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CONTENTS

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EDITORIAL ARTICLE

Physical therapy following surgical treatment of Achilles tendon injury: selected aspects

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ABSTRACT

Aim: Achilles tendon injury is a very serious clinical problem as it prevents normal functioning, thus contributing to a reduced quality of life. The aim of this paper is to evaluate physical therapy outcomes following surgical treatment after a complete Achilles tendon rupture, which was treated either with minimally invasive (percutaneous) repair or open repair.

Materials and Methods: The paper presents physical therapy after surgical treatment following a complete loss of Achilles tendon continuity. The study involved two groups of patients who underwent surgery at the Department of Trauma and Orthopaedic Surgery of the City Polyclinic Hospital, Independent Public Healthcare Unit in Częstochowa. The follow-up period was approximately 18 months. Group 1 consisted of 23 patients after percutaneous surgical treatment and Group 2 consisted of 23 patients after open surgical treatment.

Results: Outcomes were evaluated once the treatment had been fully completed. The follow-up period was at least 18 months. Functional recovery of the operated limb was assessed, including presence of pain, range of active and passive motion, muscle strength, and presence of contractures and swelling. An ultrasound performed after treatment completion showed complete restoration of tendon continuity and tendon remodelling in all patients.

Conclusions: 1. Achilles tendon injury is a difficult clinical problem. 2. Achilles tendon injuries should be treated with surgery, including minimally invasive procedures, which seem to be more beneficial for the patient. 3. Physical therapy is the basis of management after surgical treatment in patients with Achilles tendon injury.

KEY WORDS: Achilles tendon, injury, treatment

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INTRODUCTION

The Achilles tendon is the largest and strongest tendon in the human body. The incidence of Achilles tendon ruptures is relatively high at approximately 18 cases per 100 000 people. These injuries typically occur in men aged between 30 and 50 years and are the cause of approximately 40% of all tendon repair surgeries. Almost 75-80% of all cases of Achilles tendon rupture take place during sports activities. The calcaneal tendon is the common terminal part of the triceps surae, which consists of the gastrocnemius and the soleus. Achilles tendon injuries constitute 14% of all musculoskeletal injuries and the disability rate following tendon injury is approximately 5.8%. Achilles tendon injuries constitute 5% of all musculoskeletal injuries in soccer players [1-9].

The Achilles tendon plays a role in the gait cycle, which is one of its main functions. The tendon is in control particularly during the stance phase, mid-stance and terminal stance, where the muscle tone carried through the Achilles tendon exceeds 250% of the body mass. In case of pathological changes in the tendon, minor direct blunt force trauma may cause tendon rupture.

The Thompson test is used to examine the Achilles tendon. In this test, the examiner squeezes the calf at the level of the initial section of the Achilles tendon. In a normal tendon, this results in slight plantar flexion of the foot and in the heel being drawn upwards. If there is no foot movement whatsoever, considerable Achilles tendon dysfunction can be suspected, such as Achilles tendon rupture (Fig. 1-4), [9-14].

The structure and integrity of the Achilles tendon can be assessed with an ultrasound.

Magnetic resonance imaging (MRI) provides the most accurate image of the Achilles tendon and the surrounding soft tissues.

Only surgical treatment can restore full function of the Achilles tendon after a complete rupture [14, 15].

The percutaneous surgical technique reduces the risk of cutaneous complications and wound infection.

The main objective of the entire treatment process, including rehabilitation, is to restore Achilles tendon function as much as possible. Prevention of tendon overload and further injury is undoubtedly necessary to achieve good treatment outcomes.

Each stage of rehabilitation is characterised by a gradual progression in terms of weight-bearing and the level of complexity of the recommended exercises and procedures [16-25].

Fig. 1. Ruptured Achilles tendon.

Fig. 2. Pressing down on the fascia in the medial area.

Fig. 3. Cooling the Achilles tendon with CryoCuff.

The tissue healing process can be divided into three overlapping stages. At first, inflammation develops (inflammatory phase, week 0-1), which is followed by healing (proliferation, week 2-6) and eventually by remodelling (week 7 to 1 year).

Fig. 4. Mobilisation of tissues around the scar.

Cooling (with the CryoCuff system) can be used to reduce inflammation (and swelling). The system compresses the cooled tissues and has a beneficial effect on microcirculation.

During this stage, the main procedure is the mobilisation of the Achilles tendon to allow it to glide inside the sheath. The gliding can be aided by pressing on the calf and the tendon area combined with plantar flexion.

Massage and mobilisation of the plantar fascia can be used to prevent the development of fibrinoid changes in the fascia. In turn, mobilisation of flexor hallucis longus muscle glide is used to improve the mechanics between the tissues. During this period, the most important rehabilitation objectives include the following [15-22]:

- lymphatic massage of the foot and calf, mobilisation of Achilles tendon glide,
- massage and mobilisation of the plantar fascia of the foot, electrical calf muscle stimulation, mobilisation of flexor hallucis longus muscle glide, cooling of the foot and the Achilles tendon.

Since there is no weight-bearing on the limb, the muscle mass of the triceps surae decreases quickly. An electrical muscle stimulation procedure of the calf can be performed in this case. Electrical stimulation helps maintain limb function.

COOLING OF THE FOOT AND THE ACHILLES TENDON

- a cuff (for example, the CryoCuff system) is placed on the ankle joint,
- a tennis ball is placed under the heel to maintain plantar flexion in the ankle joint.

At first, the procedures and exercises performed during the therapeutic sessions are similar to those used in the inflammatory phase. There is still no weight-bearing on the operated limb and the patient is wearing two splints. Consequently, there is a particularly fast decrease in the muscle mass and tone of the gastrocnemius. Supportive exercise and electrical muscle stimulation are used in this case, which allow for achieving active plantar flexion in the ankle joint.

MOBILISATION OF TISSUES AROUND THE SCAR

Initial position: the patient is in the prone position.

How to perform: stroking and kneading (using thumbs) on both sides of the tendon from the calcaneal tuber towards the calf.

After 4 weeks, the patient start performing exercises in a sitting position. At this stage, weight-bearing can be added on the knee with a 3-kg ball and a wedge should be placed under the heels.

Remodelling is the longest stage of tendon tissue healing, during which the highest number of changes take place both in the structure and in the resistance of the tendon. The remodelling starts around the 7th week and the whole process lasts up to approximately 1 year. Another ultrasound should be performed at week 6 to evaluate tendon cohesion. Swelling can be eliminated through lymphatic massage and with the use of a compression sock.

Another diagnostic ultrasound is performed around the 12th week to evaluate the structure of the tendon, stage of healing of the sutures, degree of swelling, and tendon glide and tone (with resistance). If the ultrasound and clinical assessment show normal progress, the patient starts wearing a normal shoe, usually a sports shoe, while walking.

After 14 to 15 weeks, patients are recommended to often exercise barefoot, especially on an unstable surface.

Swimming in a pool with short swimming fins can be recommended to patients as the first sports activity (as early as after week 14). Thanks to this exercise, calf muscles become stronger in a non-weight-bearing setting.

AIM

The aim of this paper is to evaluate outcomes of physical therapy following surgical treatment after a complete Achilles tendon rupture, which was treated either with minimally invasive (percutaneous) repair or open repair.

MATERIALS AND METHODS

The study involved two groups of patients who underwent surgery at the Department of Trauma and Orthopaedic Surgery of the City Polyclinic Hospital, Independent Public Healthcare Unit in Częstochowa. The follow-up period was approximately 18 months.

Group 1 consisted of 23 patients who underwent percutaneous surgery. The mean age was 44.8 years (Fig. 5).

Group 2 consisted of 23 patients of similar age (Fig. 6) who underwent open surgery due to Achilles tendon rupture, performed by the same orthopaedist.

All patients underwent a clinical and ultrasound examination before surgery.

Out of the operated patients in Group 1, 20 were men and 3 were women; Group 2 included 22 men and 1 woman.

The most common causes of injury included improper warm-up, limb overload when doing sports, previous injury, poor sports technique, and improper shoes.

These causes are presented in Figure 7.

Based on the values shown in Figure 7, referring to the causes of injury in patients from Group 1, one may conclude that the most common cause of Achilles tendon rupture was limb overload (69.57%), followed by improper warm-up, previous injury and poor sports technique (8.7% each). Wearing improper shoes was another cause of injury (4.35%). Based on the values shown in Figure 8, referring to the causes of injury in patients from Group 2, one may notice that the most common cause of Achilles tendon rupture in this group was also limb overload (68.20%); it was followed by previous injury (18.20%), improper warm-up (9.10%) and poor sports technique (4.50%). In Group 1, the injury occurred in the right leg in 15 patients and

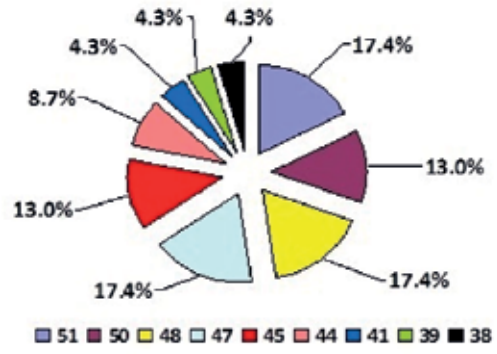

Fig. 5. Number of patients by age, Group 1.

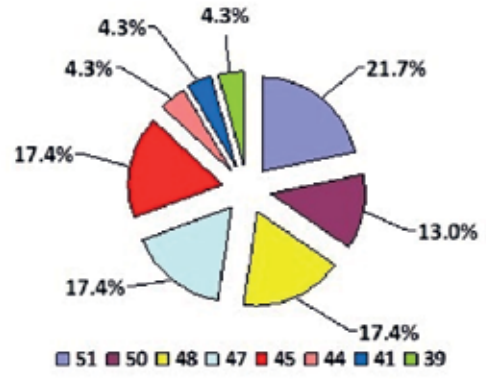

Fig. 6. Number of patients by age, Group 2.

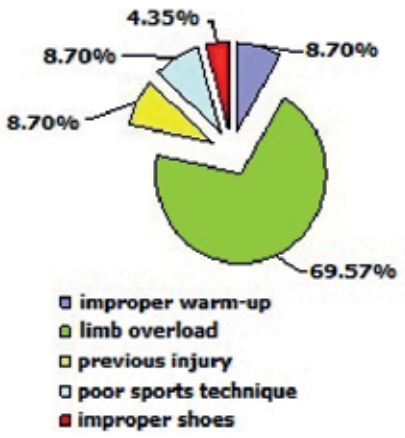

Fig. 7. Causes of injury, Group 1.

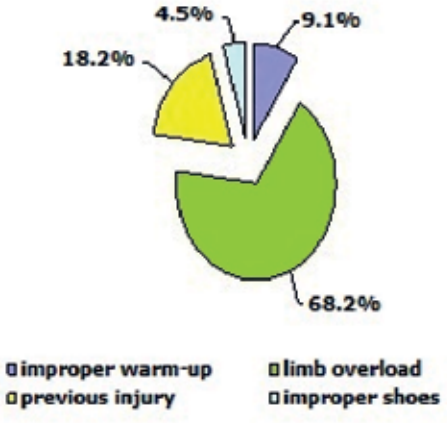

Fig. 8. Causes of injury, Group 2.

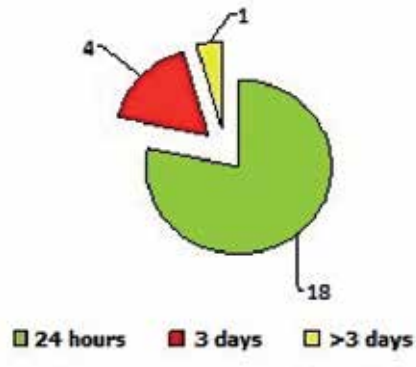

Fig. 9. Time to surgery in Group 1.

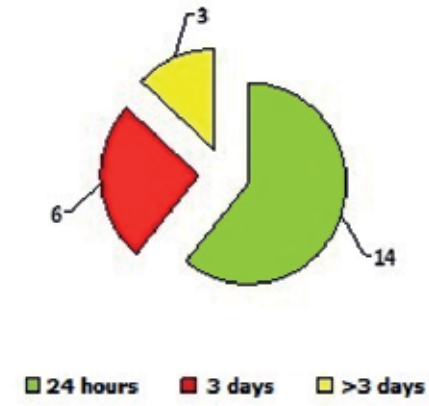

Fig. 10. Time to surgery in Group 2.

in the left leg in the other patients; in Group 2, the injury occurred in the right leg in 18 patients and in the left leg in the other patients (Fig. 9).

In Group 1, 78% of patients presented for surgery within 24 hours of the injury, 17.4% presented for surgery within 3 days and 1 person (4.3%) presented for surgery within more than 3 days.

In Group 2, 60.86% of patients presented for surgery within 24 hours of the injury, 26.0% presented for surgery within 3 days and 3 people (13.0%) presented for surgery within more than 3 days (Fig. 10).

A physical examination was performed in all patients before the start of treatment. The examination revealed swelling in the distal part of the shin accompanied by ecchymoses, palpable loss of tendon continuity, weakened plantar flexion in the talocrural joint, and lack of plantar flexion of the foot in response to calf squeezing (positive Thompson test). Study patients were also unable to stand on their toes of the affected lower limb. The patients underwent an ultrasound, which confirmed complete Achilles tendon rupture.

All 23 patients from Group 1 underwent surgical treatment. A Kessler suture was used during a minimally invasive procedure, which stabilised the Achilles tendon in its normal position. The lower leg was then immobilised in a plaster cast, ensuring equinus position of the foot, i.e. plantar flexion of 15 to 20 degrees in the talocrural joint. The immobilisation was maintained the whole time (except for during physical therapy) for a period of 6 weeks. Standard thromboprophylaxis was used during the period of immobilisation in a plaster cast.

Following surgical treatment, study patients from Group 1 stayed at the hospital department for 1 to 4 days, during which time they started rehabilitation (kinesiotherapy and learning how to walk with crutches). The rehabilitation was then continued in an outpatient setting. The proposed rehabilitation was divided into 4 periods. The first period included the hospital stay. The second period (approximately 6 weeks) included kinesiotherapy, massage and electrical muscle stimulation; its beginning depended on when the patient was admitted for treatment at the regional rehabilitation clinic. During the third period, which lasted approximately 2 months, the patients learned how to walk on an inclined and moving surface. During the fourth period, whose duration was approximately 4 months, the rehabilitation was intensified and once full function had been restored, patients returned to their previous work and sports activity. Total treatment duration was approximately 6 months after the injury.

Outcomes were assessed once the treatment had been completed. The follow-up period was at least 18 months. Restoration of normal function in the operated limb was assessed based on the medical records, history and physical examinations. The assessment included presence of pain, range of active and passive motion in the operated limb, particularly in the talocrural joint, muscle strength in the operated limb, and presence of contractures and swelling. In order to ensure that the outcomes were as objective as possible, a standard ankle and hindfoot scale was additionally used. Moreover, an ultrasound was performed to confirm the continuity of the Achilles tendon and the course of the fibres.

Group 2 included patients of similar age who underwent traditional surgery. The procedure was performed by the same orthopaedist.

Study patients from the traditional surgery group stayed at the department for 2 to 4 days. Full function was restored after 5 to 8 months. During the final assessment, limb function was fully restored in 21 patients, and interviews did not reveal any pain in the operated limb at rest or during gait. A physical examination showed a full range of passive and active motion in the talocrural joint and the other joints of the lower limb. Full muscle strength, no reduction in the circumference of the operated shin and no swelling were also found. These patients obtained the maximum score in the ankle and hindfoot scale.

An ultrasound performed after treatment completion showed full restoration of tendon continuity and tendon remodelling in all patients.

DISCUSSION

The Achilles tendon is the strongest tendon in the human body. Despite the tendon's resistance to stretching exceeding 400 kG, the incidence of Achilles tendon rupture has been increasing, especially in individuals aged 30-40 years. This age range is considered to be a risk factor for this condition. The literature includes information such as the fact that, for example, only 1% of patients who experience Achilles tendon rupture in Finland are in the first and second decade of life, i.e. under the age of 20 years. The risk of sustaining this injury increases after the age of 25 years. The incidence is particularly high in people aged 30–45 years and then gradually declines; only 2% of patients who sustain this type of injury are over the age of 70 years. The age range also depends on gender; women constituted 15% of individuals with Achilles tendon rupture aged 25-35 years and 23% of those aged 40–60 years [1-9].

Due to gradual involution of the vascular bed after the age of 30 years, accumulating microinjuries and the chronic inflammation developing as a result (tendinopathy), and additional impairment of the protective mechanism of proprioreceptors during tendon overload, especially in this age group, people who are at the highest risk of sustaining this injury are those individuals who used to do sports in the past and suddenly decide to return to this activity years later without proper warm-up and training. The risk of injury increases further when improper shoes are used and when the person is running on a hard, slippery and inclined surface. The tendon can rupture during violent, excessive dorsal flexion. The tendon usually ruptures at the level of 2 to 6 cm from the calcaneal tuber.

In most cases, surgical treatment is considered to be an optimum method of management in patients with Achilles tendon rupture [6-9].

The main goal of treatment in the case of Achilles tendon injury is to restore the original, normal length, resistance and structure of the internal tendon-muscle unit, which generates active movements in the talocrural joint.

To achieve this, the actual structure of the Achilles tendon needs to be considered when planning surgical treatment. Within the heel tendon, fibres are not parallel but spiral, with a 90-degree tendon twist. This course is typical of a hawser and ensures maximum resistance at the same time. The medial group of fibres of the medial head of the gastrocnemius constitutes the posterior layer of the heel tendon (Achilles tendon). The lateral part of the fibres of the medial head creates the lateral outline of the tendon. The fibres that constitute an extension of the lateral head create the anterior layer of the tendon. Fibres originating from the soleus muscle run through the space between these layers. Macroscopically, the spiral structure of the tendon is also reflected on the lower levels of tendon organisation, down to the level of collagen fibres. This structure is also taken into account by the intraoperative management algorithm used in the hospital when connecting the proximal and distal stumps of the tendon. In order to restore their normal rotation, the fibres of the Achilles tendon are twisted appropriately. Conservative treatment cannot restore the normal course of the fibres. The proximal tendon stump, tugged on by the heads of the triceps surae, will have the tendency to derotate even in cases where the ends of the torn fibres have been apparently brought closer. The use of minimally invasive surgery taking into consideration the normal course of the fibres helps derotate the tendon into a normal position. Consequently, this method helps achieve one of the basic objectives of the surgical treatment.

Appropriate rehabilitation following Achilles tendon surgery is also important. A four-stage rehabilitation regimen seems to be an accepted model. The rehabilitation lasts 3 to 8 months and starts directly after surgery. In the first stage (up to 2 weeks), patients receive local cryotherapy, which reduces pain and swelling, as well as laser therapy and start kinesiotherapy, mostly in the form of isometric exercises. During this period, patients also learn how to walk using elbow crutches. In the second stage, which lasts approximately 6 weeks and involves repeated limb immobilisation, patients undergo massage, kinesiotherapy and electrical muscle stimulation; the cast is removed so that the procedures can be performed. In the third stage, lasting approximately 2 months, the most important thing is for patients to gradually learn how to walk on uneven and unstable surfaces. In the fourth stage, lasting approximately 4 months, patients undergo kinesiotherapy and physical therapy and gradually return to full activity, including sports activity [18-25].

The recent years have seen a sudden increase in the number of people doing sports, or a trend towards doing sports. This trend is definitely a good thing; however, one should remember that before taking up any kind of physical activity, it is beneficial to consider a number of factors that may affect the health of the person taking up that physical activity. Some of the factors that can predispose to injury include comorbidities, past injuries, body biomechanics, body mass of the person doing the exercise, type of sports activity, frequency and intensity of training. Overload and inflammation within the Achilles tendon occur fairly often and if left untreated, they may result in further complications, including a complete rupture of the tendon. Appropriately selected treatment of Achilles tendon injuries/ruptures allows for restoring full

function only when the recommendations with respect to rehabilitation and repeat injury prevention are being followed [16-25].

CONCLUSIONS

1. Achilles tendon injury is a difficult clinical problem.
2. Achilles tendon injuries should be treated with surgery, including minimally invasive procedures, which seem to be more beneficial for the patient.
3. Physical therapy is the basis of management after surgical treatment in patients with Achilles tendon injury.

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CONFLICT OF INTEREST
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ORIGINAL ARTICLE

Crenotherapy with therapeutic sulfide water as a new direction of health resort treatment on the example of the Sulfide Reduction Diet

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ABSTRACT

Aim: The purpose of this paper was to present a summary of the research and development work carried out in the search for new and sustainable methods of using sulfide waters located in the Świętokrzyskie, as well as setting new directions for treatment and development in Busko-Zdrój.

Materials and Methods: The research was conducted as part of the project No. RPSW.01.02.00-26-0014/18 titled: "Research and development study on the use of sulfide water in weight reduction therapy" implemented under the Regional Operational Program of the Świętokrzyskie for 2014-2020, co-financed by the European Union from the European Regional Development Fund, which was carried out at Hotel BRISTOL**** ART & Medical SPA in Busko-Zdrój by FONTIA Sp z.o.o. The method of conducting the research was comparative and in the first phase it involved the search for methods of covering the smell and taste of sulfide water, and then conducting tests on patients after obtaining approval from the Medical Bioethics Committee.

Results: The study findings demonstrate that sulfide water crenotherapy positively impacts body weight and composition, mood, as well as skin and nail condition. As an outcome of this research, a novel therapy termed the Sulfide Reduction Diet (SDR) was developed and subsequently introduced into the commercial market. The research outcomes have been patented, leading to the development of two invention applications and a trademark.

Conclusions: The most important influence on our body is a balanced diet and physical exercise. Sulfide water crenotherapy is a supplement that strengthens our body, improves immunity, speeds up metabolism and strengthens skin and nails.

KEY WORDS: obesity, diet, Busko-Zdrój, crenotherapy, medical tourism

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INTRODUCTION

The use of sulfide waters and, more specifically, sulfide-hydrogen sulphide, chloride-sodium, iodide, bromide waters in spa treatment has been known and used for years. Especially Swietokrzyskie spas are famous for their sulfide waters with very high levels of sulfur compounds. A comparison of Solecko and Busko waters against those in foreign spas shows that the waters of the Swietokrzyskie region are many times superior in their mineral composition to those of Baden or Trenczyn [1]. The form in which mineral components occur in medicinal waters is of particular importance as it influences their absorption by the human body [2].

The most common treatments used in the Swietokrzyskie spas of Busko-Zdrój and Solec-Zdrój are sulfide baths. Due to the intense hydrogen sulfide odor and salty taste, these waters have generally not been used in crenotherapy. What should be noted, is that the consumption of valuable therapeutic water resources for crenotherapy is incomparably lower. A bath is about 200 liters and requires disposal expenses, while crenotherapy is only 50 ml twice a day, which is 0.05% of the daily consumption of a traditional bath. It's also worth noting that there is little dermal absorption of sulfur during bathing, while crenotherapy offers the potential for much greater sulfur absorption. As studies show, as early as 20 minutes after drinking, an increase in sulfur levels can be found in joint cartilage, bone tissue, vascular wall and intestinal mucosa. Such a form of treatment has been proven to have a beneficial effect on, among other things, the digestive tract, carbohydrate and fat metabolism, as well as anti-inflammatory and allergies desensitizing effects. In addition, sulfur is involved in the processes of removing or neutralizing free radicals. Deficiency of this component can lead to worsening of the condition of skin and nails, low mood, fatigue, anxiety and many other negative effects [3-5].

In the initial phase of industrial research, the research problem centered on mitigating unfavorable organoleptic characteristics to align with SPA&Wellness treatment trends. Subsequently, the second phase of industrial research investigated the impact of crenotherapy on patients, leading to the formulation of a therapeutic program. This program was then transformed into a commercial health tourism product in the final phase of the project.

AIM

The purpose of this paper was to present a description of the research and development work carried out in the search

for new and sustainable methods of using sulfide waters located in the Świętokrzyskie province, as well as setting new directions for treatment and development in Busko-Zdrój.

MATERIALS AND METHODS

The research was carried out as part of the project No. RPSW.01.02.00-26-0014/18 entitled: "Research and development study on the use of sulfide water in weight reduction therapy" implemented under the Regional Operational Program of the Świętokrzyskie Province for 2014-2020, co-financed by the European Union from the European Regional Development Fund, which was carried out at Hotel BRISTOL**** ART & Medical SPA in Busko-Zdrój.

Hydrogen sulfide-sulfide, chloride-sodium and iodine water, further referred to as sulfide water, is sourced from the Health Resort Mining Plant – "Las Winiarski". Renowned for its medicinal properties, this water boasts high mineralization, totaling 12.7 g/dm^3, and exhibits a crystal-clear appearance with a subtle straw-green hue. Its composition includes specific components such as:

- Hydrogen sulfide, hydrosulfide and sulfide ions (H2S, HS- , S2-) – 45 mg/dm^3 ;
- Iodide ions (I-) – 2.20 mg/dm^3.

The water also contains micronutrients valuable for health, including bromine, iodine, fluorine, potassium, lithium, selenium, silicon and boron (Table 1) [1, 2].

The method of conducting the research was comparative and in the first stage it involved the search for methods of covering the odor and taste of sulfide water, and the second stage involved tests on patients after obtaining approval from the Medical Bioethics Committee in Kielce.

The primary objective of the initial phase of industrial research was to acquire novel insights validated by the positive confirmation of hypothesis H.1. Natural smell and taste compounds contained in plants (fruits, vegetables, herbs) allow to completely cover the odor and taste of sulfide water. Accomplishing this goal involved several milestones, including the submission of a patent application for an innovative method addressing sulfide water's odor and taste, along with obtaining approval from the Bioethics Committee for conducting the research. Additionally, logistical tasks such as preparing research tools and procuring necessary equipment and software were undertaken. Through systematic experimentation, food products, specifically vegetables and fruits, were meticulously selected based on their efficacy in masking the taste and odor of sulfide water. These selections were subsequently subjected to organoleptic testing to evaluate their suitability for further investigation. The research team's focus centered on devising a natural approach to alter the physicochemical and organoleptic properties of sulfide water, representing a notable process innovation. Conducting this part of the research resulted in the positive verification of hypothesis No. 1 and submission of an invention application registered on July 15, 2019 under No.: P.430598 with the title "Method of covering the salty taste and hydrogen sulfide odor of therapeutic sulfide water and its application in crenotherapy" regarding the method of covering the smell and taste of sulfide water. The solution involves mixing sulfide water (50 ml) with freshly squeezed vegetables, fruits and herbs juices (200 ml). As an added value of the developed solution, it should be noted that the addition of approximately 10 ml of lemon juice mixtures reduces the effect of hydrogen sulfide reflux. This results in a stronger stomach closure, significantly reducing the unpleasant sulfur odor reflux.

The second phase of industrial research employed a comparative methodology involving a sample of 150 individuals, with 112 comprising the study group and 38 forming the control group. The study group comprised individuals undergoing crenotherapy, characterized by the consumption of sulfide water, whereas the control group consisted of individuals abstaining from sulfide water consumption. Participants were categorized based on various criteria, primarily their body mass index (BMI), resulting in four groups: 46 obese subjects (33 in the study group, 13 in the control group), 72 overweight subjects (55 in the study group, 17 in the control group), 18 normal weight subjects (13 in the study group, 5 in the control group), and 14 underweight subjects (11 in the study group, 3 in the control group). The study involved 122 female and 28 male participants.

Participants stayed in a hotel for 10 days under the supervision of a multidisciplinary team, including nutritionists, a physician, a pharmacist, a physiotherapist, and a personal trainer. Subsequently, therapy continued at home for 20 days according to prescribed guidelines, with the "yo-yo effect" and maintenance of lifestyle changes monitored after 3 months.

All participants underwent standardized research and health procedures tailored to their individual needs and health status. Notably, differences between the study and control groups pertained to the composition of juice and water mixes consumed, with the study group consuming mixes comprising 50 ml of sulfide water and 200 ml of freshly squeezed juices twice daily, while the control group consumed juices with regular mineral water.

The initial screening process involved the analysis of recruitment questionnaires to identify any contraindications to crenotherapy. These questionnaires comprehensively assessed participants' health status and chronic illnesses. Following this, during medical consultations, patients underwent interviews and a battery of tests, such as blood counts and abdominal ultrasounds, to rule out any conditions incompatible with crenotherapy, including liver or kidney failure, pancreatic diseases, and the presence of kidney or gallbladder stones. Additionally, careful consideration was given to potential interactions and adverse effects resulting from concurrent usage of sulfide water, medications, and dietary supplements.

Apart from crenotherapy, participants received supplementary treatments including sulfide baths, Scottish whips, and carbonic acid baths. They also underwent educational sessions on healthy lifestyles, encompassing nutrition and physical activity. Regular exercise sessions were conducted under the guidance of a personal trainer, comprising aqua fitness, stretching, and Nordic walking.

Additionally, participants had access to a designated exercise area for independent workouts.

Throughout the study, participants received dietary provisions tailored to their individual energy requirements for the initial 10-day period at the hotel. Following this, they were equipped with personalized dietary guidelines, educational materials, sample meal plans, and recipes for home preparation over the subsequent 20 days. These dietary recommendations adhered to the principles of healthy nutrition advocated by the National Center for Nutrition Education [6]. Additionally, participants maintained a daily food diary for a month, using a continuous recording method to document meal composition, weight, and timing, as well as the composition of juice-water blends, water consumption in glasses, daily physical activity in minutes, and subjective mood assessments.

In each cohort, the impact of crenotherapy on various individual metrics was assessed, encompassing weight, body composition, circumferences, as well as blood and urine laboratory parameters, among others. Measurements were conducted pre-treatment, during treatment, and up to 3 months post-treatment. Body weight and composition were evaluated utilizing the electrical bioimpedance technique employing a portable InBody 230 analyzer, while body height was measured using an ultrasonic height gauge. Circumferential measurements were obtained with a Seca metric tape. Parameters derived from the analysis included body weight [kg], body fat mass [kg], muscle mass [kg], total water volume [kg], BMI [kg/m^2], and percentage body fat [%], reported to one decimal place.

The second stage of the research was conducted under the auspices of approval granted by the Bioethics Committee affiliated with the Świętokrzyskie Medical Chamber in Kielce, designated as No. 21/2019. All participant data, including pertinent consents and declarations, were meticulously secured and maintained in adherence to the directives of the overseeing Bioethics Committee. This process ensured compliance with relevant laws and protocols governing the execution of the research and development project.

RESULTS

EFFECTS OF THE SULFIDE REDUCTION DIET ON WEIGHT, COMPOSITION, AND BODY CIRCUMFERENCES IN NORMAL-WEIGHT, OVERWEIGHT, AND OBESE PATIENTS

The normal weight group was formed based on BMI (18.5-24.9 kg/m^2). However, some subjects had a BMI at the upper limit of normal, and their body composition was not always ideal and needed improvement. After one month of therapy, a favorable effect of crenotherapy on the reduction of body weight, body fat, and body circumference was observed among normal-weight subjects. Detailed data are shown in Table 1.

The cohort categorized as overweight (BMI: 25-29.9 kg/m^2) also exhibited positive outcomes from the Sulfide Reduction Diet (Table 1). Following one month of therapy, participants in this weight category experienced an average reduction of 1.2 kg/m^2 in BMI within the study group and 0.9 kg/m^2 in the control group. Post-therapy, analysis of BMI data revealed that 15% of individuals originally classified as overweight transitioned to the normal BMI range, with a notable proportion approaching these healthy values. Moreover, within the obese subgroup, 20% achieved a reduction in BMI, shifting into the overweight BMI range.

In the cohort of individuals diagnosed with obesity, characterized by a BMI exceeding 30 kg/m^2, the study sample exhibited a greater reduction in mean body circumferences despite a lower average weight loss compared to the control group (Table 2). This observation may stem from gender disparities within the groups, as men constituted approximately 33% of the study sample compared to over 60% in the control group, with a majority (75%) weighing over 100 kg, thereby contributing to more significant weight reduction. Additionally, the control group experienced a greater loss of muscle mass compared to the study group.

Notable differences in weight reduction were observed among women with excess body weight (BMI above 25 kg/m^2). Women consuming sulfide water exhibited an average weight reduction of 3.1 kg, while those in the control group saw a reduction of 2.8 kg. However, no significant difference in weight reduction was observed among men with a BMI exceeding 25 kg/m^2.

After 3 months, the monitoring revealed that nearly 80% of individuals in the study group maintained their weight without any increase. In contrast, this percentage was slightly lower at 68% among individuals in the control group. Notably, the impact of nutrition education was evident, with over half of the participants indicating their adherence to the prescribed diets or adoption of healthier eating habits. For those who did not adhere strictly to the diet, many still exhibited positive dietary modifications, such as increased consumption of vegetables and fruits, dietary fiber, improved hydration, and enhanced physical activity levels compared to their pre-study habits. These lifestyle changes contributed significantly to further weight reduction in a considerable proportion of participants. Furthermore, a substantial number of study participants reported alleviation of gastrointestinal symptoms, including constipation, heartburn, and bloating, both during and after the treatment period.

IMPACT OF SULFIDE REDUCTION DIET ON WELL-BEING, SKIN, AND NAIL CONDITION

The conducted study demonstrated the positive influence of sulfide water crenotherapy in conjunction with dietary modifications and increased physical activity on enhancing patients' overall well-being. Interactions with fellow crenotherapy participants and the collective pursuit of health and aesthetic improvement further bolstered this effect. While individuals in the study group were marginally more inclined to rate their well-being as "very good" compared to those in the control group (77.14% vs. 69.44%), this difference was not statistically significant ($p>0.05$). Among the various weight categories within the study group, the highest percentage of "very good" well-being responses (82.35%) was reported

Table 1. The main components of sulfide water

Anions [mg/dm³]		Cations [mg/dm³]	
Chlorides Cl^-	5955,60	Sodium Na^+	3896,80
Sulphates SO_4^{2-}	1617,20	Potassium K^+	106,80
Bicarbonates HCO^{3-}	399,80	Calcium Ca^{2+}	340,68
Bromides Br^-	5,00	Magnesium Mg^{2+}	221,18

Table 2. Comparison of the effects of crenotherapy on weight, body composition and girth in the study and control groups

Changes in measurements	Proper body weight		Overweight		Obesity	
	Study group	Control group	Study group	Control group	Study group	Control group
body weight, kg	-2	-1,6	-3,3	-2,4	-3,6	-5,1
body fat, kg	-2,3	-0,5	-3,1	-2,6	-2,7	-3,4
body fat, %	-2,6	-0,6	-2,7	-2,3	-1,2	-1,9
muscle tissue, kg	+0,2	-0,7	-0,1	+0,1	-0,5	-0,9
total body circumferences, cm	-9,7	-7,9	-14,4	-12,6	-16,2	-15,4
waist circumference, cm	-4,2	-2,1	-5,5	-5	-6,3	-6,0
hip circumference, cm	-2,0	-2,3	-3,6	-3,6	-4,1	-3,7

by overweight individuals, whereas the lowest (55.56%) was observed among underweight individuals, although these differences were not statistically significant ($p>0.05$). Notably, post-treatment, 56.8% of individuals in the study group reported an improvement in well-being, compared to only 25% in the control group. Importantly, the study revealed a positive correlation between increased happiness and heightened physical activity, which in turn contributed to weight reduction.

Regarding skin and nail health, 52.3% of participants in the study group reported improvements, whereas only 12.5% in the control group noted similar enhancements.

DISCUSSION

The dynamic increase in the prevalence of excessive body weight and coexisting metabolic disorders is a global health problem. Obesity is a multifactorial disease, the treatment of which requires a holistic approach that takes into account physiological and psychological conditions. The most common method of reducing excess weight is a customized low-calorie diet and physical activity. Unfortunately, publicly available, numerous and often controversial information about low-calorie diets that guarantee unreasonable results in a short period of time mislead the average patient struggling with excessive body weight [7]. As a result, patients make numerous attempts at weight reduction that often end with unsatisfactory results, thus increasing the risk of yo-yo effect and other health consequences resulting from nutrient deficiencies in unconventional diets [8, 9].

The Sulfide Reduction Diet (SDR) is based on the healthy eating recommendations of the National Center for Nutrition Education and ensures that energy, nutrients, minerals and vitamins are properly met [6]. In addition, supplementing the diet with sulfide water provides a large dose of minerals, which prepares the body for long-term weight reduction. This is a prophylactic measure to protect against the occurrence of deficiencies, which can be a natural consequence of long-term low-calorie diets and unavoidable minor dietary errors.

The therapy protocol, complemented by well-balanced meals, incorporates personalized dietary guidance, medical consultations, physiotherapy sessions, and group education on healthy eating habits. Extensive evidence underscores the significance of nutritional education in weight management interventions [10]. The collaborative care provided by an interdisciplinary team comprising physicians, nutritionists, physiotherapists, and psychologists within structured weight reduction programs offers myriad benefits to patients, including enhanced quality of life and heightened self-perceived health levels [11].

During the study, the authors examined the impact of SDR on body weight and composition. Following treatment, analysis based on BMI revealed that 15% of individuals (11 subjects) initially classified as overweight transitioned into the normal BMI range. Additionally, among those initially classified as obese, 20% experienced a reduction in BMI, shifting into the overweight BMI range. In a separate study conducted during a weight-loss retreat, participants with an average BMI categorization in the overweight range demonstrated

an average reduction of 2.2% in BMI. However, this reduction did not lead to the entire group transitioning to a lower BMI category. Specifically, only 6.7% (2 individuals) moved from the overweight category to normal weight, with none transitioning from the obese category to overweight [12].

Individuals in the study group demonstrated a higher likelihood of rating their well-being as "very good" compared to those in the control group (77.14% vs. 69.44%). A similar positive effect of sulfur was observed in a separate study utilizing sulfide water crenotherapy combined with mint syrup among individuals with emotional disorders. Remarkable enhancements in psychosomatic parameters were observed in participants consuming sulfide water compared to those ingesting low-mineralized water. This improvement is potentially attributed to the antioxidant properties of sulfur, mediated by the action of glutathione within the central nervous system [13].

Sulfur deficiency is linked to nail brittleness, nail diseases, and increased epidermal keratosis [3]. Notably, SDR was found to ameliorate the condition of both skin and nails, with significant improvement observed in the study group compared to the control group. Furthermore, the impact of sulfur on nails was corroborated in another study investigating the efficacy of oral supplementation with a sulfur-containing product. This supplementation resulted in notable improvements in nail condition, as assessed by both experts and participants themselves [14]. Additionally, the same researchers documented the beneficial effects of a sulfur-containing supplement on skin health in a separate study. The supplement demonstrated efficacy in reducing signs of skin aging [15].

CONCLUSIONS

In conclusion, maintaining a balanced diet and engaging in regular physical exercise exert the most significant influence on our overall well-being. Sulfide water crenotherapy serves as an adjunctive factor that amplifies therapeutic effects, positively impacting the body by enhancing immunity, accelerating metabolism, and fortifying the condition of the skin and nails.

The findings of our research were disseminated during a series of conferences promoting the Project and healthy lifestyles, conducted in 2019, 2020, and 2021. These events have now become a staple in the BRISTOL ART&MEDICAL SPA**** facility's calendar of activities.

In accordance with the R&D agenda, the research outcomes have been incorporated into the commercial market and have gained significant popularity among tourists. These therapies appeal not only to individuals seeking to shed excess body weight but also to those aiming to enhance mineralization. After 1.5 years of implementation in the market, over 100 hotel guests, increasingly including international visitors, have undergone the therapy. Some guests have returned for multiple visits, achieving remarkable weight reductions exceeding 20 kg. Adherence to the recommendations has notably mitigated the yo-yo effect.

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ORIGINAL ARTICLE

Dynamics of motivational and value attitude of students of the problem of health and a healthy lifestyle

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ABSTRACT

Aim: The aim of the study is to determine the dynamics of motivational and value attitude of students of the problem of health and a healthy lifestyle.

Materials and Methods: The material for analysis was the results of a survey of students of the Educational and Scientific Institute of Physical Culture of Sumy State Pedagogical University named after A. S. Makarenko held during 2020-2023. Students of the 1st-4th courses of the 017 «Physical Culture and Sports» and 227 «Therapy and Rehabilitation» specialties took part in the comparative cross-sectional study. The experiment consisted of two stages. 412 students took part in the first stage and 395 students took part in the second. The first stage of the survey was conducted before starting the study of disciplines, the subject of research of which is directly or indirectly related to health, and the second was conducted after the completion of the study of these disciplines. Research methods: theoretical, empirical, methods of statistical data processing.

Results: The results of the study indicate the presence of significant interest of students in the problem of health and a healthy lifestyle. If before the start of the experiment the number of students who were interested in health problems was 55.09%, then after the experiment their number increased to 78.48% ($p<0.01$).

Conclusions: According to the students, the leading fields of knowledge in terms of their competence and potential impact on health are: medicine, physical culture and sports, valeology and psychology.

KEY WORDS: health, healthy lifestyle, knowledge, motivation, academic disciplines, students

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INTRODUCTION

Among the global challenges humanity faces at the current stage of development, it is important to determine priorities and focus on solving problems that in the future affect the existence of society as a whole. One of these challenges is the problem of youth health, which is of particular concern today. The situation has become more complicated due to political, economic, and demographic problems, which are also a significant factor in the negative impact on the health of children and student youth. Research results indicate that the state of health of students is very unsatisfactory. Researchers record the presence of a significant number of disorders in their state of health. This is not least due to the low level of their functional potential and physical fitness. Factors of negative impact on the health of young people are permanent emotional and mental stress, informational stress, low level of physical activity, insufficient financial and material security, bad habits, etc. [1-3].

A successful solution to health problems requires a comprehensive approach, which is based on understanding the essence of individual health, knowledge of the mechanisms of health, factors and processes that determine this state [4]. From the point of view of pedagogical practice, human health as a link of the socio-natural system depends, first of all, on human behavior, lifestyle [5], the level of general culture and the culture of health as its component [6]. Health practice involves individual activities related to the observance of the rules and norms of a healthy lifestyle, the formation of a valuable attitude to health.

Therefore, the process of reforming education should contribute to the search for new forms and methods of learning, related not only to a more successful acquisition of accumulated knowledge, but also to the formation of a culture of health in students, the development of creative health thinking, the ability to perceive and follow in practice the rules and norms of a healthy lifestyle [7].

Preservation and strengthening of the health of student youth should be carried out on the basis of improving the forms, methods, and means of the educational process, taking into account the modern conditions of the educational process in accordance with the realities of life, the socio-economic requirements of society and the state, which

are constantly changing. Therefore, the primary task of the educational community is to ensure the intellectual and physical development of the individual, taking into account his needs, abilities, value orientations, which make it possible to successfully realize his professional potential, while preserving and even increasing his health reserves [8-10].

AIM

The aim of the study is to determine the dynamics of motivational and value attitude of students of the problem of health and a healthy lifestyle.

MATERIALS AND METHODS

The material for analysis was the results of a survey of students of the Educational and Scientific Institute of Physical Culture of Sumy State Pedagogical University named after A. S. Makarenko held during 2020-2023. Students of the 1st-4th courses of the 017 «Physical Culture and Sports» and 227 «Therapy and Rehabilitation» specialties took part in the comparative cross-sectional study, who answered nine homogeneous in their totality questionnaire questions related to: interest in health problems; assessment of one's own health (self-assessment taking into account both objective and subjective indicators known only to respondents); level of awareness in health issues; practical use of knowledge about health in everyday life; by the degree of competence and relevance of various spheres and branches of knowledge to the health problem; the most important health factors; conditions and factors that prevent health care; relevance of knowledge about health for modern society.

The hypothesis of the research was formulated, which lies in that the dynamics of motivational and value attitude of students of the Educational and Scientific Institute of Physical Culture to the problem of health and a healthy lifestyle will be effective if following mastering by students of academic disciplines, the subject of which is related to the health of the human body, which will contribute to the formation of a valuable attitude to health and stimulate the practical use of health-improving means.

The experiment consisted of two stages. 412 students took part in the first stage and 395 students took part in the second. The first stage of the survey was conducted before starting the study of disciplines, the subject of research of which is directly or indirectly related to health, and the second was conducted after the completion of the study of these disciplines. The decrease in the number of students who participated in the experiment occurred for objective reasons, some of them were excluded, some could not participate in the survey because they went abroad. Among such disciplines, first of all, there were: «Fundamentals of a healthy lifestyle», «Fundamentals of individual health», «Health management», «General theory and diagnosis of the state of health», «Health and functional fitness», «Therapeutic exercises» etc.

The purpose of the first stage of the survey was also to find and implement the most effective pedagogical forms and tools that contribute to the actualization of knowledge about health, the successful mastering of relevant practical skills and abilities that become components of a healthy lifestyle, and therefore influence the formation of a culture of health in student youth. Thus, an exclusive pedagogical experiment was carried out, the second stage of which was the correction and improvement of interactive teaching methods during the teaching of the specified disciplines. At the same time, the results of the experiment made it possible to carry out a comparative analysis and find out the qualitative characteristics of these changes.

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; 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 tabular forms, conducting experimental testing; descriptive statistics – relative values (percentages) should be accompanied by error data (±), confidence limits, etc., determination of the statistical significance of differences between groups by Fisher's angular transformation method.

RESULTS

In order to assess the attitude of students to their own health and many aspects of the mentioned problem, we formulated questions for the questionnaire and offered options for answers. The results of the answers to the first question before the pedagogical experiment (before the study of health-oriented disciplines) indicate the presence of significant interest of students in the health problem. The number of those who answered that they were very interested in this problem was 227 people, or (55.1%). In addition, 134 respondents (32.52%) answered that they were interested in this problem, but not so much that it is constantly in the center of their interests. 51 respondents (12.37%) from among those surveyed were interested in their health in periods when problems arise with it.

Significant changes occurred after the experiment. In particular, the share of those interested in health problems increased from 227 (55.09%) to 310 (78.48%) people ($p<0.01$). Accordingly, the number of students who are less interested in this issue decreased from 134 (32.52%) to 80 people (20.25%) ($p<0.05$), and those who are interested in health only in periods when problems arise decreased from

51 (12.37%) to 5 (1.27%) people (p<0.01). Thus, all interviewed students, to one degree or another, at different times, but are interested in the health problem. It is noteworthy that not a single respondent, both before and after the experiment, indicated that he was not interested in the health problem at all (Table 1).

The second question concerned the assessment of one's own health. According to the results of the first stage of the survey, the majority of students (65.29%) consider themselves healthy. At the same time, almost 11% of young people (45 people) answered this question negatively. In addition, 98 students (23.79%) found it difficult to answer this question. Perhaps their health problems are not serious enough to significantly affect their quality of life compared to those who clearly answered that they do not consider themselves healthy, but such numbers are a good reason for concern, because our respondents are between 18 and 23 years old. And among these young people, the total share of those who cannot confidently say about themselves that he (she) is completely healthy is almost 35%. After the experiment, the indicated parameters did not change (p>0.05) (Table 2).

The third question determined the self-assessment of students regarding their knowledge of health (Table 3). During the first stage of the survey, 88 respondents (21.36%) considered themselves sufficiently knowledgeable about health issues. Insufficient awareness was indicated by 51 students (12.38%). The vast majority of students (273 people) determined their awareness only within the limits of certain questions.

After the experiment, the number of students who consider themselves sufficiently knowledgeable about health issues increased from 88 (21.36%) to 142 people (35.95%), and the share of those who do not consider themselves sufficiently knowledgeable decreased from 12.38% to 4.05%. Of course, the results of this survey reflect the personal and, therefore, subjective opinion of each respondent. To what extent it is consistent with the real, objective level of their awareness, only an expert assessment can determine.

Since knowledge about health is important only if it is applied practically, so the fourth question concerned the implementation of theoretical knowledge in everyday practice (Table 4). Before the experiment, 126 respondents

Table 1. Interest in a health problem

Questionnaire questions and answer options	Results				
How interested are you in human health?	Before the experiment		After the experiment		p
	n	%	n	%	
Very interested	227	55.09	310	78.48	<0.01
Interested, but it is not the focus of my interests	134	32.52	80	20.25	<0.05
Interested only in periods when health problems arise	51	12.37	5	1.27	<0.01
Not interested at all	0	0	0	0	

Table 2. Self-assessment of students' health status

Questionnaire questions and answer options	Results				
Do you consider yourself a healthy person?	Before the experiment		After the experiment		p
	n	%	n	%	
Yes	269	65.29	253	64.05	>0.05
No	45	10.92	43	10.89	>0.05
Hard to answer	98	23.79	99	25.06	>0.05

Table 3. Self-assessment of health awareness

Questionnaire questions and answer options	Results				
Do you consider yourself sufficiently knowledgeable about health issues?	Before the experiment		After the experiment		p
	n	%	n	%	
Yes	88	21.36	142	35.95	<0.01
No	51	12.38	16	4.05	<0.01
Only in certain issues	273	66.26	237	60.00	<0.05

Table 4. Practical use of health knowledge

Questionnaire questions and answer options	Results				
Do you use health knowledge in your own daily life practice?	Before the experiment		After the experiment		p
	n	%	n	%	
Yes	126	30.58	211	53.41	<0.01
No	23	5.58	0	0	<0.01
Partially	218	52.91	163	41.27	<0.01
Episodically	45	10.92	21	5.32	<0.01

(30.58%) answered the question in the affirmative. 23 students (5.58%) reported that they do not apply knowledge about health at all. The largest number of students (218 people, or 52.91%) indicated that they use it partially, and 45 (10.92%) respondents indicated that they used it sporadically. Therefore, this survey gives reasons to claim that the vast majority of students (389 people or 94.41%) practically use knowledge about health. We are talking about those who apply them both on a permanent basis and partially or episodically.

After the experiment, the share of students who use the acquired knowledge increased significantly from 126 (30.58%) to 211 (53.41%) people ($p<0.01$). Accordingly, the number of those who applied their knowledge partially (from 218 (52.91%) to 163 (41.27%) persons) or episodically (from 45 (10.92%) to 21 (5.32%) persons) decreased ($p<0.01$). It is also important that at the second stage of the experiment there was not a single respondent who did not use his knowledge about health.

The fifth question aimed to find out the degree of competence and relevance of various spheres (fields of knowledge) to the health problem in the students' perception (Table 5). The peculiarity of this survey was that the respondents had the opportunity to choose one or more answers, which was used by the majority of the respondents, as well as to offer their own option, not specified in the questionnaire. In total, students marked 1,036 options, which is an average of about 2.5 answers per respondent. The option «Medicine» received the highest number of marks, which was indicated by 320 respondents, i.e. 77.67%. And for 65 people (15.77%) this is the only answer among all the ones offered. Physical culture and sports were preferred by 252 people, or 61.16% of the respondents, 19 of whom (4.61%) marked it as the only plausible option. 147 (35.68%) people indicated valeology, of which 13 (3.15%) marked it as the only option. Psychology was one of the important options for 139 students (33.74%). The rest of the answers showed a much smaller number of preferences. 28 students (6.8%) used the «Your option» answer. The most typical answers were: «All the specified areas should participate in health care», «Each area is certain knowledge about health, therefore it is important to know all», «Each person's personal responsibility», «a comprehensive approach, each area competence is important in human health», «all these sciences complement themselves in the field of health competence».

After the experiment, there were some changes in the students' perception of the competence of various fields and their possibilities in terms of impact on health. In particular, the positions of physical culture and sports (from 252 to 187 people) and valeology (from 147 to 95 people) decreased significantly ($p<0.01$). Instead, the role of psychology increased slightly (from 139 to 163 people) ($p<0.05$). Biology almost did not change its position (85 before and 68 after the experiment) ($p>0.05$). The role of pedagogy decreased significantly (from 53 to 26 people) ($p<0.01$). The number

Table 5. Competence (relevance) of various fields of knowledge to the health problem

Questionnaire questions and answer options	Results				
In your opinion, knowledge about health is an area of competence:	Before the experiment		After the experiment		p
	n	%	n	%	
Medicine	320	77.67	295	74.68	>0.05
Physical culture and sports	252	61.16	187	47,34	<0.01
Valeology	147	35.68	95	24.05	<0.01
Psychology	139	33.74	163	41.27	<0.05
Biology	85	20.63	68	17.22	>0.05
Pedagogy	53	12.86	26	6.58	<0.01
It is difficult to answer	12	2.91	5	1.27	<0.05
Your option	28	6.8	148	37.47	<0.01

of supporters of medicine decreased slightly (from 320 to 295 people) ($p>0.05$). At the same time, the number of students who indicated their option increased significantly (from 28 to 148 people, or 37.47%) ($p<0.01$). Their answers are similar to those given above. So, it can be said that after the experiment, critical thinking is formed in a large part of the students and more supporters of the integrated approach in solving health-related issues appear.

Thanks to the sixth question, we found out the priority spectrum of factors, which, in the students' opinion, is the most important and effective in terms of impact on health. Respondents were asked to choose 3 of the specified factors, which, in their opinion, are the most important (Table 6). There was also an opportunity to express your own opinion (your option). The leaders among these factors were: «Nutrition» (239 people, or 58%), «Day mode, rest, good sleep» (170 people, or 41.26%) and «Heredity» (166 people, or 40.29%). Students also attach importance to psycho-emotional state (164 answers, or 39.8%), physical culture (147 answers, 35.68%) and the absence of bad habits (113 answers, 27.43%). Sport in this rating took the seventh position with the result of 110 answers (26.7%).

Therefore, in choosing the most influential factors of health, the student audience prefers, first of all, body-oriented practices, because such an option as spirituality attracted the attention of only 9 (2.18%) respondents. At the same time, tempering remained underestimated (11 supporters, or 2.67%), which is inconsistent with the actual use of tempering procedures, as stated by 47 respondents.

After the experiment, the number of supporters of nutrition increased significantly (from 239, or 58% to 269, or 68.1%) ($p<0.01$). Pharmacology and modern medical technologies somewhat strengthened their positions, while sports, ecology and the state of endoecology, on the contrary, decreased their rating ($p<0.05$). The number of those who expressed a personal opinion increased significantly (from 9 to 21) ($p<0.01$). The most characteristic answers were the following: «Healthy lifestyle without bad habits», «All of the above», «From lifestyle, workload, specifics of work, which determine nutrition, sleep, rest and emotions», «All the indicated factors are important, because each of them has a specific effect on body and health». The rest of the factors did not undergo significant changes.

The purpose of the seventh question was to find out the range of means used by our students to strengthen their own health (Table 7). In this survey, respondents also had the opportunity to choose one or more answer options. According to the results, the most rated were: nutrition (239 answers, or 58% of the respondents); lifestyle without harmful habits (205 (49.76%) responses); sports (205 (49.76%) answers). 177 (42.96%) respondents are engaged in physical culture and for 21 (5.1%) of them this tool is the only option for improving health among all the listed. A significant number of students (83 (20.15%)) indicated that they use pharmacological preparations. Moreover, for 17 (4.13%) respondents, this option was the only answer among all those mentioned. The total number of responses was 1094 (the average indicator is 2.66 responses per respondent).

After the experiment, the «Sport» option significantly lost its position (from 205 to 142 respondents), instead, the number of supporters of physical culture (from 177 to 216 people) and psycho-emotional practices (from 102 to 142 people) increased ($p<0.01$). The number of supporters of a healthy lifestyle (from 205 to 221), cleansing the body (from 34 to 47), and the number of those using pharmacological preparations (from 83 to 58) decreased ($p<0.05$). The rest of the positions did not undergo significant changes. The total number of responses was 1105 (an average of 2.8 responses per respondent).

Table 6. The most important health factors

Questionnaire questions and answer options	Results				
Among the listed factors of influence on human health, choose 3, which, in your opinion, are the most important and effective	Before the experiment		After the experiment		p
	n	%	n	%	
Nutrition	239	58.00	269	68.10	<0.01
Day mode, rest, good sleep	170	41.26	168	42.53	>0.05
Heredity	166	40.29	147	37.22	>0.05
Psychoemotional state	164	39.80	147	37.22	>0.05
Physical culture	147	35.68	132	33.42	>0.05
Absence of bad habits	113	27.42	105	26.58	>0.05
Sports	110	26.70	79	20.00	<0.05
Ecology and state of endoecology	62	15.04	42	10.63	<0.05
Pharmacology and modern medical technologies	25	6.07	37	9.37	<0.05
Hardening	11	2.67	16	4.05	>0.05
Spirituality	9	2.18	10	2.53	>0.05
Your option	9	2.18	21	5.32	<0.01

Table 7. Means of improvement in one's own practice

Questionnaire questions and answer options	Results				
In your own health promotion practice, you use:	Before the experiment		After the experiment		p
	n	%	n	%	
Nutrition	239	58	237	60.00	>0.05
A lifestyle without bad habits	205	49.76	221	55.95	<0.05
Sports	205	49.76	142	35.95	<0.01
Physical culture	177	42.96	216	54.68	<0.01
Psycho-emotional practices (positive emotions, imagery and volitional moods, self-training, prayer, meditation, etc.)	102	24.76	142	35.95	<0.01
Pharmacological preparations	83	20.15	58	14.68	<0.05
Hardening procedures	47	11.4	37	9.37	>0.05
Cleansing the body	34	8.25	47	11.90	<0.05
Your option	2	0.49	5	1.27	>0.05

It is noteworthy that before the experiment, two students (0.49%) indicated in their own answers that they did not practice any health care products, but after the experiment, 5 students (1.27%) indicated that their health program «includes all options in a complex».

The eighth question related to the conditions and factors that prevent students from taking care of their health (Table 8). At the beginning of the experiment, laziness was the leader among the specified factors with 288 answers (almost 70% of respondents). Moreover, for 85 (20.63%) students, this was the only stated reason. 167 (40.53%) respondents complained about being busy with cases, lack of time, and for 66 (16%) people it is only one reason. 100 people (24.27%) had an insufficient level of knowledge and feared of harming their health, and 34 (8.25%) of them had this option as the only answer. 38 (9.22%) respondents expressed confidence in the effectiveness of drugs and the possibilities of modern medicine, and 17 (4.13%) of them marked it as the only possible option. 34 (8.25%) respondents gave their own answers. Their generalized meaning can be formulated as follows: «Nothing is in the way, I take good care of my health»; «When it comes to health, nothing should stand in the way». A small number of respondents, namely 6 people (1.46%) are sure that any efforts in this direction are useless and will not change anything. The total number of responses is 703, i.e. 1.7 per respondent.

It is important to note that after studying health-related disciplines, the number of students for whom laziness is the main obstacle on the way to health has significantly

Table 8. Factors hindering health care

Questionnaire questions and answer options	Results				
What prevents you from taking care of your health?	Before the experiment		After the experiment		p
	n	%	n	%	
Laziness	288	69.9	137	34.68	<0.01
Workload, lack of time	167	40.53	216	54.68	<0.01
Insufficient level of knowledge and fear of harming health	100	24.27	47	11.9	<0.01
Belief in the effectiveness of drugs and the possibilities of modern medicine	38	9.22	5	1.27	<0.01
The influence of the environment, circles of friends who are indifferent to health	30	7.28	16	4.05	<0.05
Lack of desire to engage in health care activities	21	5.1	11	2.78	<0.05
Loss of the meaning of life, lack of satisfaction with life, spiritual discomfort	19	4.6	16	4.05	>0.05
Confidence that any efforts in this direction are useless and will not change anything	6	1.46	5	1.27	>0.05
Your option	34	8.25	53	13.41	<0.01

Table 9. Importance of health knowledge for society

Questionnaire questions and answer options	Results				
As far as. In your opinion. is knowledge about health important and necessary for our society?	Before the experiment		After the experiment		p
	n	%	n	%	
Very necessary	389	94.41	384	97.21	<0.05
Not needed	2	0.49	0	0	<0.05
It is difficult to answer	21	5.1	0	0	<0.01
Your option	0	0	11	2.78	<0.01

decreased (from 288 to 137 people) ($p<0.01$). At the same time, the number of students for whom workload became an obstacle had increased (from 167 to 216 people) ($p<0.01$). Also, the share of those who were hindered by an insufficient level of knowledge and fear of harming their health decreased (from 100 (24.27%) to 47 (11.9%) people), conviction in the effectiveness of medicines and the possibilities of modern medicine also decreased (from 38 (9.22%) to 5 (1.27%), the influence of the environment, circles of friends who are indifferent to health lowered (from 30 (7.28%) to 16 (4.05%) people), lack of desire to engage in health also decreased (from 21 (5.1%) to 11 (2.78%) persons). After the experiment, significantly more students, namely 53 (13.41%), formulated their own answer to the question, where they indicated a point of view similar to the previous ones.

The questionnaire was completed by a question about the importance of health knowledge for society (Table 9). Before the experiment, the vast majority of respondents, namely 389 (94.41%) indicated that such knowledge was very necessary. Two students (0.49%) indicated that it was not needed. It was difficult for 21 respondents (5.09%) to answer. None of the respondents gave their own version of the answer to the experiment.

After the experiment, the opinions of our respondents underwent some transformation. In particular, none of the respondents indicated that society does not need knowledge about health, and there were no respondents who found it difficult to answer this question. The number of those who believe has significantly increased. that this knowledge is very necessary ($p<0.05$). 11 respondents gave their version of the answer, where they expressed their own opinions about the importance of health knowledge for society.

DISCUSSION

The processes of integration of the higher education system of Ukraine to European standards increase the quality characteristics of professional training of future specialists, promote more active participation of students in the planning and organization of educational activities, the choice of forms and methods of assimilation of educational material. Improving the quality of professional education today is one of the urgent problems for the pedagogical community, the solution of which is connected with the modernization of the content of the educational process, as well as rethinking the purpose and result of education. The implementation of this approach forms a new vision of the very content of education, and also contributes to the reorientation of traditional cognitive trends of higher education, its methods and technologies, since modern world trends put forward new requirements related to the entry of a person into the social space and productive adaptation in it [20-23].

The educational sector faces a new task, which consists in achieving a more complete, personal and socially integrated result. World transformations, which gradually accumulated, led to the reorientation of the educational direction and the formation of a new paradigm of the result of education. Currently, there is a process of changing the orientations of higher education from the training of a highly specialized specialist to the training of a versatile professional who possesses a high level of culture and mobility in the conditions of a dynamic society that is permanently changing. Thus, the strategy of reforming the higher education system involves changing the quality indicators of educational services in order to ensure the competitiveness of future specialists, their mobility and employment in the labor market [24-26].

In the conditions of a market economy, the health of a specialist appears as an important economic lever, because the fierce competition of the modern business world requires constant physical and intellectual stress. In such conditions, success is usually achieved by those who keep themselves in good shape. In the conditions of intensifying competition in the labor market, there is an urgent need to form a culture of health among student youth, to form motives for observing the rules and norms of a healthy lifestyle, preserving and strengthening health. The success of students in acquiring knowledge about health is largely determined by a complex of organizational and psychological-pedagogical measures that ensure the development of certain personal qualities and contribute to the formation of a culture of health among student youth.

The results of the first stage of the survey prompted the development and implementation of new methods of presentation of lecture material, conducting practical classes based on the accumulated experience and trends of modern education. In order for students to effectively acquire knowledge about health and be ready to use it

as the basis for designing the content of health-oriented disciplines, it is important to put content modules of cognitive information aimed at the development of creative health thinking, emotional and valuable attitudes to health, rules and norms of a healthy lifestyle, health culture, formation of motivation for health activities [27].

The use of health care products should be emotionally valuable, that is, conscious. Not realizing the importance of this or that health care tool or procedure, not giving it due importance, not understanding why it is needed, a person simply will not do physical exercises, eat right, toughen up, move, etc. Knowing about the essence and mechanism of the health-improving effect of certain means and procedures allows you to consciously practice and benefit from the use of health-improving means. The choice of teaching methods involves the involvement of students in an active, purposeful and conscious search for individually appropriate ways to strengthen health and their practical application in everyday life, because it is thanks to one's own practical experience that one can learn the deep mechanisms of action of this or that health remedy, and therefore master the necessary practical knowledge that cannot be acquired only in theory [28].

The results of the pedagogical experiment became the basis for the search and implementation of new pedagogical forms, means, interactive teaching methods that actualize knowledge about health in the minds of students, increase their significance, create opportunities for successful mastery of this knowledge and effective practical application. Acquiring relevant experience is important not only from the point of view of mastering relevant practical skills and abilities, which then become habits and components of a healthy lifestyle, but also from the point of view of forming the motivation of student youth to use this knowledge. Behavior is always related to motivation, which is created precisely in the process of training, education and personality development. The widespread use of interactive teaching methods, based on closer subject-subject relationships between teachers and students, the empowerment of those who teach and those who learn, contributes to a more responsible attitude of students to self-training, self-education as a learning process, as well as in household or professional activities.

CONCLUSIONS

The results of the study indicate the presence of significant interest of students in the problem of health and a healthy lifestyle. At the same time, the study of disciplines, the subject of which is related to health, contributed to the increase of students' interest in the specified problem. If before the start of the experiment the number of students who were interested in health problems was 55.09%, then after the experiment their number increased to 78.48% ($p<0.01$).

According to the results of the self-assessment of the state of health, it was established that 65.29% of the respondents consider themselves to be healthy. The number of those who do not consider themselves healthy was 10.92% of respondents. It was difficult to answer this question for 23.79% of respondents. So, the total share of those who was not able to confidently say that he (she) is healthy was 34.71%.

The study of health-oriented disciplines creates favorable conditions for increasing self-assessment of the level of awareness of students in matters related to health. Thus, the number of students who consider themselves sufficiently knowledgeable increased from 21.36% at the beginning of the experiment to 35.95% after its completion, and the share of those who did not consider themselves sufficiently knowledgeable decreased from 12.38% to 4.05% ($p<0.01$).

The pedagogical experiment stimulated the use of knowledge about health in the everyday life of students. After the experiment, there was not a single respondent who did not apply their knowledge, and the number of students who constantly use their knowledge increased from 30.58% to 53.41% ($p<0.01$). Accordingly, the number of those who applied knowledge partially (from 52.91% to 41.27%) or episodically (from 10.92% to 5.32%) decreased.

According to the students, the leading fields of knowledge in terms of their competence and potential impact on health are: medicine, physical culture and sports, valeology, and psychology. After the experiment, the number of respondents who formulated their answer option increased significantly (from 6.8% to 37.47%), which indicates the formation of critical thinking, as well as the actualization of a comprehensive approach to solving health-related issues.

After the experiment, the respondents' point of view on the importance of health knowledge for society underwent some changes. In particular, the number of those who believe that this knowledge is very necessary increased from 94.41% to 97.21% ($p<0.05$).

Prospects for further research are to study the range of components of a healthy lifestyle and means of improvement that students prefer in everyday life.

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ORIGINAL ARTICLE

Exercise tolerance and thoracic mobility of patients with systemic scleroderma

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ABSTRACT

Aim: To analyze the exercise tolerance and thoracic mobility of patients with systemic scleroderma treated at the Department of Dermatology of the PIM of the Ministry of Internal Medicine after 2 years of individually tailored rehabilitation.

Materials and Methods: The study group consisted of 55 patients aged 27 years to 80 (mean 56.4) with systemic scleroderma, who receive rheological treatment in the Department of Dermatology on a cyclical basis. In addition, the therapy was supported by individually tailored rehabilitation for 2 years. Before and after the therapy was completed, the results of the study were analyzed. Forty-two patients completed the project.

Results: The results of the 6-minute walk test improved over the course of the project. More than half of the patients obtained results within the normal range 57.1% of the patients improved their results by completing the test compared to the beginning of the study. On the other hand, the chest circumference values obtained allow us to conclude that its momentum decreased after 2 years of rehabilitation.

Conclusions: When interpreting the result of the 6-minute test measurements, it is also necessary to take into account gait altered by changes in the skin of the feet and limitations due to muscle function. The study also shows a significant reduction in joint mobility under the influence of the lesioned skin and subcutaneous tissue.

KEY WORDS: systemic scleroderma, rehabilitation, chest mobility, 6-minute walk test

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INTRODUCTION

Systemic scleroderma is a rare generalized disease, one of the most common symptoms of which is scleroderma, or thickening of the skin (Fig. 1, 2). The disease includes: skin, subcutaneous tissue, facial skin lesions, which due to fibrosis of the skin, mucosa, and resorption of the jawbone has a mask-like appearance, the symptom is narrowing of the oral cavity [2-6]. These changes cause problems with the wide opening of the mouth, protrusion of the tongue, which affects the ability to take food, maintain proper oral hygiene, and makes it difficult to carry out dental treatment. In the digestive system, it can lead to: esophageal dilatation, decreased peristalsis in the lower 2/3 of the esophagus, loss of longitudinal folds of mucosa, alteration of the lower esophageal sphincter, impaired esophageal emptying in the supine position, erosions and superficial ulceration of the lower esophagus, large and deep ulceration in the lower esophagus, decreased ability to contract the smooth muscles of the stomach and its dilatation, gastrointestinal reflux, malabsorption in the small intestine and significant dilatation, excessive bacterial growth. In the large intestine : features of constipation, pseudomembranous diverticula (mainly) in the transverse descending colon, significant dilatation of the large intestine, decreased rectal motility and decreased rectal sphincter tone [1]. Dilatation of small vessels on the fingertips, painful ulcers appear [7]. In the advanced stage, contractures in the joints of the fingers of the hands, limiting the performance of activities of daily living. Arthralgia, less commonly arthritis of the metacarpophalangeal joints, wrists, knees, elbows and shoulders, tendon sheath inflammation, muscle weakness, less commonly features of myositis and soft tissue calcification occur [8]. The deposition of collagen and subsequent fibrosis results in fatal consequences due to organ complications of the disease such as pulmonary fibrosis, pulmonary arterial hypertension, aggressively progressive interstitial lung disease and scleroderma renal breakthrough [4, 9-16]. Cardiac lesions can be asymptomatic or manifest as left ventricular systolic or diastolic dysfunction, arrhythmias, pericarditis, enlargement of the heart cavities, valvular changes, and the presence of fluid in the pericardial cavity [17-22].

AIM

To analyze the exercise tolerance and thoracic mobility of patients with systemic scleroderma treated at the Department of Dermatology of the PIM of the Ministry of Internal Medicine after 2 years of individually tailored rehabilitation.

Fig. 1. Plantar surface of foot of patient with scleroderma.

Fig. 2. Open wound on the anterior part of the patient's shin with systemic sclerosis.

MATERIALS AND METHODS

Patients with systemic scleroderma, a disease with a chronic and progressive course, have been treated in the Department of Dermatology at PIM of the Ministry of Internal Medicine for more than 20 years. The Ethics and Human Research Oversight Committee of the hospital approved rehabilitation during the patient's stay in the Department. Physiotherapy consisted of individually selected exercises on the basis of measurements taken: capacity test (six-minute walk test), Marty Index (measurement of inhalation and exhalation at the height of the last rib and the gladius process of the sternum), assessment of motor skills (Barthel Index), angular measurements (according to the SFTR system), ranges of motion in the joints of the hands (finger goniometer), measurement of hand strength (dynamometer), assessment of hand function and limb circumference. Each patient was given a set of exercises to take home and was taught self-massage of the face and limbs. Measurements preceded and ended the project, as well as were carried out during the patient's 2-year follow-up.

The study group initially consisted of 55 people, including 42 women and 13 men, ranging in age from 27 years to 80 (mean 56.4), with an average of 8 years of treatment at the Department of Dermatology. In the end, 42 people completed the project: 5 people changed the place of treatment, 1 was treated with alternative methods, 3 developed cancer (2 prostate, 1 breast), 1 person had a kidney transplant, 1 person had 2 heart attacks, 2 people had to abandon rheologic treatment due to the treatment of other conditions. There were 35 women and 7 men continuing the study, with ages ranging from 28 to 80 (mean 57.57).

RESULTS

Over the course of the study, the average 6-minute test score increased slightly from a value of 402.14 m to 417.74 m (Fig. 3). It can be assumed that the increase was gradual over time, due to the average score of this test obtained during the control. The median (from 420 m to 445 m) and the dominant (from 420 m to 500 m, but it should be remembered that in the case of widely varying results, the dominant is not a recommended indicator for analyzing distributions) also increased. The standard deviation increased, which means that the average deviation of the results from the arithmetic mean increased. The results of the surveys conducted during and after the study are disturbed by very low outliers contained in the 0-100 range, which were not recorded at the beginning of the study. This means that the rapid deterioration of the results of a small number of patients, affected the overall result, which would have been even higher if the extreme values were excluded. The score of the vast majority of patients did not change over the course of the study or improved. The distribution of the change in scores is similar for all variants, which leads us to believe that the change in scores

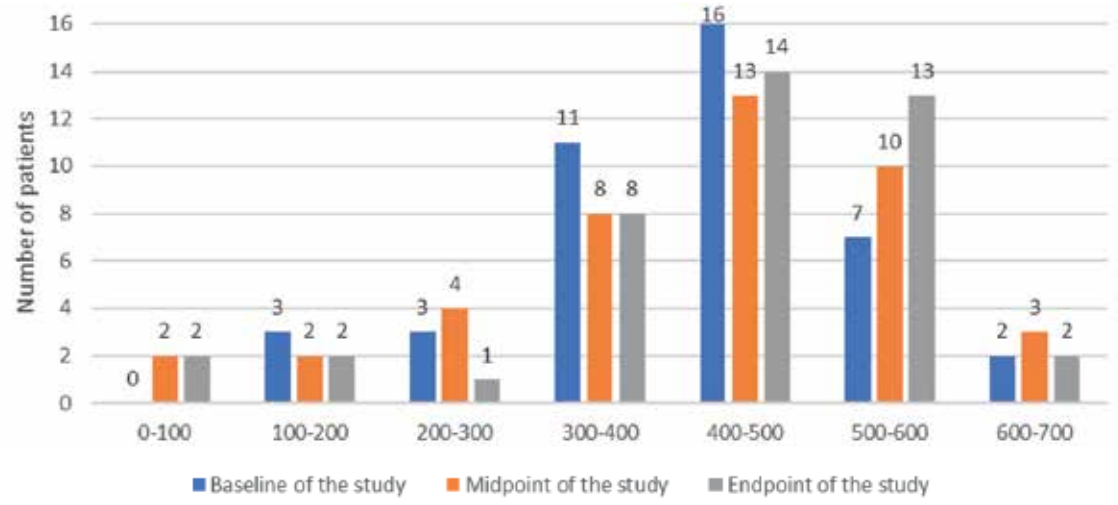

Fig. 3. Difference between the results of the 6-minute test: comparison of measurements taken at different stages of the study.

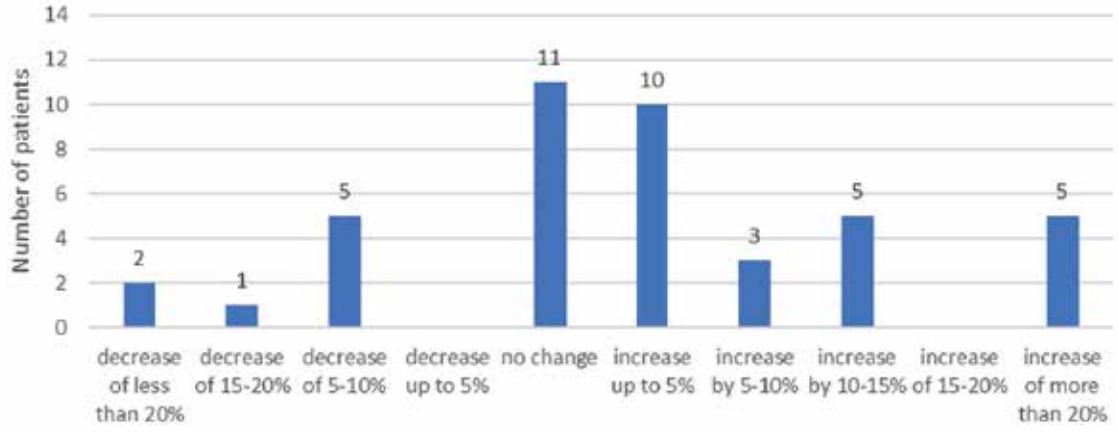

Fig. 4. Difference in the 6-minute test score during the study – Variant I (differences between the start of the study and the control group during the study).

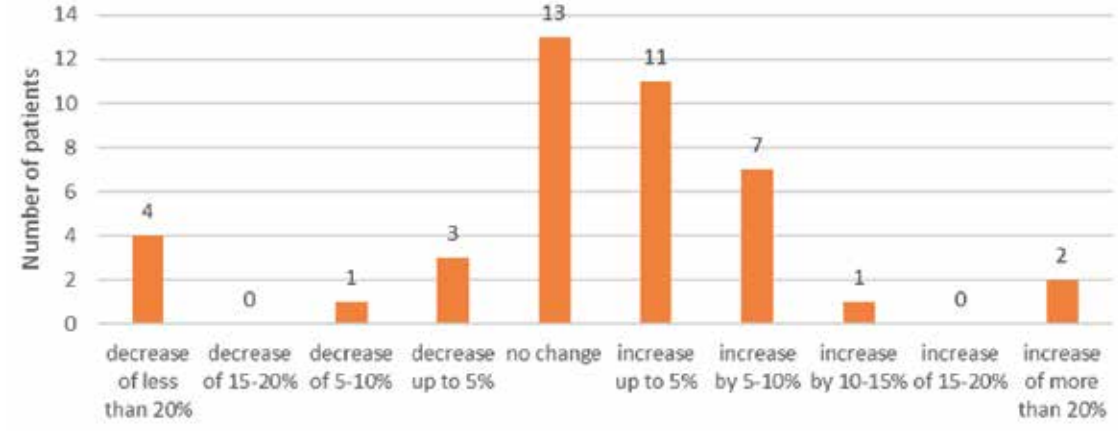

Fig. 5. Difference in the 6-minute test score during the test - Variant II (differences between controls during the test and at the end of the test).

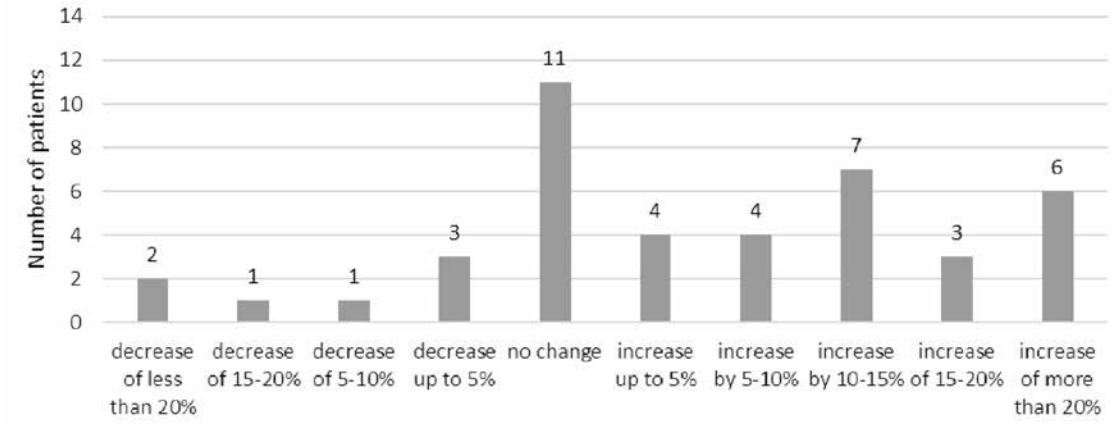

Fig. 6. Difference in the 6-minute test score during the test - Variant III (differences between the control group during the test and at the end of the test).

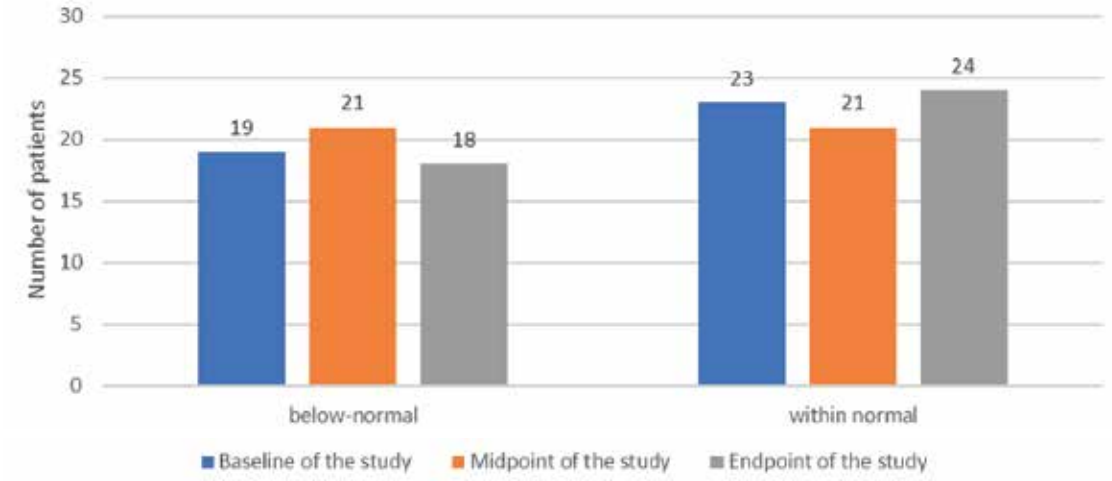

Fig. 7. Comparison of the results of the 6-minute test.

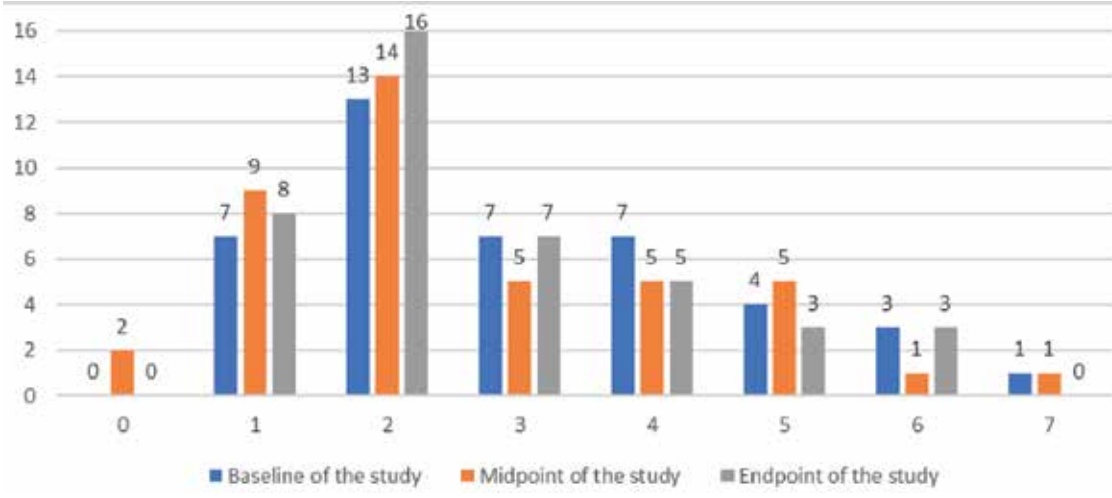

Fig. 8. Chest expansion - comparison of measurements taken at baseline, midpoint, and endpoint of the study.

was already observable at the beginning of the study, and certainly before the follow-up examination (Fig. 4-7). Once again, the results are very much influenced by the extreme values: very significant improvement and very significant deterioration of results. However, it should be borne in mind that this applies to relative magnitudes. For absolute quantities, the distributions and results can be quite different. A greater rate of change is evident in the period from the start of the study to the follow-up tests conducted during (variant I) than in the period from the follow-up tests to the end of the study (variant II). This means that the effects of the rehabilitation carried out are more effective in the initial period and most patients maintain the improvement in their results until the end of the study (Fig. 8).

Over the course of the study, the average chest expansion decreased slightly from 3.024 cm to a value of 2.595 cm, and finally to a value of 2.714 cm. The median during and after the study also decreased slightly compared to the measurements taken at the beginning (dropping from a value of 3 cm to a level of 2 cm). The dominant did not change. The standard deviation for the measured values increased slightly during the study to decrease at its conclusion. This means that the average deviation of the results from the arithmetic mean after the end of the survey is lower than at the beginning. Based on the results, it can be assumed that, on average, chest expansion decreased by about 0.310 cm during the study. In addition, the effects are more pronounced in the case of the follow-up study conducted during, there the thoracic momentum decreased by an average of about 0.429 cm. The median did not change and is equal to the dominant in each case. For most patients, there was no difference in the values of chest expansion before and after the test. The values obtained allow us to conclude that thoracic momentum did not change for most patients during the study. The extreme values distort the results of the arithmetic mean, which affects the variability and asymmetry of the distributions. Over the course of the study, the number of patients whose chest expansion was within the established norm decreased from 14 to 11 patients. At the end of the study, not a single patient had chest expansion above normal. In an overwhelming number of patients, the results did not change when it came to the individual limits of the norm (24 people -no change and results below the norm, 8 people -no change and results within the norm). In 3 people, there was an improvement and chest expansion returned to normal, while in 7 patients there was a worsening of the parameters (Fig. 9, 10). The results of the Wilcoxon test indicate statistically significant changes within each population over the course of the study, demonstrating the impact of the treatments on patient outcomes (Fig. 11-14).

The results of the Wilcoxon test show that in each case there was a statistically significant change between the populations, i.e. during the study. This shows that the treatments performed had an impact on the test results obtained by the patients.

DISCUSSION

Systemic sclerosis (SSc) is a disease that leads to multi-organ failure including the heart and lungs [2, 4]. The 6-minute walk test (6MWT) is used to objectively assess patients' functional exercise capacity. It does not require sophisticated equipment and high technical expertise. Safe with low complexity, it involves walking as fast as possible along a 30-meter corridor for 6 minutes; the outcome measure is the distance measured in meters. The results before and after 6 minutes are also analyzed: dyspnea according to Borg, systolic and diastolic blood pressure, heart rate, hemoglobin oxygen saturation level, and time to return to baseline parameters measured every minute. It seems reasonable to consider the following for interpreting the results: vascular, pulmonary and musculoskeletal exercise limitations [23]. Various data confirm that many extra pulmonary aspects of SSc contribute to the results of the test, to make it useful it is recommended to perform, for example, lung diffusing capacity for carbon monoxide (DLCO) and its components (membrane diffusion and

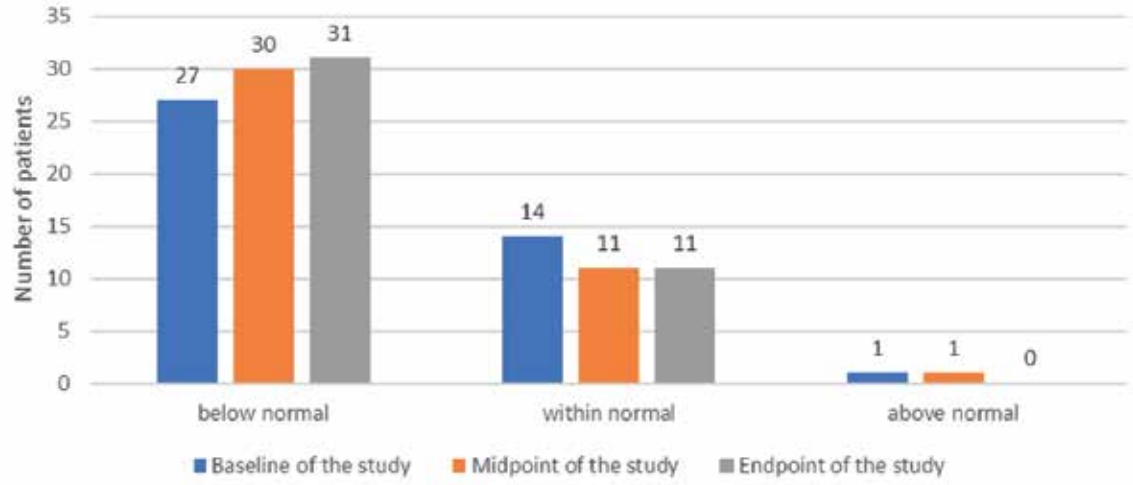

Fig. 9. Chest expansion at baseline, midpoint, and endpoint of the study.

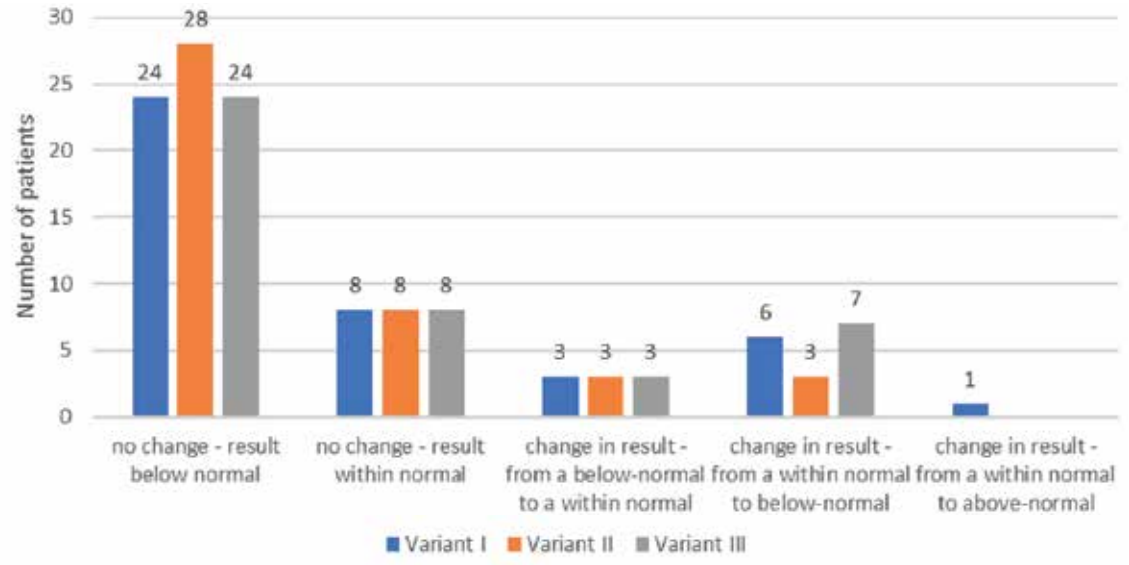

Fig. 10. Changes in the value of thoracic momentum within the established normative ranges over the course of the study.

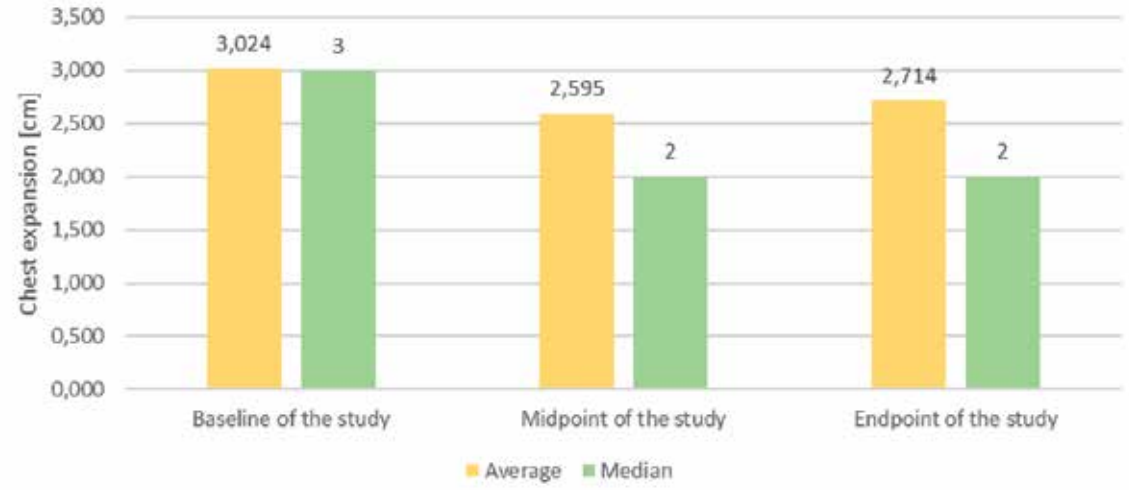

Fig. 11. WIlcoxon test results – chest expansion.

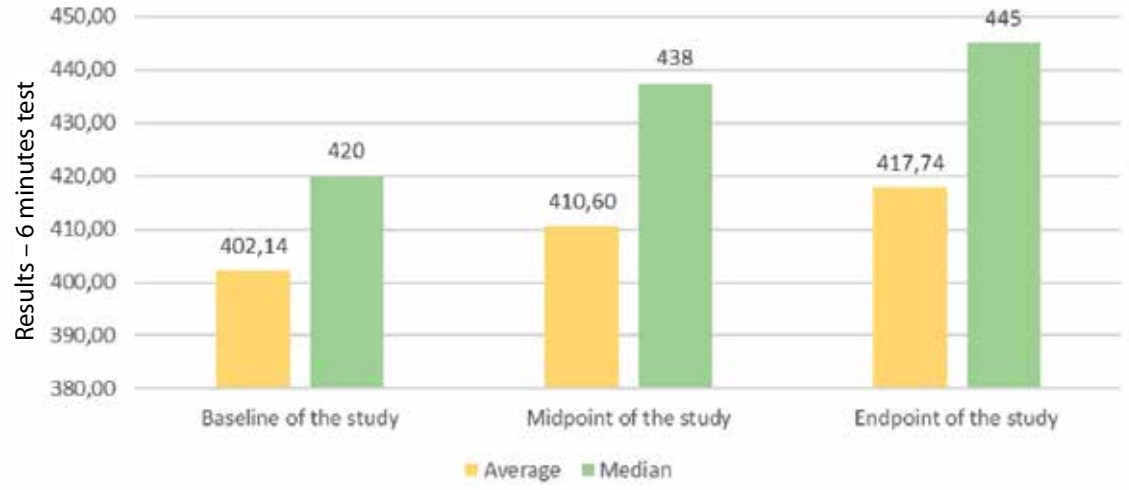

Fig. 12. Wilcoxon test results – 6 minutes test.

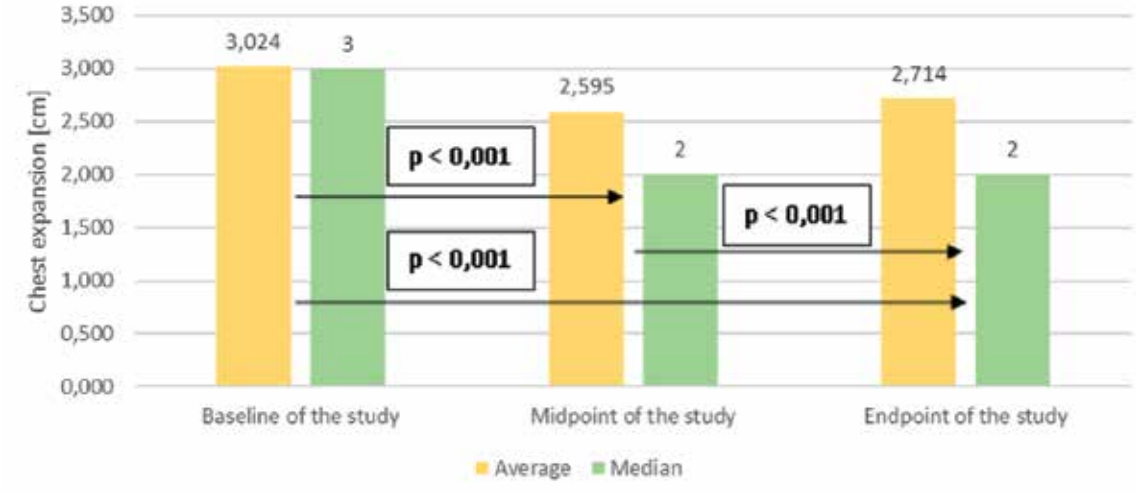

Fig. 13. WIlcoxon test results – chest expansion.

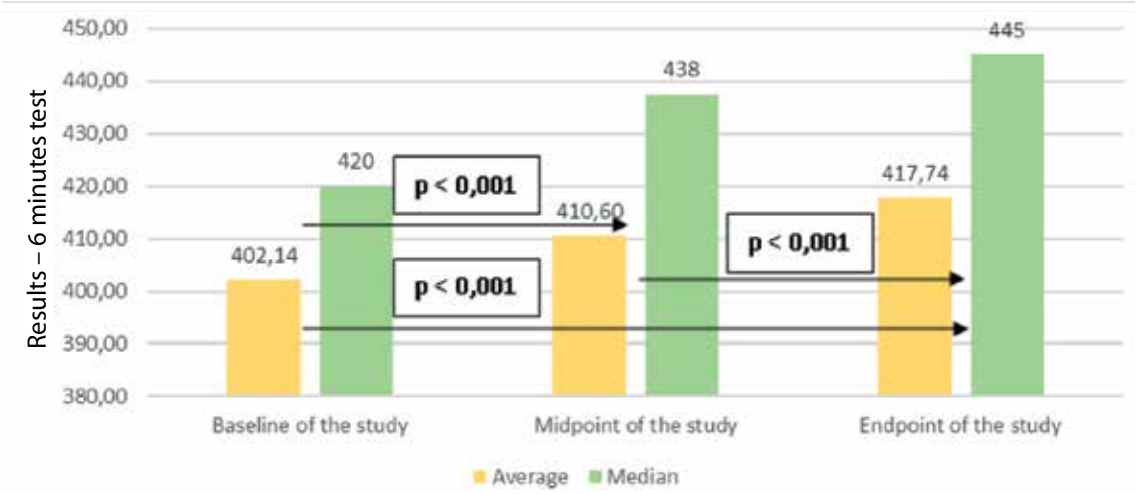

Fig. 14. Wilcoxon test results – 6 minutes test.

capillary volume) or the Scleroderma Health Assessment disability index to objectify them [24]. When interpreting the result of the 6 MWT measurements, it is also necessary to take into account gait altered by changes in the skin of the feet and limitations due to muscle function [25]. The study also shows a significant reduction in joint mobility under the influence of the lesioned skin and subcutaneous tissue. The severity of skin lesions is assessed according to the Rodnan scale, which quantitatively estimates the degree of skin hardening, determined in the following body regions: face, chest, abdomen, arm, forearm, hand, fingers, thigh, shank and foot. The Rodnan scale defines the severity of skin lesions as: mild, moderate, severe or terminal stage terminal [26, 27]. It is also an important factor affecting prognosis. Extensive skin sclerosis with a high Rodnan score is associated with more severe complications, while less skin involvement is a good prognostic factor [28, 29].

CONCLUSIONS

When interpreting the result of the 6 MWT measurements, it is also necessary to take into account gait altered by changes in the skin of the feet and limitations due to muscle function. The study also shows a significant reduction in joint mobility under the influence of the lesioned skin and subcutaneous tissue [Fig. 13, 14].

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ORIGINAL ARTICLE

Application of deep electromagnetic stimulation in the treatment of stress urinary incontinence in peri-menopausal women

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ABSTRACT

Aim: The aim of the study is to assess the effect of deep electromagnetic stimulation of the pelvic floor muscles on the severity of stress urinary incontinence (SUI) symptoms in perimenopausal women.

Materials and Methods: The study included a group of 57 women aged 44 to 60 with SUI, who underwent a series of 10 treatments of deep electromagnetic stimulation of the pelvic floor. The effectiveness of therapy was assessed based on the Revised Urinary Incontinence Scale (RUIS).

Results: After the therapy, a statistically significant reduction in the severity of SUI symptoms assessed according to the RUIS scale was observed – before the therapy, half of the patients obtained an average score of 8.4±2.4 points, and after the therapy 5.1±3.2 points. A statistically significant (p=0.0002) decrease in the incidence of urinary incontinence episodes during physical activity and a decrease in the amount of urine lost were also observed. The effects of the therapy were not long-lasting. After three months, the return of symptoms to the pre-therapy level was noted in 45.3% of patients, the return of symptoms but less severe in 22.6% of the patients, and the effect of improvement was maintained in only 18.9% of the patients.

Conclusions: Deep electromagnetic stimulation of the pelvic floor muscles reduces the severity of the SUI symptoms associated with physical exertion, coughing or sneezing. The improvement effect is not long-lasting.

KEY WORDS: stress urinary incontinence, pelvic floor muscles, electromagnetic stimulation

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INTRODUCTION

During perimenopause, a variety of changes occur in a woman's body. Hormonal changes promote the appearance of a number of symptoms that reduce the quality of life. The most common include: a sudden heat sensation, weight gain and mental irritability. Decrease in estrogen levels causes gradual tissue sagging, which contributes to the occurrence of many dysfunctions. One of them is urinary incontinence. According to the World Health Organization – WHO and the International Continence Society – ICS definition, it is an involuntary leakage of urine through the urethra, which results in hygienic problems and hinders social interactions. The relaxation of the pelvic floor muscles and ligaments resulting from hormonal changes during menopause is conducive to the development of this problem, especially during physical exercise. Factors that additionally predispose to urinary incontinence include lowering of the reproductive organ, previous childbirth and gynaecological surgeries. An increase in intra-abdominal pressure during the activation of the abdominal press, e.g. during coughing, sneezing, laughter and physical activity, causes urine loss. Stress urinary incontinence (SUI) significantly increases in the fifth and sixth decade of women's lives [1-4].

Urinary incontinence is a discomforting issue that is usually not reported due to its embarrassing nature. Difficulty maintaining hygiene adversely affects the psyche of women. This is conducive to withdrawal from social activities and limiting intimate relationships [5-8]. Early treatment may reduce the progression of symptoms. Currently, there are many treatments for SUI in women. Urogynecological physiotherapy emphasizes the activation of the pelvic floor muscles [9-11]. The pioneer of this approach, in the middle of the last century, was the American gynecologist Arnold Kegel. He recommended exercising the pelvic floor muscles to prevent their weakening [12]. Electrostimulation, Biofeedback therapy, and manual therapy are intended to help patients consciously activate these muscles [13, 14]. The therapy can be carried out on an outpatient basis or in spa environment [15]. However, undergoing treatment with vaginal or rectal electrodes is often uncomfortable and embarrassing for women [6,10, 14].

An alternative method that provides the patient with full comfort is deep electromagnetic stimulation. The procedure is performed on a specially designed URO chair with a field applicator mounted in the seat. During the procedure, the fully dressed patient sits comfortably in the chair. The therapy involves stimulating the pelvic floor muscles with

an alternating magnetic field with a frequency of 1 to 50 Hz and magnetic induction of a maximum of 2.5 T. The penetration depth reaches up to 10 cm. Properly selected parameters of the electromagnetic field increase blood circulation and stimulate muscle contraction. The therapy is distinguished by a clearly perceptible vibration of the tissues during the procedure.

AIM

The aim of the study is to assess the effect of deep electromagnetic stimulation of the pelvic floor muscles on the severity of stress urinary incontinence symptoms in perimenopausal women.

MATERIALS AND METHODS

The study was conducted on a group of 57 women aged 44 to 60 with stress urinary incontinence. The mean age in the study group was 55.6±4.7 years, half of the patients were no more than 57 years old (IQR: 53-59 years).

The exclusion criteria were: pregnancy, cancer, epilepsy, metal in the treatment area, electronic implants and the use of other physiotherapeutic procedures within the previous 3 months.

The research was approved by the Bioethics Committee No. RNN/395/17/EC. All patients were informed about the principles of deep electromagnetic stimulation and signed a written consent to treatment and inclusion in the research.. The procedure cycle included ten deep electromagnetic stimulation treatments of the pelvic floor muscles performed with the Salus-Talent URO device. In accordance with the manufacturer's recommendations, the therapy uses the automatically programmed M2 mode, which uses low-frequency stimulation of 50 Hz, pulse duration of 3 seconds, pause duration of 6 seconds. The treatments were performed every second day and lasted 20 minutes each. In order to evaluate the results, the patients were examined according to an established study protocol before and after the series of treatments. The survey took into account the number and type of births, the occurrence of menopause-related symptoms, and the use of hormone replacement therapy. The Revised Urinary Incontinence Scale (RUIS) was used to assess the severity of SUI symptoms. It is a validated, five-point scale in which a score of 0-3 means no urinary incontinence; 4-8 – mild urinary incontinence; 9-12 – moderate urinary incontinence, and a score of 13 or above – severe urinary incontinence [16].

Additionally, 3 months after the end of therapy, information was collected on the duration of the effect achieved.

STATISTICAL ANALYSIS

Quantitative variables are described by providing the mean and standard deviation, as well as ordinal measures: median (Me) and interquartile range (IQR), minimum and maximum, depending on the normality of the distribution of the studied variables. The normality of the quantitative variables was verified using the Shapiro-Wilk's normality test. For categorical variables, the number of observations for each category (N) and the corresponding percentage (%) are given.

For quantitative variables, Student's t-test for dependent samples was used to compare patients before and after a series of treatments. In addition, the effect size was assessed using Cohen's d as an effect size measure. The effect is considered small when $d \in [0.20\text{-}0.50)$, intermediate when $d \in [0.50\text{-}0.80)$ and large when $d \geq 0.80$. Cohen's d values <0.2 indicate a lack of effect.

In the case of qualitative variables, the McNemar's test or exact McNemar's test was used to compare the results before and after therapy, and in the case of more categories - the McNemar-Bowker test. To compare the independent groups, due to quantitative variables, the Student's t-test or the Mann-Whitney U test was used, depending on the distribution of variables. In the case of qualitative variables, the Chi-square test for independence was used.

Results at $p<0.05$ were considered statistically significant. The calculations were performed using the statistical packages PQStat v. 1.8.6 and Statistica PL v. 13.3.

RESULTS

Most patients were overweight (22 patients; 38.6%), almost one in four (14 patients; 24.6%) was obese. 21 respondents (36.8%) had normal weight. The mean BMI was 27.7±5.2 kg/m2; in half of the patients, the body mass index did not exceed 27 kg/m2 (IQR: 24.0-29.2 kg/m2).

The mean duration of SUI was 6.8±7.7 years, in half of the patients it did not exceed 4 years (IQR: 2-7 years). Every third respondent (19 individuals; 33.3%) stated that the problem of SUI is getting worse, 37 patients (64.9%) – that it remains unchanged, and only 1 (1.8%) – that it is decreasing.

More than half of the patients (29 individuals; 50.9%) gave birth to 2 children; 22 respondents (38.6%) delivered 1 child, 5 respondents (8.8%) had three children; only 1 patient (1.8%) did not give birth. Physiological deliveries accounted for 88.4% of all births, caesarean sections for 11.6%.

30 patients (52.6%) reported at least one symptom associated with menopause, including: hot flashes – 21 respondents (36.8%), mood changes – 19 respondents (33.3%), night sweats – 17 respondents (29.8%) and insomnia – 23 respondents (40.4%). Hormone replacement therapy was used by 7 patients (12.3%).

Table 1 summarizes the proportions of patients reporting urinary incontinence according to the circumstances before and after a series of treatments.

Prior to the therapy, the most frequently reported circumstances of urinary incontinence were sneezing (53 patients; 93%) and coughing (51 patients; 89.5%). The fewest patients reported urinary incontinence when climbing stairs (10 women; 17.5%). After the therapy, in each case, the proportion of patients reporting the incidence of urinary incontinence while performing the analyzed activities decreased. Except for climbing stairs, all of the changes were statistically significant.

The RUIS scale was used to assess the severity of urinary incontinence symptoms. Table 2 summarizes the results for each sub-question, including the pre- and post-therapy questionnaire. None of the patients reported a problem

Table 1. Occurrence of urinary incontinence according to the circumstances before and after the therapy

Activity	Before therapy		After therapy		p-value
	N	%	N	%	
Standing up/sitting down	13	22.8	7	12.3	0.0391
Walking	14	24.6	8	14.0	0.0156
Walking the stairs	10	17.5	8	14.0	0.2500
Lifting	28	49.1	17	29.8	0.0026
Jumping	31	54.4	21	36.8	0.0044
Cough	51	89.5	32	56.1	<0,00.1
Sneezing	53	93.0	32	56.1	<0.0001
Laughter	33	57.9	17	29.8	0.0002
Doing sports	14	24.6	9	15.8	0.0313

Table 2. Assessment of the severity and frequency of urinary incontinence before and after therapy

Do you experience and if so how much are you bothered by:	Answers	Before therapy		After therapy		p-value
		N	%	N	%	
Urine leakage related to physical activity, coughing or sneezing	Not at all	3	5.3	23	40.4	0.0002
	Slightly	20	35.1	22	38.6	
	Moderately	20	35.1	9	15.8	
	Greatly	14	24.6	3	5.3	
Small amounts of urine leakage (drops)	Not at all	6	10.5	26	45.6	0.0002
	Slightly	24	42.1	23	40.4	
	Moderately	22	38.6	6	10.5	
	Greatly	5	8.8	2	3.5	
How often do you experience urine leakage?	Never	0	0.0	5	8.8	0.0938
	Less than once a month	2	3.5	13	22.8	
	A few times a month	14	24.6	13	22.8	
	A few times a week	17	29.8	14	24.6	
	Every day and/or night	24	42.1	12	21.1	
How much urine do you lose each time?	None	0	0.0	9	15.8	0.0028
	Drops	13	22.8	30	52.6	
	Small splashes	29	50.9	13	22.8	
	More	15	26.3	5	8.8	

with urinary incontinence related to the feeling of urgency, therefore this question was excluded from the list.

Analysing the results presented in Table 2, it can be concluded that before the therapy, the problem of urinary incontinence related to physical exertion, coughing and sneezing, which occurred regularly, was reported by 35.1% of the respondents, and for every fourth patient (24.6%) it was a major problem, hindering everyday functioning. After the therapy, a statistically significant (p=0.0002) reduction in the frequency of urinary incontinence during physical exercise, sneezing or coughing was observed – in 40.4% of patients the problem ceased to appear, and in 38.6% the incidence was rare.

The issue of small amounts of urine loss before therapy occurred rarely in 42.1% of patients and regularly in 38.6% of the respondents. After the therapy, a statistically significant (p=0.0002) reduction in the incidence of the problem was observed – 45.6% of the respondents did not report the occurrence of the problem, and in 40.4% it occurred rarely.

Analysing the amount of urine lost before therapy, the study found small stains in 50.9% of patients and larger amounts of urine lost in 26.3%. After the therapy, a statistically significant (p=0.0028) decrease in the amount of urine loss was observed – in more than half of the women (52.6%) these were drops, and in the case of 15.8% of patients there was no urine loss reported.

The frequency of experience of urinary incontinence problem did not change statistically significantly after therapy (p=0.0938).

Table 3. Summary assessment of the severity of urinary incontinence according to the RUIS scale before and after therapy

Measure	Score		p-value	Cohen's d
	Before therapy	After therapy		
Mean ± SD	8.4±2.4	5.1±3,2	<0.0001	1.7995
Me (IQR)	8 (7-10)	5 (3-7)		
Min-Max	2-13	0-13		

Table 3 presents the total RUIS score of urinary incontinence symptoms severity. As can be observed, after the therapy there was a statistically significant (p<0.0001) reduction in urinary incontinence symptoms. Before the therapy, half of the patients obtained an average score of 8.4±2.4 points, and after the therapy 5.1±3.2 points. The effect obtained should be classified as considerable.

A decrease in the RUIS total score by at least 1 point was observed after the therapy for 48 patients, which constitutes 84.2% of the respondents. Only in 9 patients the total number of RUIS points remained unchanged after the therapy.

There were no statistically significant correlations found between the reduction of urinary incontinence symptoms after therapy and the age of the patients, BMI, duration of urinary incontinence and the number of births.

Figure 1 presents changes in the assessment of the severity of urinary incontinence symptoms according to the RUIS scale before and after therapy.

Before the therapy, for more than half of the respondents (50.9%) urinary incontinence constituted a mild problem (4-8 points on the RUIS scale), and for 42.1% it was a problem of moderate severity (9-12 points). After the therapy, a statistically significant (p=0.0002) reduction in the severity of symptoms was observed. Similarly, the percentage of patients with a mild issue (4-8 points) was 50.9%, while for 1/3 of the respondents (33.3%) the total score ranged between 0-3 points (no problem or incidental problem).

Following the therapy, in the case of 32 (56.1%) patients, a significant reduction in symptoms and a change in the category describing the severity of urinary incontinence according to the RUIS scale was found. As in the case of the summary assessment, no statistically significant correlations were found between the reduction of urinary incontinence symptoms after therapy and the age of the patients, BMI, duration of urinary incontinence and number of births.

Three months after the therapy, information was obtained from 53 patients regarding the duration of the effects of the

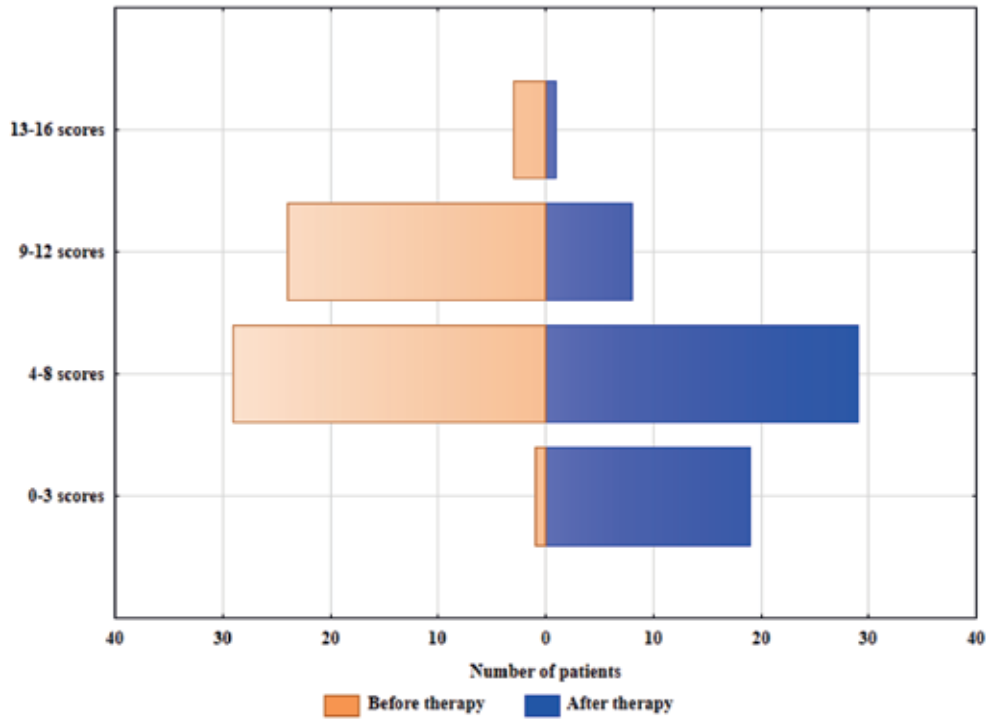

Fig. 1. Severity of urinary incontinence symptoms assessment according to the RUIS scale - before and after therapy.

therapy. A return of symptoms to the pre-therapy level was observed in 24 (45.3%) patients, the return of symptoms but less severe in 12 (22.6%) patients, the improvement was maintained only in 10 (18.9%) of the patients.

DISCUSSION

The occurrence of stress urinary incontinence is a common clinical problem in perimenopausal women and it increases with age. Numerous scientific publications confirm the co-occurrence of SUI with overweight and previous childbirths [3, 17]. Such correlation was also found in this study. Among the participants, more than 60% were overweight and obese, and approximately 88% had physiological deliveries.

There are many activities described in the literature that can cause uncontrolled urine loss resulting from weakening of the pelvic floor muscles. Physical activity, lifting, climbing stairs are some of them [18]. In this study, the most frequently reported symptoms were coughing and sneezing.

The therapy consisting in stimulating the pelvic floor muscles to contract is commonly used in the treatment of SUI.

Deep electromagnetic stimulation is a relatively new method, most often used to treat orthopedic conditions. Due to its operational depth, this procedure has been used in urogynecological physiotherapy. In a pilot study on the effectiveness of six electromagnetic stimulation treatments, Wiecheć et al. [18] achieved a reduction in the symptoms of stress urinary incontinence. The authors point out the ease of performance and non-invasiveness of this therapy, which makes it positively received by women.

He et al. [19] conducting a meta-analysis of eleven studies that applied magnetic field stimulation, found that it was an effective method that alleviated symptoms and reduced the incidence of urinary incontinence. In addition, the authors indicate that the respondents' quality of life has improved. Based on a literature review, similar conclusions are presented by Gözlersüzer et al. [20].

The Revised Urinary Incontinence Scale is commonly used to assess the severity of urinary incontinence [21, 22]. In this study, the use of electromagnetic stimulation of the pelvic floor muscles resulted in reducing the severity of symptoms assessed with the RUIS scale. As a result of the treatments, 40% of patients stopped passing urine during physical exertion, sneezing and coughing. Both the frequency and quantity of urinary incontinence were reduced. Episodes of small amounts of urine loss decreased significantly.

While examining the effect of external magnetic neurostimulation of the pelvic floor muscles in the treatment of stress urinary incontinence in older women, Weber-Rajek et al. [22] also confirmed the efficacy of the procedure. In addition, the authors found a correlation between positive results of urinary incontinence severity assessed by the RUIS scale and quality of life measured by the Kings Health Questionnaire (KHQ).

In order to reliably assess the effectiveness of the therapy, it is necessary to determine long-term outcomes.

The improvement in pelvic floor muscle function achieved as a result of electromagnetic stimulation was not permanent. The surveyed women noticed a return of the symptoms after an average of three months. Lim et al. [23] found similar – positive, but short-term effects of deep electromagnetic stimulation therapy in a meta-analysis of the results of 8 studies. In a meta-analysis of eleven studies presenting positive results, He et al. [19] also point out the need for longer follow-up observation to determine the durability of the treatment effect. The results of our own and other authors' studies may suggest the need to supplement the therapy with other procedures or to repeat it, due to its short-term improvement effect observed.

The reduction in the severity of urinary incontinence symptoms that results from electromagnetic stimulation of the pelvic floor supports the need for further research aimed at establishing a long-term treatment strategy.

CONCLUSIONS

1. Deep electromagnetic stimulation of the pelvic floor muscles reduces the severity of stress urinary incontinence symptoms.
2. The application of the therapy reduces episodes of urinary incontinence caused by physical exertion, coughing or sneezing.
3. The sustained effect of improvement is not long-lasting.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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

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ORIGINAL ARTICLE

Effectiveness of the influence of complex of physical exercises on the dynamics of work of the cardiovascular system according to performance tests in children with scoliosis

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ABSTRACT

Aim: The article is dedicated to the study of the efficiency of complex of physical exercises on the dynamics of work of the cardiovascular system in primary school-age children with. Evaluation of the efficiency of influence of the complex of physical exercises on the dynamics of work of the cardiovascular system of children with scoliosis.

Materials and Methods: 30 children (18 boys and 12 girls) with scoliosis, who performed the complex program of physical exercises, were examined. The age range of children is from 7 to 10. The activity of the cardiovascular system was evaluated based on the parameters of pulse pressure, stroke volume, maximal and relative aerobic capacity, pulse tolerance limit, and mean aortic pressure.

Results: A possible increase in all parameters of the cardiovascular system after physical exercises was found. Increase in Maximum aerobic capacity (200,01±11,27 against 94,11±6,79 in boys; 210,01±7,90 against 64,32±1,22 in girls; ($p<0,05$) and relative Maximum aerobic capacity (5,97±0,51 against 3,57±0,79 in boys; 6,81±0,67 against 2,62±0,19 in girls; $p<0,05$) was shown. A possible increase in aortic pressure after physical exercises can indicate the increased pressure on a child's organism.

Conclusion: Scoliosis progression in children forms increased pressure on the work of the cardiovascular system, which manifests in the increase of pulse, mean aortic pressure, and stroke volume, and differs depending on age and sex and requires the development of the individual rehabilitation plan with consideration of found changes.

KEY WORDS: children, scoliosis, cardiovascular system, physical load

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INTRODUCTION

Recently, the incidence of the pathology of the musculoskeletal system, in particular, scoliosis in preschool children, has significantly increased in recent years due to the ecological and economic situation in Ukraine [1]. One of the most effective methods of physical rehabilitation in scoliosis is a complex approach which enables the combination of kinesiotherapy and manual therapy, which contributes to the formation of correct posture and muscle corset, strengthening the muscles of the back, as well as improves the general tone of the organism and normalises functional abilities of cardiovascular and respiratory systems. Kinesiotherapy can influence the harmonious development of the musculoskeletal system, develop the skills of correct posture, and achieve permanent compensatory and therapeutic effects [2].

Interaction of cardiovascular, nervous, muscular, respiratory and immune systems, endocrine glands, sensory organs, as well as the pituitary-hypothalamic complex and limbic system of the brain plays an essential role in support of homeostasis and its regulation [3, 4]. Abnormal spine deviation displaces the spine in all three planes of the body from its natural position, creating morphological changes in the trunk and intervertebral discs, which causes structural changes in vertebrae, which can develop in any stage of life and to scoliosis, which makes the study of this issue relevant among the researchers [5]. Children with immature skeletons have the highest risk of progression during a pubertal growth spurt, therefore, early treatment is critical. Scoliosis treatment is limited due to the absence of understanding of their aetiology and pathogenesis. Defining aetiology, some authors assume that one of the causes is generalised growth or functional defects in skeletal muscles. Available information indicates that the distribution of type I muscle fibres, responsible for postural control, on muscles that straighten the spine, is significantly higher on the convex side than on the concave

side [6]. Asymmetric load on the spine can cause further progression during skeleton growth. Thus, it is possible to conclude that effective treatment with the use of physical exercises for scoliosis in children should be introduced in the early stages of scoliosis development and applied during the whole growth phase in adolescence [7].

Exercises play an important role in scoliosis treatment in combination with other forms of treatment such as fixation or physiotherapy. Special exercises, directed at the main muscles, can improve posture and alignment of the spine. Regular exercises increase muscle strength and flexibility, helping to keep balance and a stable spine. This also positively influences the psychological well-being of patients, providing them with the feeling of control over their condition [8].

While exercising, children can face different problems, which can include muscle imbalance, limited movement and discomfort. To ensure the safety and well-being of children, it is necessary to adapt exercises to their individual possibilities and restrictions. Proper instructions and supervision are decisive for the support of correct form and technique [1].

Vessel abnormalities influence the musculoskeletal system depending on the affected tissue (skin, subcutis, muscle, cartilage, or bone), lesion level and type of the development defect (arteries, capillaries, veins or lymphatic pathways) [9]. These development symptoms can cause many symptoms of musculoskeletal apparatus. Leg length discrepancy, intra-articular lesions, muscle lesions, and primary and secondary scoliosis are common problems. These problems can cause pain, deformation and some functional limitations. They may be treated with the use of intervention and non-intervention means of support. Non-surgical (non-intervention) treatment includes lifting shoes to compensate for leg length discrepancies, physiotherapy for stretching joint contractures and bracing for scoliosis. Surgical treatment varies from minor procedures such as joint synovectomy, controlled growth/epiphysiodesis for leg length discrepancy or percutaneous Achilles tendon lengthening in case of equinus contracture, and main procedures such as spinal spondylolysis in case of scoliosis, joint substitution or amputation. Scoliosis in patients with vessel development defects can be caused mainly by intra-osseous or soft tissue formation. Secondary scoliosis can be caused by leg length discrepancy. It may also present in syndromes such as congenital, lipomatous, overgrowth, vascular malformations, epidermal nevi, and skeletal/ spinal/scoliosis (CLOVES) [10]. Early-onset scoliosis is defined as a curvature of the spine ≥10° in the frontal plane that occurs before the age of 10. Early-onset scoliosis includes a heterogeneous group of patients with the aetiology of idiopathic, congenital, syndromic and neuromuscular scoliosis [11]. Therefore, more and more studies began to focus on the study of effectiveness of complex of physical exercise on the dynamics of work of the cardiovascular system in primary school-age children with.

AIM

The study aimed to evaluate the effectiveness of the influence of the complex of physical exercises on the dynamics of work of the cardiovascular system of children with scoliosis.

Tasks:

- to study gender and age peculiarities of the state of parameters of work of the cardiovascular system before physical load in children with scoliosis;
- to evaluate the efficiency of the influence of the complex of physical exercises on the dynamics of work of the cardiovascular system of children with scoliosis.

MATERIALS AND METHODS

Within the work, 30 children (18 boys and 12 girls) with scoliosis at the age of 7 to 10 were examined. The study was conducted on the basis of Oleksiievo-Druzhkivka General Sanatory Boarding School of I-III grades No. 13 for children with scoliosis of Donetsk Regional Council.

Exclusion criteria – the study involved school-age children with a diagnosed spine defect – scoliosis. Inclusion criteria – preschool children and children older than 10 years old.

All children performed the developed complex program of physical exercises for long-term rehabilitation of school-age children. The influence of physical exercises on the parameters of physical performance, general well-being and quality of life of children was determined. The dynamics of the work of the cardiovascular system were defined according to physical performance tests. Functional activity of the cardiovascular system was evaluated based on the parameters of pulse pressure, stroke volume, Maximum aerobic capacity and relative Maximum aerobic capacity, pulse tolerance limit, and mean aortic pressure.

Statistical data processing was conducted based on the determination of mean values (m) of the standard error of mean arithmetic value (±m), reliability of the data for independent samples was calculated according to Student's t-criterion, the difference was considered reliable at $p<0,05$.

The work was conducted according to "Convention for the Protection of Human Rights and Dignity of the Human Being" of the Council of Europe, "Ethical Principles for Medical Research Involving Human Subjects", adopted by the 52nd Assembly of World Medical Association, "Universal Declaration on Bioethics and Human Rights", adopted by resolution of General Conference of UNESCO, principles of the Declaration of Helsinki (1964), and compliance with regulatory requirements of Ukraine. The study was approved by the Commission for the Issues of Medical Ethics.

Before the beginning of the study, parents of all children provided written informed consent on observation and examination of their children and the use of the received data in the scientific work.

RESULTS

Before the conduction of rehabilitation measures, the complex program of physical exercises was developed, and the state of parameters of work of the cardiovascular system of all children were measured. The beginning data of these parameters is presented in Table 1.

Before the conduction of the rehabilitation complex for physical exercises in the state of rest, all parameters

Table 1. State of parameters of work of the cardiovascular system of children with scoliosis before physical exercises

Parameters, measurement units		Boys (n = 9)	Girls (n = 6)
Pulse pressure, mm Hg	rest	31.01±1.77	23.33±1.27
	load	39.17±3.19	33.32±1.36
	1 rest	29.36±2.59	28.33±1.80
	2 rest	33.77±2.76	26.63±2.61
Stroke volume ml/beat	rest	45.63±3.10	38.68±1.22
	load	44.89±2.39	39.65±1.08
	1 rest	40.14±3.68	42.37±2.02
	2 rest	43.39±4.65	44.10±1.53
Maximum aerobic capacity, watts	rest	94.11±6.79	64.32±1.22
	load	121.56±4.52	98.98±5.64
	1 rest	90.07±4.18	77.02±2.18
	2 rest	104.32±3.04	93.67±1.90
Relative Maximum aerobic capacity, watts	rest	3.57±0.79	2.62±0.19
	load	4.32±0.51	3.35±0.23
	1 rest	3.33±0.56	3.22±0.16
	2 rest	3.99±0.43	3.27±0.23
Pulse tolerance limit, beat/ minute	rest	40.08±1.80	40.05±1.15
	load	60.89±4.12	60.66±1.07
	1 rest	42.56±3.51	32.32±2.06
	2 rest	42.86±4.27	41.07±1.33
Mean aortic pressure, mm Hg.	rest	92.62±6.25	86.10±1.13
	load	96.78±18.84	103.05±4.28
	1 rest	93.22±4.74	90.68±1.21
	2 rest	99.28±3.39	92.10±1.77

of the work of the cardiovascular system in girls were statistically significantly lower than relevant parameters in boys. It is necessary to note that the largest reduction by 1,5 ($p<0,05$) was found in girls compared with boys of the parameter of Maximum aerobic capacity.

An increase in parameters of both groups of boys and girls was admitted during physical load. No statistically significant load was determined in the distribution of the parameter of pulse tolerance limit among girls and boys at load ($p>0,05$).

During the first rest, the parameters of the load on the cardiovascular system reduced without possible gender differences for parameters of pulse pressure, stroke volume, relative Maximum aerobic capacity and mean arterial pressure ($p>0,05$). During the first rest, Maximum aerobic capacity in examined boys statistically exceeded the relevant value in girls by 1,2 ($p>0,05$), and parameters of pulse tolerance limit also differed by 1,3 ($p>0,05$).

During the second rest, the tendency in the distribution of parameters of the load of the cardiovascular system did not change.

After the use of complex of physical rehabilitation, a possible increase in parameters of work of the cardiovascular system in boys and girls was found (Table 2).

The highest level of increase of the parameter of maximum aerobic capacity (Fig. 1) was found in boys (by 2,1, $p<0,05$) and in girls (by 3,3, $p<0,05$) and relative maximum aerobic capacity in boys (by 1,8, $p<0,05$) and in girls (by 2,6, $p<0,05$) (Fig. 2).

A possible increase in aortic pressure after rehabilitation with the use of physical exercises can indicate the increased load on a child's organism.

After the conduction of the developed complex program of physical exercises for the rehabilitation of school-age children, gender differences disappeared in the distribution of the parameters of work of the cardiovascular system both in rest, as well as the load and two rests after the load. This can indicate that the cardiovascular system of both boys and girls has equal tolerance to physical load.

DISCUSSION

Randomised controlled studies, evaluating a small population of patients of high risk, are not numerous in

Table 2. State of parameters of work of the cardiovascular system of children with scoliosis after physical exercises

Parameters, measurement units		After the study	
		Boys (n = 9)	Girls (n = 6)
Pulse pressure, mm Hg	rest	44.71±1.95	45.98±3.37
	load	38.17±2.01	14.87±1.67
	1 rest	50.07±2.31	50.04±3.47
	2 rest	51.09±2.17	51.71±2.17
Stroke volume ml/beat	rest	56.87±1.92	57.98±2.47
	load	30.07±2.27	35.21±2.18
	1 rest	58.37±1.95	58.01±3.47
	2 rest	60.39±2.18	59.11±3.12
Maximum aerobic capacity, watts	rest	200.01±11.27	210.01±7.90
	load	170.02±4.95	214.70±21.90
	1 rest	220.45±12.31	230.45±9.90
	2 rest	222.11±13.17	241.37±9.72
Relative Maximum aerobic capacity, watts	rest	5.97±0.51	6.81±0.67
	load	5.30±0.45	6.97±0.64
	1 rest	6.87±0.41	7.47±0.74
	2 rest	7.01±0.23	7.65±0.75
Pulse tolerance limit, beat/ minute	rest	33.03±3.02	34.93±3.17
	load	61.17±2.71	61.07±3.97
	1 rest	34.78±3.47	33.73±2.59
	2 rest	35.07±1.73	36.05±1.87
Mean aortic pressure, mm Hg.	rest	135.05±5.17	136.19±4.59
	load	167.07±3.87	161.27±5.81
	1 rest	144.23±7.97	148.11±7.14
	2 rest	141.47±10.12	146.95±7.18

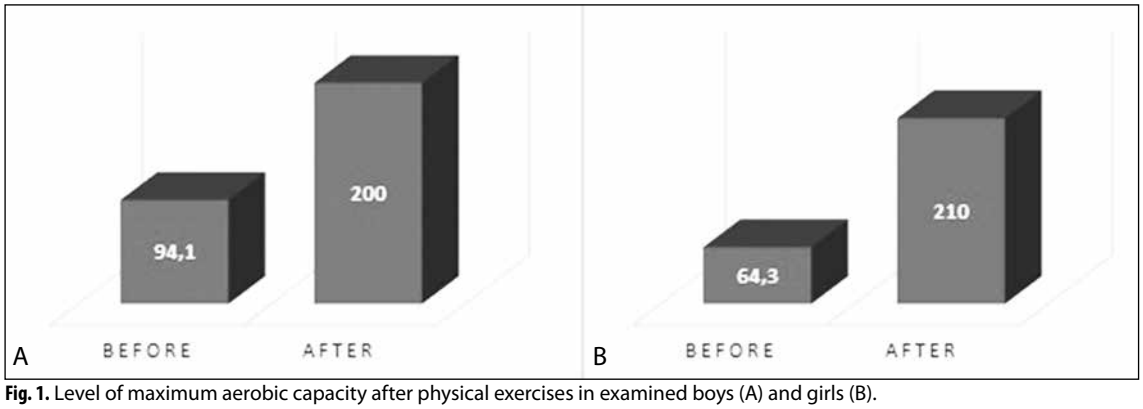

Fig. 1. Level of maximum aerobic capacity after physical exercises in examined boys (A) and girls (B).

the literature due to aetiological differences of early-onset scoliosis in combination with its low prevalence.

Most researchers share the opinion that regular physical exercises play a decisive role in the treatment of this condition in children. It not only helps to improve posture and muscle strength but also reduces the risk of curvature progression [12]. Still, it is important to select correct exercises and follow individual programs of exercises, recommended by experts

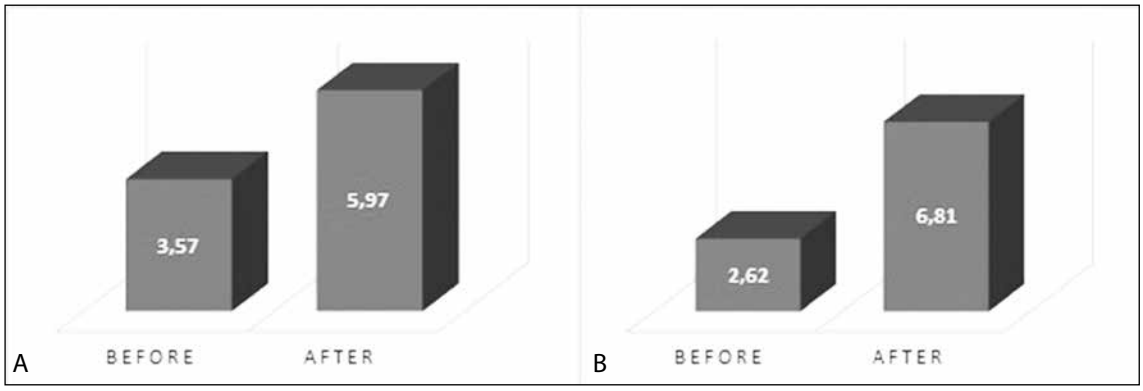

Fig. 2. Level of relative aerobic capacity after physical exercises in examined boys (A) and girls (B).

for ensuring safety and effectiveness. Including these special programs of exercises and recommendations into the workday of a child, can support them to maintain physical well-being and help to lead an active life. Early intervention and consistent efforts are essential for effective condition management [13].

No pathological changes were found as the result of our study of the dynamics of certain parameters of work of the cardiovascular system and aerobic capacity due to physical load for primary school-age children with scoliosis.

Personalised programs of exercises play a decisive role in their treatment, including exercises aimed at the abdominals [14, 15]. Complying with experts' recommendations is essential for ensuring the safety and effectiveness of these exercises. Strengthening the main muscles, in particular, the abdominals can help to improve posture and stability, while yoga and stretching exercises can increase spine flexibility. Motivating to regular physical exercises may also be useful for children. By including these exercises in the workday, children can actively manage their condition and improve their general well-being [10, 16].

Thus, scoliosis can be a significant modifier of cardiac load and risk of serious unfavourable cardiovascular complications during the whole life of both children and adults. This has clinical consequences for the consideration of the issue of surgical treatment of scoliosis to reduce the load on the cardiovascular system, therefore, it is necessary to take all possible measures for early correction of the diagnoses impairments with the use of a personalised complex of physical exercises on the dynamics of work of the cardiovascular system while using physical performance tests in children with scoliosis.

CONCLUSIONS

During growing up, scoliosis progression in children forms increased pressure on the work of the cardiovascular system, which manifests in the increase of pulse, pulse pressure, and mean pressure, stroke volume, and differs depending on age and sex and requires the development of the individual rehabilitation plan with consideration of found changes. Parameters of work of the cardiovascular system differ depending on the age and sex of patients with scoliosis. Thus, most parameters in boys statistically significantly exceeded relevant parameters in girls in the group of children aged -10. At the same time, both boys and girls tolerated physical load well. Gender differences in the distribution of the results of physical performance tests of children with scoliosis encourage developing individual rehabilitation plans with consideration not only of the stage of the primary disease but also the age and sex of a child.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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REVIEW ARTICLE

The effect of thermotherapy on functions of the circulatory system. Review literature

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ABSTRACT

According to the National Institute of Public Health – National Institute of Hygiene, cardiovascular diseases account for 34.8% of deaths in Poland. In 2020 and 2021, contrary to the previous downward trend, cardiovascular disease mortality increased by 8.7% and 12.6%, respectively [1]. In addition to pharmacological intervention, physical activity, adherence to dietary recommendations, weight reduction, mental health care, and psychosocial and smoking interventions play a key role in preventing the development of cardiovascular disease [2]. In recent years, there has been a growing interest in the impact of lifestyle and environmental factors on the development of cardiovascular risk. The purpose of this study was to evaluate the effects of thermotherapy on cardiovascular fitness indices and to analyze the efficacy and safety of this form of treatment in people with cardiovascular disease. For this purpose, the literature from 2013-2023 available in the Pubmed database was searched. The results of the papers suggest beneficial effects of various forms of thermotherapy on cardiovascular function.

KEY WORDS: hyperthermia, cardiovascular system, sauna, steam baths

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INTRODUCTION

The Finnish sauna is a type of passive thermotherapy that has been best studied to date. During a sauna session, the body is subjected for a period of 5-30 minutes to an ambient temperature between 80 and 100 degrees Celsius at a humidity level of about 10-20% [3]. The sauna custom is deeply rooted in Finnish culture and is traditionally combined with relaxing, healing properties and beneficial effects on cardiovascular health, while also serving a social function [4-6]. Modern studies attribute its positive effects on cardiovascular regulation by lowering blood pressure, improving vascular endothelial function, reducing oxidative stress and inflammatory response, favorably modulating autonomic system function, and improving lipid profile and arterial compliance [7, 8]. Another method of heat treatment is Waon therapy. This is a type of sauna popular especially in Japan, in which a session is conducted at 60°C for 15 minutes [9]. Other types of saunas are – similar to Waon therapy – Infrared Sauna (IR), Steam Sauna and Wet Sauna, each characterized by different humidity and temperature. Among the thermotherapy methods used, we also distinguish the immersion of the body in hot and cold water.

MATERIALS AND METHODS

The literature available in the Pubmed database was considered. The keywords used were "(sauna) AND (cardiovascular system)" and "(thermotherapy) AND "(cardiovascular system)". Papers in English were considered. Results were limited to clinical trials with a control group, randomized controlled clinical trials, and meta-analyses with human participants from 2013-2023. Off-topic and duplicate articles were excluded from the resulting database, yielding 12 publications meeting the listed criteria.

REVIEW AND DISCUSSION

11 of the 12 publications considered in the study describe the beneficial effects of various forms of thermotherapy on cardiovascular function. 1 paper reports no association between thermotherapy and cardiovascular parameters.

A meta-analysis by Ye WN (2020) summarizes the results of studies on the effect of thermotherapy on a population of patients with congestive heart failure. The analysis of patients' NYHA score before and after treatment with various forms of thermotherapy presents interesting data. A significant majority of the 310 patients studied had a transfer to a lower class. Other benefits of treatment include a reduction in systolic and diastolic blood pressure, mitigation of the average pulmonary-cardiac index or improvement in BNP, a marker of oxidative stress. Most significant, however, seems to be the recording of improvements in the subjects' quality of life expressed by a significant reduction in cardiac deaths and rehospitalizations [10]. A meta-analysis by Li Z et. al (2012) involving a total of 968 participants elucidates a particularly beneficial short-term as well as long-term effect of the Finnish Sauna in patients

with poor cardiovascular fitness. This study highlights the role of elevated body temperature on maintaining patency of arteriovenous anastomoses, which, by reducing peripheral vascular resistance, lowers cardiac workload [11]. Another large study by Pizzey FK and colleagues (2021) summarizes the results of work on IR therapy and warm water immersion. The meta-analysis took into account studies on healthy people with congestive heart failure and those with risk factors for coronary heart disease. The results of the study describe the beneficial effects of thermotherapy on lowering blood pressure, improving endothelial function as expressed by vasodilatation of the brachial artery, or reducing vascular stiffness, and improving microcirculatory function in both groups of patients [12].

A randomized clinical trial by Lee E et. al (2022) analyzes the relationship between undergoing regular sauna sessions in concurrent athletes and cardiovascular parameters. It shows an improvement in cardiovascular fitness and a reduction in systolic blood pressure in people who combine both forms of cardiovascular conditioning [13]. The largest experimental study to date on Finnish Sauna was conducted by Laukkanen, T. et. al (2017) on a group of 102 participants in which each had at least one risk factor for developing CVD. The results of the study suggest a significant effect on lowering blood pressure and reducing vascular stiffness expressed by a decrease in pulse wave velocity in people who regularly use the Finnish sauna for short cycles. The authors also note the safety of this form of thermotherapy in a group of disease-laden patients [14]. Radtke T. et. al. (2016), meanwhile, examined the association between Finnish Sauna therapy and subsequent exposure to 12°C water immersion and arrhythmia risk and adrenergic system tone in a group of congestive heart failure patients. The similarity of the cardiovascular response in sick and healthy patients and the lack of significant differences in the rate of premature ventricular beats between the groups suggest the safety of heat and cold thermotherapy among congestive heart failure patients [15]. A study by Källström M. et. al (2018) evaluates the effects of infrared sauna on a population of patients with congestive heart failure. Despite an unknown effect of the therapy on indices such as systolic and diastolic blood pressure and left ventricular and left atrial dimension relative to the control group, the authors cite a significantly beneficial effect on ejection fraction values and a 38% reduction in cardiac events over a 5-year follow-up period [16]. Kominami K. and colleagues (2020) described the effects of a variant of IR popular in Japan called Waon therapy and, similar to it but requiring less equipment, a method involving heating subjects with warm compresses on cardiovascular parameters. The decrease in afterkiad expressed by an increase in brachial artery diameter and an increase in radial artery blood flow velocity in subjects suggests a beneficial effect of thermotherapy on the treatment of patients with heart failure [17]. Brunt VE et. al (2016) investigated the effect of passive thermotherapy involving immersion of subjects in 40.5°C water during 60-minute sessions. The patient population consisted of young people with sedentary lifestyles. The authors demonstrate beneficial effects on such cardiovascular parameters as endothelium-dependent vasodilation, arterial stiffness, vessel wall thickness and blood pressure. Comparing the effects of the therapy to those obtained during regular exercise, they suggest the possibility of using this treatment method in patients in whom regular exercise is not possible [18]. A study comparing the effect of IR sauna and regular aerobic exercise on cardiovascular parameters in healthy women was conducted by Hussain JN and colleagues (2021). It is noteworthy that, unlike other studies, the authors found no significant differences in blood pressure, heart rate variability and vascular stiffness between the study participants undergoing exercise and heat therapy in IR sauna conditions and the control sample. It should be noted, however, that due to the small study sample (n=10) and other design errors, the experiment was subject to a large bias as the authors themselves point out [19].

CONCLUSIONS

In an era of developing public awareness of the importance of lifestyle on health, the authors have made great progress in recent years toward increasing the state of knowledge about the effects of thermotherapy on cardiovascular health. Their analyses prove the safety of this form of therapy in groups of patients with cardiovascular risk. The results of the work comparing the effect of thermotherapy and exercise give hope for the development of non-pharmacological treatments for those unable to participate in sports. The results of studies combining exercise and thermotherapy also seem promising. Numerous studies have highlighted the beneficial effects of sauna on improving cardiovascular fitness indices. However, data are still lacking from randomized control trials conducted on large research groups.

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REVIEW ARTICLE

Balneotherapy and thermal resort in dermatology

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ABSTRACT

One of the oldest specialties in medicine is balneotherapy, which examines how to treat patients with mud and groundwater. Many nations use water therapy as a kind of treatment. The Blue Lagoon in Iceland, the Dead Sea in Israel, the Kangal hot springs in Turkey, several thermal pools in France, as well as Poland, are examples of natural balneotherapy locations. For the patient, this therapy is painless, and there are almost no adverse effects. Its positive effects have also been demonstrated in the management of lupus, psoriasis, atopic dermatitis, rosacea and other inflammatory skin conditions. The primary components of the mechanism are the deep water and peat baths' chemical, mechanical, thermal, and immunomodulatory impacts. It is desirable to use balneotherapies both alone and as a supplement to systemic therapy. Based on the most recent studies and clinical data, this article seeks to assess the present scientific understanding of the role of balneotherapy in dermatological care.

Key words: balneotherapy, psoriasis, lupus, atopic dermatitis, thermal water

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INTRODUCTION

Balneology, a name derived from Latin and Greek, meaning balneum – "bath", lógos – "word, science". It is a branch of physical medicine concerned with the study of the therapeutic benefits of naturally occurring mineral waters. It has been a cornerstone in therapeutic regimens for various ailments since ancient times. The therapeutic effects of bathing in thermal mineral waters and spa therapy on chronic skin diseases have been known around the world for centuries [1]. Water was seen as an extraordinary gift from the Gods. To heal the soul as well as the body, Egyptians and Israelites immersed themselves in the waters of the Nile and Jordan, and Indians in the Ganges River. The ancient Greeks also found the use of water to treat skin diseases and relieve muscle pain. Greek mythology tells the story of Hercules, who bathed in the springs of Thermopylae to regain his strength [2]. Particularly in dermatology, balneotherapy offers promising complementary strategies for a spectrum of skin diseases, taking advantage of the unique mineralogical profiles of these waters.

AIM

While historical narratives and anecdotal evidence highlight the benefits of mineral baths for skin health, systematic research in recent decades has begun to elucidate the molecular mechanisms underlying these effects. This article aims to examine the current scientific understanding of the role of balneotherapy in dermatologic care, based on recent research and clinical findings.

MATERIALS AND METHODS

The purpose of this study was to review the literature from PubMed and Google Scholar databases published between 2000 and 2023 on the use of balneotherapy in dermatological conditions. The literature data were analyzed to identify the most common dermatological conditions in which this field of physical medicine is applied. Publications containing the following keywords were selected for analysis: balneology, dermatology, psoriasis, Atopic Dermatitis, acne, rosacea, allergic urticaria. Out of 41 papers, 21 sources containing key information related to the topic of the paper were selected.

REVIEW AND DISCUSSION

Balneology, the therapeutic use of naturally occurring mineral waters, has established itself in the annals of dermatological treatment over the centuries. The exact mechanisms of action of balneotherapy remain a topic of research. However, it is believed that a combination of minerals such as sulfur, sodium, calcium, magnesium and other trace elements play a key role. These minerals can exhibit anti-inflammatory, keratolytic and immunomodulatory effects

on the skin [1]. Sulfur-rich waters are particularly beneficial in inflammatory conditions due to their keratolytic and anti-seborrheic properties. Inflammatory skin diseases, which include conditions such as psoriasis, atopic dermatitis and rosacea, pose a major therapeutic challenge due to their recurrent and often refractory nature. Balneology, rooted in the therapeutic use of mineral waters, has emerged as a potential adjunct or alternative treatment route for these conditions. Many studies indicate that various mineral compositions, mainly sulfur, magnesium and selenium, in these waters exert strong anti-inflammatory effects on the skin [1]. In particular, the therapeutic environment of the Dead Sea has been singled out for its effectiveness in alleviating psoriasis exacerbations, which can be attributed to its unique salinity and mineral concentration [3]. What's more, balneotherapeutic settings, through stress relief and relaxation, can alleviate inflammatory cascades exacerbated by psychological factors, particularly important in conditions such as atopic dermatitis [4]. Some studies have suggested that balneotherapy can provide symptom relief in patients with eczema, particularly with sulfur- and magnesium-rich baths [5]. Sulfur-rich waters have been used to treat acne due to their antibacterial and keratolytic properties [6]. Balneotherapy can help reduce symptoms associated with chronic venous insufficiency, including skin lesions [7].

BALNEOTHERAPY METHODS

Balneotherapy, rooted in the therapeutic use of mineral waters, offers a spectrum of methods tailored to various dermatological conditions. The essence of these treatments is the use of unique minerals and gases derived from natural springs or muds [1]. One of the best known is immersion therapy, in which patients bathe in mineral-rich waters; studies highlight its effectiveness in alleviating conditions such as psoriasis and atopic dermatitis [3]. Another effective approach is mud therapy, which involves applying therapeutic muds or clays, known for their anti-inflammatory and keratolytic effects, to the skin, making them particularly beneficial for acne or seborrheic dermatitis [8]. Moreover, the modality of spa therapy includes not only direct application or immersion, but also inhalation of vapors and gases, targeting a holistic therapeutic experience. As our understanding of these treatment modalities deepens, it is necessary to continuously refine and adapt these methods to achieve optimal therapeutic results in the field of dermatology.

IMMUNOMODULATORY EFFEC,TS OF BALNEOLOGY IN DERMATOLOGICAL INTERVENTIONS

The importance of balneotherapy in dermatology goes beyond symptom relief, delving into the realm of immunomodulation. Naturally occurring mineral waters, equipped with elements such as sulfur, magnesium and selenium, are believed to induce systematic immune responses that are beneficial in skin diseases [9]. Recent studies have highlighted the potential of balneotherapy to reduce levels of pro-inflammatory cytokines and promote regulatory T-cell function, thereby alleviating skin inflammation [10]. For example, in conditions such as psoriasis and atopic dermatitis, in which immune dysregulation plays a key role, spa therapies are associated with modulation of Th1/Th2 cytokine balance, fostering an environment conducive to skin repair [11]. However, it is necessary to emphasize that although these immunomodulatory effects are promising, their temporal dynamics, potential systemic implications and precise underlying mechanisms require further intensive research.

EFFECTS ON MENTAL HEALTH

The therapeutic use of balneotherapy goes beyond physiological improvement, offering potential benefits in the psychological domain. Historically, spas and wellness centers have been revered as sanctuaries of relaxation and mental rejuvenation, and modern research seeks quantitative confirmation of these anecdotal benefits [1]. Several studies have reported the effect of balneotherapy on reducing stress-related hormones, suggesting its effectiveness in alleviating stress and anxiety disorders [11]. Additionally, the immersive experience of balneotherapy, combined with a therapeutic spa environment, can promote mindfulness and better mood regulation, attributes that may be crucial in the treatment of depressive disorders [12]. However, it is important to approach these findings with caution. While the integrative benefits of balneotherapy for mental health are promising, rigorous, randomized, controlled trials, with standardized protocols and objective psychological assessments, are necessary to fully define its role in psychotherapeutic interventions.

PSORIASIS

Psoriasis, a chronic and often debilitating dermatological disease, is a key therapeutic target in balneological research. The unique interaction of mineral-rich waters, especially from regions such as the Dead Sea, has been repeatedly documented for efficacy in alleviating psoriatic lesions. Emmanuel et al [3] compared the therapeutic results of sun and bathing in the Dead Sea with standard natural sun exposure and found significant regression of psoriasis plaques under the former. It is postulated that the high magnesium content of these waters plays a key role in such interventions. Another dimension is the combined effect of climatotherapy. The synchronized effect of sun exposure and mineral immersion has consistently shown increased benefits [4]. However, while the short-term benefits of balneotherapy in psoriasis are empirically supported, there is an urgent need for more longitudinal studies to establish the durability of these results and identify potential side effects or resistance to long-term exposure. The integration of balneotherapy into the comprehensive treatment of psoriasis appears promising, but requires further empirical rigor to determine the optimal therapeutic window.

ATOPIC DERMATITIS

Atopic dermatitis (AD), a recurrent inflammatory skin condition characterized by intense itching and eczematous lesions, has become a focal point for balneology-based interventions. Studies have shown that the strategic use of mineral-rich waters can provide significant therapeutic

benefits for patients with AD. One of the main mechanisms appears to be the anti-inflammatory effects induced by minerals such as sulfur, magnesium and selenium, commonly found in medicinal waters [13]. In particular, spa therapies using these waters have been shown to enhance skin barrier function, reduce transepidermal water loss and modulate cutaneous inflammatory responses in AD [14,15]. Moreover, the added benefits of relaxation and stress reduction in a spa setting further enhance the therapeutic response, given the known exacerbating effects of stress on AD. However, while preliminary data are promising, there is a compelling need for randomized, controlled trials to solidly establish the position of balneotherapy in AD treatment protocols, including assessing its synergy with contemporary treatments.

ACNE VULGARIS

Acne vulgaris, a common dermatological affliction affecting mainly adolescents but also a significant adult population, has spurred the search for various therapeutic approaches, among which balneotherapy is emerging as a notable contender. Mineral-rich waters, especially those rich in sulfur, have historically been advertised for their dermatological benefits [16]. Modern research confirms this, highlighting the inherent antibacterial and keratolytic properties of sulfur, which may be instrumental in combating Cutibacterium acnes and reducing hyperkeratinization of hair follicles, two major pathogenic factors in acne [17]. Additionally, mud therapy, or the use of therapeutic mud or clay, offers further benefits given its anti-inflammatory and sebum-regulating potential [8]. While these findings provide compelling arguments for the role of balneotherapy in the treatment of acne, it is crucial to emphasize that balneotherapy should ideally be positioned as an adjunct rather than a primary treatment modality. Comprehensive studies defining its comparative efficacy, optimal protocols and potential synergy with conventional treatments are essential for its full validation in the therapeutic arsenal of acne.

ACNE ROSACEA

Rosacea, a chronic inflammatory skin condition manifested by facial erythema, telangiectasias, papules and pustules, often poses a therapeutic challenge due to its multifactorial etiology and episodic exacerbations. Among the myriad therapeutic interventions for rosacea, balneotherapy has emerged as a complementary option that deserves clinical attention. Central to this approach is the use of mineral-rich waters, with sulfur-containing springs of particular interest due to their known vasoconstrictive and anti-inflammatory properties [1]. Studies highlight that consistent use of these waters can help alleviate the erythema associated with rosacea and reduce inflammatory changes [8, 18]. Furthermore, a holistic spa environment that provides both relaxation and structured therapeutic regimens can potentially alleviate stress-induced exacerbations. While preliminary results indicate the potential utility of balneotherapy in the treatment of rosacea, a comprehensive understanding requires further randomized, controlled trials to determine its exact role, optimal treatment protocols and long-term benefits when integrated with standard therapies.

ALLERGIC URTICARIA

Allergic urticaria, a cutaneous manifestation characterized by transient wheals often accompanied by pruritus, poses a major therapeutic challenge due to its unpredictable nature and multifaceted triggers. Recent scientific studies have begun to shed light on the potential benefits of balneotherapy in treating this condition. It has been postulated that mineral-rich waters, especially those with significant sulfur content, exert anti-inflammatory and antipruritic effects on the skin [1]. Preliminary clinical studies suggest that balneotherapeutic interventions may reduce the release of histamines and other mediators from mast cells, which are crucial in the pathogenesis of allergic urticaria [19]. Additionally, the relaxation and stress-reducing environment of the spa may play a role, given the known association between stress and urticaria exacerbations. While these results are indeed encouraging, they underscore the need for more rigorously designed studies to definitively determine the role and efficacy of balneotherapy in the treatment of allergic urticaria.

CONCLUSION

In the ever-evolving field of dermatological therapies, balneotherapy holds a distinctive position, combining ancient practices with modern scientific insights. The therapeutic use of mineral-rich waters and muds has shown promise across the spectrum of skin diseases, from inflammatory disorders to chronic ailments [19]. While the empirical evidence supporting the benefits of balneotherapy continues to accumulate, a comprehensive and standardized approach to its use remains an area for further research. Balneotherapy, with its multifaceted mechanisms ranging from direct anti-inflammatory effects to psychosomatic relaxation, offers a holistic pathway for patient care. However, as we move forward, the onus is on the scientific community to rigorously validate, optimize and potentially integrate these treatments into mainstream dermatology practice, providing evidence-based, patient-centered care [20]. Although balneotherapy offers many benefits, some issues need to be addressed. The mineral composition of waters can vary widely, making it difficult to standardize treatment. Moreover, while the short-term benefits are clear, the long-term effects and potential for recurrence after cessation of therapy remain insufficiently studied [21].

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CLINICAL CASE

Central Pontine Myelinolysis in a patient with a severe course of Covid-19. Case report

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ABSTRACT

The article presents the course of treatment and rehabilitation of a 73-years old Covid-19 patient with severe hyponatremia due to persistent vomiting and diarrhea. In spite of the restoration of the water-electrolyte balance, the patient continued to show consciousness disturbances, psychomotor retardation and mild tetraparesis. Those deficits were interpreted as symptoms of 'brain fog' in the course of Covid-19 as well as manifestation of critical condition polyneuropathy. It was laboratory diagnostics, performed after the patient's discharge from the hospital, that revealed central pontine myelinolysis sustained by the patient in the course of the infection. The article describes neuroimaging changes on magnetic resonance imaging diffusion weighted imaging (MRI DWI) characteristic of central pontine myelinolysis which is a rare disease. In addition, the article describes subsequent stages in working on the improvement of the patient's psychomotor abilities and in encouraging the doctor to rationally supplement sodium deficits, in compliance with the guidelines, as well as argues for continuing research into CNS impairment in the course of Covid-19.

KEY WORDS: Central Pontine Myelinolysis, Covid-19, rehabilitation, neuropsychological therapy

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INTRODUCTION

Diffusion weighted imaging (DWI) is an imaging method of magnetic resonance examination developed in the 80s of the 20th century and consistently applied in clinical medicine since the 90s. It has contributed to significant progress in imaging diagnostics. Introduced in the clinical application in the examination of animals by Moseley and co-workers and of people by Warach and co-workers [1, 2], DWI was initially used in the diagnostics of the ischaemic stroke and later of other neurological disorders. Its application has then been expanded to other fields of medicine, primarily to oncology. At present, DWI is a sequence routinely applied in every MR examination of the head and in almost all MR examinations of any other part of the body.

In the Military Institute of Medicine in Warsaw (Poland) this sequence has been applied on every MR examination of the head/brain consistently since February 2009.

We are presenting its usefulness on the basis of the description of central pontine myelinolysis (CPN), a specific disease entity. The osmotic demyelination syndrome (ODS) is an entity embracing myelination of the central pontine myelinosis (CPM) and extrapontine myelinosis (EPM). The disease entities referred to above encompass changes in the brain which develop due to metabolic disturbances – such as quickly treated hyponatremia. What then seems to be adversely affected and even damaged by the osmotic stress which develops are the brain areas with a dense presence of myelin fibres rich in oligodendrocytes [3].

CASE REPORT

The patient aged 73, hitherto treated only for chronic arterial hypertension, was admitted to Hospital for persisting vomiting and diarrhea resulting in severe hyponatremia – sodium concentration on hospital admission was 106 nmol/l. Already in the A&E Unit, the patient was diagnosed with Covid-19 and admitted to the Infectious Diseases Ward where a balanced sodium concentration was gradually restored. While there, the patient suffered temporary respiratory failure and was connected to a life-support machine. The applied treatment included: antibiotic therapy for bacterial superinfection with Covid-19, low molecular weight heparin, fluid therapy and loop diuretics. In spite of the restoration of the water-electrolyte balance, successful treatment of Covid-19 and return to independent respiratory capacity, the patient showed disturbances of consciousness, considerable psychomotor deterioration and mild tetraparesis. The deficits referred to above were interpreted as manifestations of "brain

fog" in the course of Covid-19 as well as features of critical condition polyneuropathy. The patient was transferred to the Rehabilitation Clinic of the Military Medical Institute.

PATIENT'S CONDITION ON ADMISSION TO THE REHABILITATION CLINIC OF MIM

On initial assessment on admission to the Rehabilitation Clinic, the patient showed:

- on the level of interaction: no verbal-logical contact, dependence on third persons and need of assistance in most everyday life activities, including self-service and change of position.
- on the level of activity: recumbent position, inability to shift to a lateral position or to move even within the confines of the bed, inability to maintain an unsupported sitting position when placed in it and ability to maintain a supported sitting position.
- on the level of body structure and function: significant tetraparesis, muscular strength in MRC of 1-2 signifying difficulties in independent performance of anti-gravity force movements [4]; deep and superficial sensory disturbances were not assessed due to lack of logical communication with the patient.

The short-term aim was to obtain movement within bed, change of position to lying on the side, ability to shift to a sitting position, self-service.

The long-term aim of the therapy involved transfers and learning locomotion with the assistance of a third person.

Bedside rehabilitation in the first period focused on spatial orientation, learning to turn around on one's own as well as attempting to sit on one's own. Attempts at passive and active-passive verticalization were also made.

Subsequent stages of rehabilitation focused on muscle strength restoration, improvement in performed activities, continuation of active verticalization, learning transfers and learning to move with a walker and assistance as well as climbing stairs with the help of the hand rail and assistance.

The procedures used in therapy included respiratory exercises, passive exercises, active-passive exercises, assisted exercises, conducted exercises, active-passive verticalization, active verticalization, balance exercises, coordination exercises, PNF method, learning locomotor activities by a walker, learning stairs-climbing [4-6,15].

INITIAL PSYCHOLOGICAL ASSESSMENT

The patient was admitted to the Rehabilitation Clinic for functional improvement after SARS-CoV-2 infection. The patient was conscious, in a state of fogged consciousness and with superficial verbal contact. The contact was poor: questions had to be repeated, the patient's psychomotor responses was slowed down and her speech was slurred. The patient's normal orientation to person was maintained while her normal orientation to time, place and person partly impaired (orientation to place maintained, while orientation to time impaired). Imaginary stories related to the period of contracting the disease appeared which resulted in anxiety and depressed mood. Episodic and semantic memory as well as attention were impaired; the patient reported retrograde amnesia as regards the contraction of the disease. In dialogue, the patient had problems with updating words.

THE PATIENT'S CONDITION ON DISCHARGE FROM THE MIM REHABILITATION CLINIC

The patient's condition on discharge from the Clinic, analysed according to the ICF:

- on the participation level: the patient is in good verbal-logical contact, independent within the hospital room, able to perform most daily activities on her own, makes transfers, uses the toilet without need of assistance [4].
- on the level of activity: the patient is able to change position in bed and switch to a sitting position on her own, make transfers to a wheelchair and back to bed, stand on her own, cover with a walker and assistance a distance of 60 m, cope with architectonic obstacles such as stairs with the help of another person covering 12 steps.
- on the level of body structure and function: mild tetrapod weakening of muscle strength. Muscle strength of MRC 4 signifies independent performance of movements against the force of gravity [4]. Exteroception and proprioception maintained. Balance problems. The Up & Go result – 30 s – indicates the need for assistance by a third party while walking [4-6].

Further rehabilitation in an outpatient's unit was recommended to improve muscle strength, perform balance exercises in a standing position, attempt to increase stability in all directions, improve coordination and gait as well as cope with architectonic barriers.

PSYCHOLOGICAL ASSESSMENT ON THE PATIENT'S DISCHARGE FROM THE REHABILITATION CLINIC

The patient's condition gradually improved during her stay in the Rehabilitation Clinic – she became critical of her earlier delusional statements, her episodic memory improved while her retrograde memory of the period of contracting the disease remained unchanged. On the 55th day of stay in the Rehabilitation Clinic, the patient was given a screening cognitive function test ACE-III (Addenbrooke's Cognitive Examination version A) in which she obtained the following values in individual subscales: Attention – 80%, Memory – 77%, Fluency – 43%, Language – 69%, Visual-Spatial Functions – 63%. The total result: 70 points, with the cut-off point for dementia on the basis of normalization in the Anglo-Saxon language version: with very high sensitivity – 88 points and with very high specificity – 82 points [7].

After the discharge from the Rehabilitation Clinic, both the patient's physical condition and her cognitive functions kept improving.

It was the outpatient diagnostics in the form of brain MRI with the DWI and ADC option performed about three months after the contraction of the disease by the patient that revealed that the patient developed central pontine myelinolysis in the course of the disease (Fig. 1-3). In spite of the seemingly slow and rational restoration of sodium concentration, the patient developed a condition with a death risk factor of 33-55% [3].

Fig.1. MR of the head performed with SymphonyTim MRC37255 by SIMEN, with a T2-dependent transverse image – visible midsaggitally on the pons is a sharply delineated area of a high signal in the form of a tent.

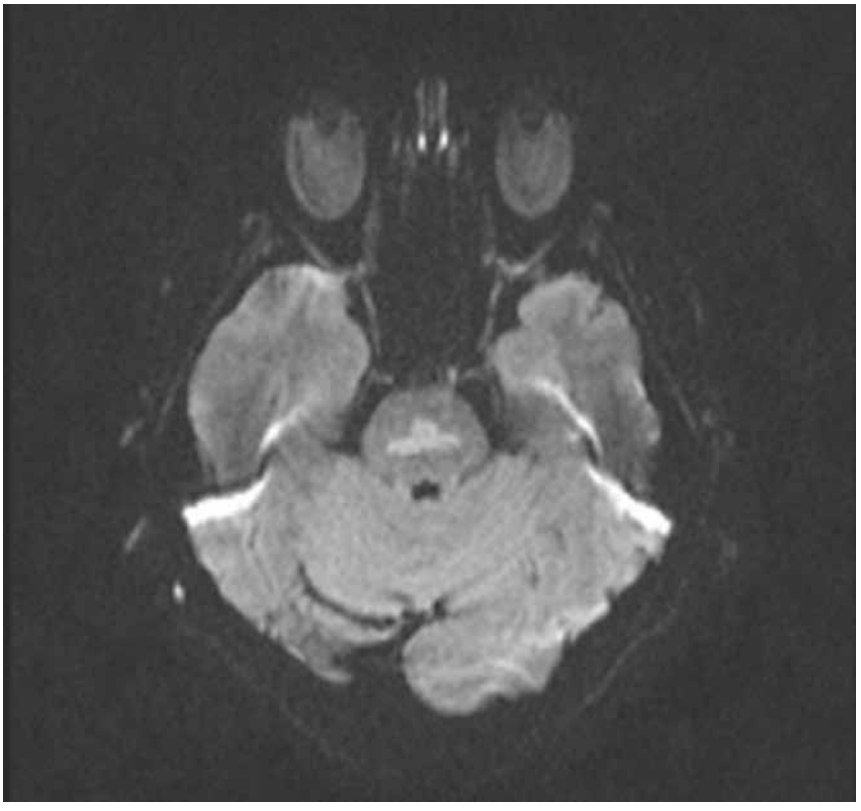

Fig. 2. MR of the head of the same patient with a DWI (b-1000), cross-section - visible midsaggitally on the pons is a poorly delineated area of a high signal in the form of a tent.

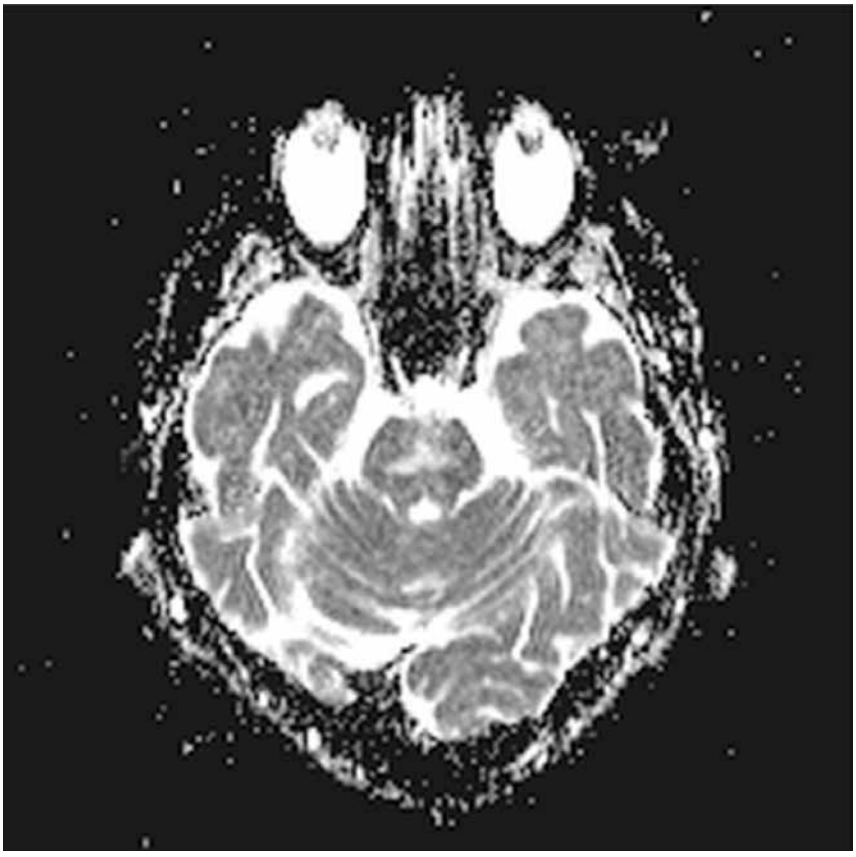

Fig. 3. MR of the head of the same patient with an ADC map - visible midsaggitally on the pons is a poorly delineated area of a high signal in the form of a tent.

IMAGING BASICS

The human body consists in 60-70% of water. The DWI method makes use of the free microscopic movements of water particles in all directions caused by thermal energy, called Brown's movements. In an ideally homogenous environment, their diffusion is random and isotropic, that is directed with equal probability, in all directions. Yet organ tissues are not homogenous and differ from the ideal environment. Hence, an extracellular model and an intracellular model of tissues were adopted, its being assumed that water particles diffuse freely in the extracellular compartment.

Increased penetration of sodium ions and water to the intracellular space in the course of cell membrane damage due to ischaemia or in the course of restoring balance in the level of sodium ions in the blood serum causes a decrease in the extracellular space and hampers the free movement of water particles. The symptom of an increased signal on DWI images appears quickly, even several minutes after the cell damage [8].

A similar effect of extracellular space reduction can be triggered by an increase in the number of cells as a result of neoplastic cells multiplication.

Diffusion images are performed with the application of the b-value coefficient. The b-value coefficient applied can be different in the examination of different organs. In MR examinations of the head, it is the b-0 and b-1000 that are applied.

The great advantage of the DWI method is the possibility of performing a quantitative measurement. The quantitative measurement of diffusion is presented in the form of Apparent Diffusion Coefficient (ADC) maps. The ADC measurement allows to assess and monitor the severity of the disease as well as to monitor the treatment.

In the case of ischaemic brain changes, the ADC parameter is the fastest normalizing indicator among all the abnormal sequences of head MRI examinations.

Decreased diffusion manifests as an elevated signal in DWI images while as a decreased signal on ADC maps. An elevated signal on ADC maps with a high DWI signal is considered an effect of an excessive exposure to light of T2-dependent images and is not treated as a true diffusion restriction.

RADIOLOGICAL IMAGES ON MR EXAMINATION IN CENTRAL PONTINE MYELINOLYSIS

The radiological pictures of central pontine myelinolysis vary depending on the period of the disease. Radiological changes may not be present at the early stage of the disease in 23% of patients [9]. At the acute stage, the high DWI image signal is most frequently accompanied by a low signal on ADC maps +/- an elevated signal on T2-dependent images. Myelinolytic changes are situated centrally on the pons. On cross-sections they are round or oval and do not reach the edge of the pons [10].

In the chronic condition as well as in the case of past central pontine myelinolysis, the high DWI image signal is

most frequently accompanied by a high signal on ADC maps and a high signal on T2-dependent images. Characteristic changes are symmetrical, located midsagitally, spreading in transverse images in the shape of tents or tridents, not reaching the edge of the pons [11].

DISCUSSION

Magnetic resonance is an imaging method subject to intensive scientific and research development. Sequences using new diagnostic factors (functional, perfusion, metabolic sequences) tend to be brought into general use fairly fast. Moreover, sequences already used and seemingly well-known open to application in further new disease entities owing to frequently small but meaningful modifications. We can see it in the case of magnetic resonance diffusion. Initially applied in the diagnostics of overacute and acute brain strokes, it has come to be used in demyelinating diseases, inflammatory brain diseases, dementias as well as metabolic and toxicological brain diseases. Neither can we imagine oncological examinations without the use of DWI and ADC maps these days. They are used to diagnose a disease, but also to assess the response to therapy or to detect a neoplastic developments recurrence.

The MRI of the head has also become a basic imaging method in the diagnostics of CPM. The computer tomography examination of the head is of lesser importance because a normal image does not necessarily exclude this disease [11].

MR images of the head assess the intensity of the signal on T1-dependent, T2-dependent and FLAIR images, on DWI images and on ADC maps within the pons as well as other structures which might be affected by myelinating changes. Graff-Radford and co-workers found out examining 24 patients that the pons is the structure affected in all the patients. Other structures likely to be affected include the thalamus (36% of patients), midbrain (27%), cortical grey matter (14%), hippocampus (14%), caudate nucleus (9%), brain shell (9%) and middle cerebellar peduncles (9%). In addition, the same researchers showed that there are no correlations between the clinical picture and the radiological picture, DWI included, and the appearance on MR of the head examination of areas of extrapontine myelinolysis, though the researchers did not refer to the value of the ADC coefficient.

Foerster and co-workers also pointed to the lack of correlation between the size and dissemination of brain changes, on DWI and ADC maps included, and the severity of clinical manifestations as well as the outcome of the disease [12].

The importance of ADC value as a prognostic factor in the course of osmotic myelinolysis of the brain was indicated by Dervisoglu and co-workers - ADC maps were standardized parallelly to the clinical condition of the patient studied in the first week and month of the treatment [13].

In the group of 8 patients examined by Foester and co-workers, four patients manifested elevated ADC values, three - lowered, one - no changes. The authors of the study assumed that the values found on ADC maps reflect different stages of the disease in individual patients and not the severity of the disease. In this group of patients, DWI images with an elevated signal were present in 7 patients [12].

The MR of the head should always be performed in CPM patients, and the examination protocol should always include DWI and assessment of ADC maps in spite of the fact that part of the patients does not show restriction of water diffusion at the early stage of the disease.

What constitutes a limitation of MRI DWI is the fact that at an early stage of the disease the MR image of the head may be normal. This does not exclude the development of changes at a later time and their detection on a repeated MR examination of the head. Neither is there a possibility to differentiate chronic and past changes. MRI DWI does thus not allow to specify the exact time of the onset of the disease. DWI and ADC images are not sharp and the size of changes they reveal is therefore difficult to measure. T-dependent images provide a more reliable measurement of the size of changes as the borders of changes on T2-dependent images are sharp.

CONCLUSIONS

What is an undeniable merit of the DWI method is that it provides an easy diagnosis of central pontine myelinolysis, with a simultaneous approximate determination of the period of acute as well as chronic and past course.

Central pontine myelinolysis is a disease entity often underdiagnosed, encumbered with a high, over 50%, risk of death. Moreover, its treatment is still largely non-specific and experimental. It is thus strongly advisable to focus on the prevention and dissemination of the knowledge about the potentially adverse consequences of incorrectly performed hyponatremia adjustment [3, 15].

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CONFLICTS OF INTEREST

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VARIA

Kurs pt.: „ Balneologia i medycyna fizykalna. Metody lecznicze oraz wybrane problemy z medycyny uzdrowiskowej”


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W dn. 3.06.-14.06. bieżącego roku zorganizowaliśmy kolejny już 26 kurs balneologiczny dla lekarzy. Tematyka kursu: „Balneologia i Medycyna Fizykalna. Metody Lecznicze oraz Wybrane Problemy z Medycyny Uzdrowiskowej”.

Program obejmował 78 godzin zajęć dydaktycznych, w tym 74 godziny wykładów, 4 godziny przeznaczono na ćwiczenia w zakładzie balneologicznym. W części praktycznej lekarze sami przyjmowali zabiegi balneologiczne i fizykoterapeutyczne, śledzili technikę ich wykonywania, dzięki temu mogli na sobie sprawdzić ich działanie.

Celem całego 2-tygodniowego szkolenia było zapoznanie lekarzy pracujących w uzdrowiskach lub innych ośrodkach leczniczych z podstawowymi problemami balneologicznymi i uzdrowiskowymi. Wykłady, prowadzone na wysokim poziomie, miały zainspirować do dalszej nauki w zakresie medycyny uzdrowiskowej. Znaczna część uczestników nie pracowała jeszcze w uzdrowisku, ale deklarowała chęć w najbliższej przyszłości podjęcia pracy w polskich uzdrowiskach, inni już pracują ale chcieli pogłębić swoją wiedzę. W kursie wzięło udział 53 lekarzy z ponad 30 miejscowości z całej Polski, w tym m.in.: z Bydgoszczy, Szczecina, Torunia, Lublina, Jeleniej Góry, Buska Zdroju,, Krakowa, Warszawy, Ustronia, Szczecinka, Tarnowa, Dusznik, Dębicy, Tomaszowa Lubelskiego, Siennej, Pruszcza Gdańskiego, Białegostoku, Łodzi, Świdnika, Radłowa, Nieborowic, Sycowa, Poznania i innych. W obecnym kursie uczestniczyli również lekarze spoza Polski – Niemiec, Anglii i Ukrainy. Lekarze uczestniczący w kursie reprezentowali prawie wszystkie kliniczne specjalizacje lekarskie. Ponad połowę uczestników stanowiły osoby młode, co nas bardzo cieszy.


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Kurs obejmował zagadnienia podstawowe z zakresu geologii uzdrowiskowej, klimatologii, balneochemii, wskazań i przeciwwskazań do leczenia uzdrowiskowego, infrastruktury uzdrowiskowej oraz omówienie wybranych dziedzin klinicznych w aspekcie uzdrowiskowym, jak: ortopedia, reumatologia, nadciśnienie tętnicze, kardiologia, geriatria i gerontologia, hepatologia, diabetologia, endokrynologia i inne tematy kliniczne. Ponadto zapoznano uczestników z najważniejszymi metodami stosowanymi w lecznictwie uzdrowiskowym, jak: balneohydroterapia, peloidoterapia, balneogazoterapia, hydroterapia, kinezyterapia, ciepło- i zimnolecznictwo, ultrasonoterapia, magnetoterapia, laseroterapia, elektroterapia. W czasie kursu uczestnicy mieli szansę spotkania się z Krajowym Konsultantem w dziedzinie Balneologii i Medycyny Fizykalnej dr A. Sędziak, co pozwoliło na poznanie zagadnień organizacyjnych uzdrowisk polskich oraz dało możliwość zadania pytań o prognozy rozwoju uzdrowisk polskich. Do prowadzenia wykładów zaproszono wybitnych specjalistów, którzy od wielu lat z nami współpracują. Są to najczęściej pracownicy naukowo-dydaktyczni mający równocześnie specjalizację kliniczną i balneologiczną.

Na zakończenie kursu uczestnicy zobowiązani byli do zdania testu obejmującego 41 zestawów pytań jednorazowego wyboru z tematyki poruszanej na kursie. Wszyscy uczestnicy test zdali z wynikiem dobrym i bardzo dobrym. W ostatnim dniu kursu wszystkim uczestnikom wręczono uroczyście z aplauzem całej grupy certyfikaty ukończenia kursu wraz z uprawnieniami.

Z satysfakcją podkreślam, że wszyscy uczestnicy wykazywali duże zainteresowanie, pilnie korzystali z zajęć dydaktycznych, po wykładach odbywała się ożywiona dyskusja. Takie spostrzeżenia mieli wszyscy wykładowcy. Uczestnicy kursu mieli też szansę na zakupienie od wydawcy 2-tomowego podręcznika pt.: „Wielka Księga

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Balneologii, Medycyny Fizykalnej i Uzdrowiskowej" oraz Encyklopedii, dzięki temu będą mogli wiedzę nabytą na kursie utrwalić i poszerzyć. Zgodnie z opinią lekarzy kurs był na bardzo wysokim poziomie, miał charakter interdyscyplinarny, holistyczny. Wielu uczestników było zdziwionych, że medycyna uzdrowiskowa obejmuje tak szeroki, interdyscyplinarny zakres wiedzy medycznej. Część lekarzy uczestniczących w kursie deklarowało chęć pogłębienia wiedzy w ramach specjalizacji z balneologii i medycyny fizykalnej. Dzięki kontaktowej formie zajęć można było rozwinąć szeroką dyskusję między lekarzami i z wykładowcami oraz nawiązać kontakty.

Kurs odbył się w dobrych warunkach lokalowych w sanatorium St. George w Ciechocinku, położonym w samym centrum uzdrowiska. W tym miejscu pragnę podziękować Właścicielom i Pracownikom obiektu za zaangażowanie i stworzenie miłej atmosfery dla uczestników kursu. W czasie trwania kursu panowała koleżeńska, pełna życzliwości atmosfera. Wybrany przez lekarzy Starosta doskonale współpracował z organizatorami kursu. Starał się też uprzyjemnić spędzenie wolnego czasu, co dodatkowo wpłynęło na integrację grupy. Przed wyjazdem do domów wszyscy wymienili się adresami celem kontynuacji znajomości i współpracy. Kurs zakończono wykonaniem zdjęcia familijnego, oraz całą sesją zdjęciową w mniejszych grupach, część z nich załączam.

Dziękuję wszystkim uczestnikom i wykładowcom za zaangażowanie i stworzenie koleżeńskiej atmosfery, a zwłaszcza Staroście – Panu dr. M. Sosnowskiemu.

Kierownik naukowy kursu
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