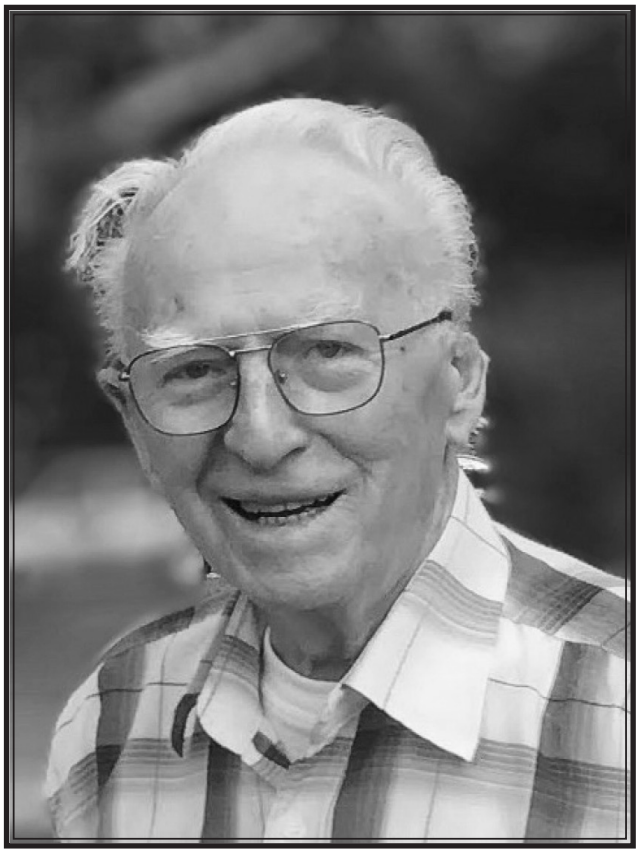
IN MEMORY

In memory of Professor Wiesław Kochański (1932-2023)



Jan Wiesław Kochański was born on July 26th, 1932, in Krypno Kościelne, Podlesie Province. From 1938 to 1944 he lived in Tuczna, Lublin Province. Towards the end of the occupation of Poland by Nazi Germany his family had to hide for fear of reprisals because of his parents' affiliation to the Home Army (AK). In October 1944 he moved to Białystok, where he graduated from grammar and secondary schools. In 1951 he started studies at the Medical University of Białystok, at the Faculty of Medicine. In March 1954 he was arrested by Department of Security (UB) because of his political convictions and relegated from the University. Consequently he was deported to a labour camp in the Mining Corps. In November 1956 he returned to Medical School which he graduated in 1959. From 1959 to 1961 he completed the medical internship and residency. On November 14, 1960 he received the medical practitioner license/diploma. He got married in 1960. On October 1, 1961 he started to work in "Health Resort Lądek-Długopole" in Lądek Zdroj in the Rehabilitation Department. From 1968 to 1978 he was the vice-manager in "Health Resort Lądek-Długopole" as well as the Chief Physician in Health Resort Lądek Zdrój. He obtained the following specialties: Rehabilitation - I° (1965) and II° (1967), Health Protection Management (1973) and Physiotherapy and Balneoclimatology (1977). In 1966 he received the Doctorate of Medical Science degree from the Medical University of Silesia and in 1975 the higher Doctorate in Physical Medicine and Rehabilitation from the same university. From 1978 to 1982 he practiced in Libya, including 3 years in the Rehabilitation Centre in Tripoli. In February 1983 he returned to work in the health resort as the chief physician at the rehabilitation ward. From 1990 to 1997. he was the manager of "Health Resort Lądek-Długopole" (position based on the job contest result). He retired from this position on August 1st 1997. In 2012 professor Kochanski was awarded the tittle Honorary Citizen of Lądek-Zdrój. In 2013 PTBiMF awarded Wiesław Kochański the Wojciech Oczko Medal for his contribution to the development of balneology and physical medicine. From 1996 to 2004 he was employed as an associate professor at the Faculty of Physiotherapy at the University of Physical Education in Wrocław. From 2000 to 2010 he worked as a professor at Faculty of Physiotherapy at the Humanistic Academy in Wroclaw. Since 2000 he has been employed at The Academy of Physiotherapy in Wrocław, In 2010 he started to work at the Academy of Physical Education of Poznań, in the Nonresident Faculty of Physical Education placed in Gorzów Wlkp.

From 1994 to 1998 he was President of Home Team of Medical Consultant in Balneology and Physiotherapy – Home Consultant. From 1999 to 2002 he was the Regional Consultant in Balneology and Physiotherapy for the Silesian Province and Opole Province. Also he was the Vice-President of the Main Board of the Polish Balneology, Bioclimatology and Physical Medicine Association, (1993-2001). From 2001 to 2005 member of the board. His professional achievements include 100 publications, among them 2 scripts and 5 tutorials: "Balneology and Hydrotherapy" (2002), "Handbook of Physiotherapy" (2003), "Health resort Therapy" (2008), "Physical Medicine" (2009), The Big Book of Balneology ,Physical and Spa Resort (2017) . He was a supervisor of 9 Ph.D. theses at the University of Physical Education in Wroclaw.

It is difficult to demonstrate here the whole richness of the Professor's life and accomplishments for he was a very active and hard working person with a broad range of interests.

Died on July 20, 2023.

Włodzisław Kuliński
Editor in Chief
Acta Balneolgica

Wspomnienie o Profesorze Wiesławie Kochańskim (1932-2023)

Jan Wiesław Kochański urodził się 26 lipca 1932 r. w Krypnie Kościelnym, województwo podlaskie. Od 1938 do 1944 r. mieszkał w miejscowości Tuczna woj. lubelskie. Pod koniec okupacji cała rodzina ukrywała się z powodu prześladowań rodziców za przynależność do AK. Od listopada 1944 r. zamieszkał w Białymstoku gdzie ukończył szkołę podstawową i średnią. W 1951 r. rozpoczął studia na Wydziale Lekarskim Akademii Medycznej w Białymstoku. W marcu 1954 r. został aresztowany przez UB za przekonania polityczne, a następnie wydalony z uczelni i wcielony na 2 lata do Batalionów Pracy Korpusu Górniczego. W październiku 1956 r. ponownie rozpoczął studia, które ukończył w 1959 r. W latach 1959-1961 odbył staż przed- i podyplomowy. Dyplom lekarza medycyny otrzymał 14.10.1960 r. W 1960 r. zawarł związek małżeński. Od 01.11.1961 r. rozpoczął pracę w Przedsiębiorstwie Państwowym „Uzdrowisko Lądek-Długopole" w Lądku Zdroju na Oddziale Rehabilitacji. Od 1968 r. do 1978 r. był zastępcą dyrektora ds. Lecznictwa Przedsiębiorstwa Państwowego „Uzdrowisko Lądek-Długopole" oraz Lekarzem Naczelnym Uzdrowiska Lądek Zdrój. Uzyskał specjalizację I° z rehabilitacji (1965 r.) i II° (1967 r.), specjalizację z Organizacji Ochrony Zdrowia (1973) oraz z Fizjoterapii i Balneoklimatologii (1977). Stopień doktora nauk medycznych uzyskał w 1966 r. w Śląskiej Akademii Medycznej. Stopień doktora habilitowanego w zakresie rehabilitacji narządów ruchu uzyskał w 1975 r. w Śląskiej Akademii Medycznej. Od 1978 do 1982 r. pracował w Libii, w tym 3 lata w Centrum

Rehabilitacji w Trypolisie. Od roku 1983 ponownie pracował w Przedsiębiorstwie Uzdrowiskowym na stanowisku ordynatora oddziału rehabilitacji. W okresie od 1990 do 1997 r. był Dyrektorem Przedsiębiorstwa Państwowego „Uzdrowisko Lądek-Długopole" aż do przejścia na emeryturę 01.08.1997. W 2012 r. nadano profesorowi Kochańskiemu tytuł Honorowego Obywatela Lądka Zdroju. W 2013 r. PTBiMF przyznało Wiesławowi Kochańskiemu Medal im. Wojciecha Oczko za zasługi w rozwój balneologii i medycyny fizykalnej. Od 1996 do 2004 r. zatrudniony był na stanowisku profesora nadzwyczajnego na Wydziale Fizjoterapii Akademii Wychowania Fizycznego we Wrocławiu, a od 2000 do 2010 r. w Wyższej Szkole Humanistycznej we Wrocławiu na kierunku fizjoterapia. Od 2000 r. pracował w Wyższej Szkole Fizjoterapii z siedzibą we Wrocławiu. Od 2010 r. w AWF Poznań w Zamiejscowym Wydziale Kultury Fizycznej (kierunek fizjoterapia) w Gorzowie Wlkp.

Od 1994 do 1998 r. był konsultantem krajowym i przewodniczącym Krajowego Zespołu Konsultanta Medycznego w Dziedzinie Balneologii i Fizjoterapii. Od 1999 do 2002 r. Konsultant Regionalny w dziedzinie balneoklimatologii i fizjoterapii dla obszaru województwa śląskiego i dla obszaru województwa opolskiego. Wiceprzewodniczący Zarządu Głównego Polskiego Towarzystwa Balneologii, Bioklimatologii i Medycyny Fizykalnej w latach 1993-2001, a od 2001 do 2005 r. Członek Zarządu Głównego. Jest autorem około 100 publikacji naukowych w tym dwóch skryptów i pięciu podręczników: Balneologia i hydroterapia (2002), Vademecum fizykoterapii (2003), Lecznictwo uzdrowiskowe (2008), Medycyna fizykalna (2009), Wielka Księga Balneologii, Medycyny Fizykalnej i Uzdrowiskowej (2017). Był promotorem 9 przewodów doktorskich na AWF we Wrocławiu.

Profesor był osobą bardzo aktywną, pracowitą o rozległych zainteresowaniach, dlatego trudno jest tutaj przedstawić całe bogactwo Jego życia i dokonań.

Zmarł 20 lipca 2023 r.

Włodzisław Kuliński
Redaktor Naczelny
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