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THE THERMAL WATER IN BIHOR COUNTY AND ITS BENEFITS FOR TREATING ARTHRITIS. A CASE STUDY: BĂILE 1 MAI RESORT

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ABSTRACT. Due to the existence of important thermal water resources, in Bihor County there are many locations where thermo-mineral waters are used for bathing or for leisure. In this study, we focus on the spas in Bihor County (Băile Felix, Băile 1 Mai, Băile Tinca, Stâna de Vale, to which we add the village of Sarcău), where these waters have been used for a long time and which have the necessary infrastructure for therapy. Thus, we aim to highlight the particularities of these waters, the presentation of the balneotherapy procedures used and the emphasis on the beneficial effects of balneotherapy on osteoarthritis (most of the pathologies treated here are osteoarthritis). In the spa treatment bases, along with thermal water, other procedures are used that enhance the effect of these waters (physiotherapy, TENS (transcutaneous electrical nerve stimulation), TCARE (capacitive and resistive electrical transfer), therapeutic massage, lymphatic drainage massage, ultrasound, electrotherapy, low frequency electromagnetic pulse therapy, galvanic baths, paraffin wraps, laser therapy). The main pathologies treated by the mentioned procedures are inflammatory rheumatic diseases, neuromuscular diseases.

Keywords: thermal water, balneotherapy, arthropathy, Băile 1 Mai.

1. INTRODUCTION

Bihor County has many locations where thermo-mineral waters are used for bathing or for leisure. In this study, we focus on the spas in Bihor County (Băile

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Felix, Băile 1 Mai, Băile Tinca, Stâna de Vale), where these waters have been used for a long time and which have the necessary infrastructure for therapy. We have also added the village of Sarcău, after the year 2010, it has witnessed a strong development of tourism and spa infrastructure (Fig. 1).

Because thermo-mineral waters in Bihor County have been known for a long time, there are numerous studies on: thermal aquifer systems (Țenu, 1975, 1981; Cohut, 1986; Gilău et al., 2001; Páal, 2013; Orășanu, 2016; Borodi, Nemet, 2016) or the spa tourism phenomenon (Czaran, 1903; Marușca, 2008; Gaceu et al., 2009; Ilieș et al., 2011; Marian, 2012; Teodoreanu, Gaceu, 2013; Herman, Tătar, 2015; Vlaicu et al., 2016; Tatar et al., 2018).

Thermo-mineral waters come from geothermal deposits and are the main natural curing factor, along with lakes, therapeutic muds and therapeutic gases. Balneotherapy (thermo-mineral water bath) is a type of therapy that aims to reduce pain and improve daily functioning (Verhagen et al., 2015). Balneotherapy for patients with osteoarthritis is one of the oldest forms of therapy (Verhagen et al., 2008). Osteoarthritis is a degenerative disease of the joints marked by degeneration of articular cartilage, bone hypertrophy at the edges and changes in the synovial membrane (Solomon, 1997). Osteoarthritis is one of the most common forms of arthropathy and affects men and women alike. For many adults, osteoarthritis is one of the leading causes of long-term disability (Solomon, 1997).

There is currently no cure for osteoarthritis, and therefore treatment often focuses on managing symptoms such as pain, stiffness and mobility. Treatment options include pharmacological interventions, physiotherapy or balneotherapy treatments. Immersion in mineral water is the main balneological method in spa therapy programmes. Clinical studies in Europe, Turkey and Israel have shown the clinical benefits of balneotherapy in several pathologies related mainly to rheumatic and musculoskeletal disorders and dermatological diseases (Naumann and Sadaghiani, 2014; Kardes et al., 2019; Kamioka et al. 2020). However, the mechanisms by which balneotherapy can improve patients' clinical symptoms have been less documented in the literature. There is some evidence from preliminary studies that suggests that balneotherapy has an influence on physiological mechanisms, the immune system, inflammation and oxidative stress (Fioravanti et al. 2012).

Any joint can be affected by osteoarthritis. However, due to the mechanism by which this pathology occurs, the most prone joints are those that are intensely and continuously used, such as the knee, hip and intervertebral joints.

In Europe, spa therapy is often prescribed for knee osteoarthritis. Forestier et al. (2010) show a study of 451 patients with osteoarthritis of the knee usually without balneotherapy. Future studies investigating the clinical efficacy, safety profile and possible mechanisms of action of regional balneotherapy are needed to better understand the role of balneotherapy and whether it has local differences.

In this study, we aim to highlight the peculiarities of thermo-mineral waters, present the balneotherapy procedures used and highlight the beneficial effects of balneotherapy on osteoarthritis in Băile 1 Mai resort.

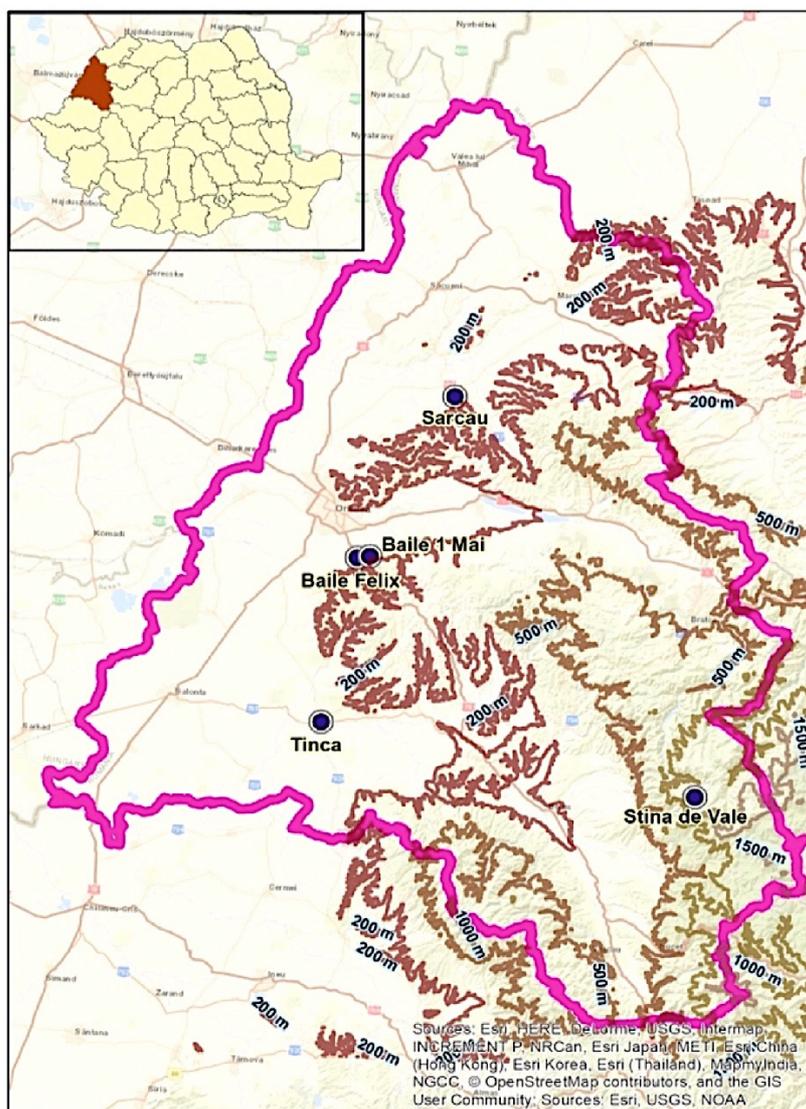


Fig. 1. The position of the studied localities in Bihor county

2. DATA AND METHODS

In order to carry out this study, data was collected from bibliographic sources, but also from the field, respectively from the Băile 1 Mai resort - The spa treatment and recovery of work capacity Company - where the patient register and the annual balance register for an 11-year period (2010-2020) were analysed.

The field observation method was also applied to gather information. The method of comparison, was used to draw a parallel between the particularities of the thermo-mineral waters, the balneotherapeutic procedures and the pathologies treated in each

resort. The cartographic method served to represent data graphically. In addition, for the processing of data obtained from patient records and annual balance sheets, the statistical method was applied, using Excel. As a temporal typology, it is a retrospective study in which the existing data concerning the properties of thermomineral waters, the balneological procedures used and the pathologies treated with the balneological procedures were analysed.

3. RESULTS AND DISCUSSIONS

Following the analysis of the test reports (carried out by the National Institute of Recovery, Physical Medicine and Balneotherapy), but also the study of bibliographic resources (Gilău et al., 2001, Marușca 2008, Teodoreanu, Gaceu, 2013) it results that thermo-mineral waters from Bihor county present various pharmacodynamic actions and therapeutic indications. The physical-chemical peculiarities of the thermal waters from the study locations are briefly presented below.

3.1. Physical-chemical features and therapeutic indications of thermo-mineral waters

Băile Felix. The chemical composition of the thermal water in the Băile Felix area is recommended as oligomineral, but it contains small amounts of bicarbonates, sulfates and calcium and is weakly radioactive (0.37 millimicroCurie/l), with a mineralisation of 825.5 l g/l and a temperature of 40° C.

Băile 1 Mai. The thermal water from Băile 1 Mai has approximately the same properties as those from Băile Felix, coming from the same geothermal deposit.

Băile Tinca. They have springs with alkaline, calcium, magnesium, sodium, low carbon dioxide, hypertonic thermo-mineral waters (with osmotic concentration over 325 mOsm). According to the analysis / test report for 2021, the chemical composition of the water is varied, having a rich content of active substances necessary for the body: chlorine (404.3 mg / l), sulfates (5.1 mg / l), bicarbonate (2470.5 mg / l), sodium (1105.8 mg / l), potassium (19.0 mg / l), calcium (25.6 mg / l). The mineralization of this water is 4090.5 mg / l, and the water temperature is 14°C. The waters from Băile Tinca are administered both externally and internally (crenotherapy, aerosols).

Sarcău. Mineral water from Sarcău is very concentrated in: chlorine, potassium, bromine, calcium, iodine, magnesium, bicarbonate, iron, sodium and other minerals in small quantities. It is also hypotonic (with an osmotic concentration below 325 mOsm) and hyperthermal (temperature above 40°C).

Stâna de Vale. This resort has oligomineral, hypotonic, non-radioactive waters, with a mineralisation varying between 92 -202 mg/l (Orășeanu, 2016).

The chemical effect of thermo-mineral waters is highlighted by the absorption of trace elements from mineralized water through the skin and the modulation of the immune system (Halevy et al., 2001). Depending on the specifics and endowments of the treatment bases, the therapeutic indications of thermo-mineral waters are for

several pathologies (Table 1). Thus, in Bihor County, all types of rheumatic diseases and post-traumatic diseases of the musculoskeletal system are treated in all spas, except Stâna de Vale, where the therapeutic indications of the waters refer to endocrine, respiratory, anemia or asthenia (Vlaicu et al. 2016).

Table 1. Therapeutic indications of thermo-mineral waters in the spas of Bihor County

Treated pathologies	Băile Felix	Băile 1 Mai	Băile Tinca	Sarcău	Stâna de Vale
Degenerative rheumatic diseases	✓	✓	✓	✓	
Inflammatory rheumatic diseases	✓	✓	✓	✓	
Abarticular rheumatic diseases	✓	✓	✓	✓	
Post-traumatic disorders of the musculoskeletal system	✓	✓	✓	✓	
Neurological disorders	✓	✓	✓		
Neuromuscular disorders, conditions associated with metabolic disease	✓	✓			
Gynaecological condition (chronic metroanexitis, minor puberty or menopausal disorders)		✓			
Chronic gynaecological disorders (pelvic inflammatory disease)			✓	✓	
Digestive tract disorders			✓		
Infertility			✓		
Hepatic-biliary disorders			✓		
Endocrine disorders					✓
Asthenic neurosis					✓
Respiratory disorders	✓	✓	✓		✓

As a way of administering thermo-mineral waters, they are used both in the external treatment in the form of baths and in the internal treatment in the form of inhalations, aerosols, and crenotherapy. Thus, in all five locations, the thermo-mineral water, respectively oligomineral water (Stâna de Vale), is administered in the external treatment, and in two of them (Stâna de Vale and Tinca), it is also administered internally (Table 2).

Table 2. Administration of thermal and mineral waters

Location	External treatment	Internal treatment (crenotherapy, inhalations, aerosols)
Băile Felix	✓	
Băile 1 Mai	✓	
Băile Tinca	✓	✓
Sarcău	✓	
Stâna de Vale	✓	✓

3.2. The balneotherapeutic procedures used

The use of the natural therapeutic factor in medical supervision is accompanied by a series of procedures to maximize the therapeutic effects towards an increase in the quality of life of patients.

In each treatment base in the Bihor resorts, balneotherapy, physiotherapy, therapeutic massage and electrotherapy are used as common treatment procedures. In addition, depending on the specifics of the resort or the related endowment, other procedures are used (Table 3).

Table 3. Balneotherapeutic procedures used

The balneotherapeutic procedures used	Băile Felix	Băile 1 Mai	Băile Tinca	Sarcău	Stâna de Vale
Physiotherapy	✓	✓	✓	✓	✓
Balneotherapy	✓	✓	✓	✓	
Hydro-physiotherapy	✓	✓			
Therapeutic massage	✓	✓	✓	✓	✓
Ultrasound therapy	✓	✓	✓	✓	
Electrotherapy	✓	✓	✓	✓	✓
Low frequency electromagnetic pulse therapy	✓	✓	✓	✓	✓
Galvanic baths	✓	✓	✓		
Ionisations	✓	✓			
Paraffin wraps	✓	✓	✓	✓	
Lymphatic drainage massage	✓	✓	✓	✓	
TENS (transcutaneous electrical nerve stimulation)	✓	✓	✓		
TCARE (capacitive and resistive electrical transfer)	✓	✓	✓		
Mineralised mud wraps	✓	✓	✓		
Shockwave therapy				✓	
Aerosol	✓	✓	✓		
Saline		✓	✓		
Occupational therapy	✓	✓	✓		
Robotised therapy - (Lokomat, Reo-Go, Hand of Hope)	✓				
Robotic re-education of the lower limbs therapy		✓			
Multi-sensor stimulation therapy		✓			

3.3. Pathologies treated through balneological procedures at Băile 1 Mai resort

From the annual balance sheets analysed at the Spa Treatment and Work Capacity Recovery Company from Băile 1 Mai, it resulted that in the period 2010 – 2020, a number of 131,875 patients benefited from spa treatments. The highest number of patients treated (13,515) was recorded in 2016, and the lowest number (5,252 patients) was recorded in 2020, due to the state of emergency and the state of alert determined by the epidemiological situation created by SARS-CoV-2 (Fig. 2).

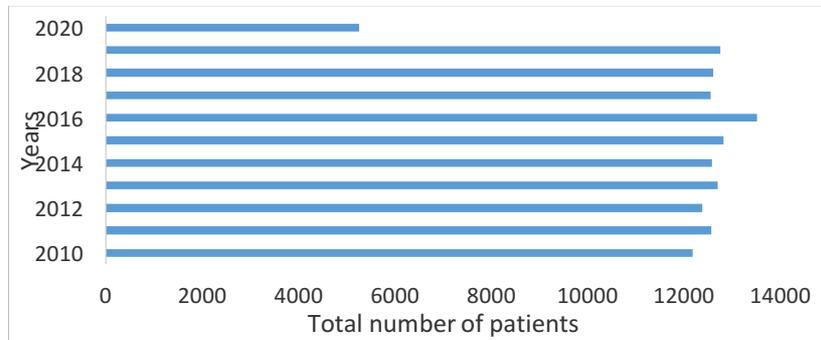


Fig. 2. Annual number of patients treated at the Spa Treatment and Work Capacity Recovery Company from Băile 1 Mai between 2010 and 2020

Regarding the categories of beneficiaries of spa treatment according to the type of treatment tickets (Fig. 3), the beneficiaries of treatment tickets settled by the National House of Public Pensions (80,182 patients) are the most important, which highlights the social character of the type of tourism practiced. A much lower percentage is found in patients who are treated on their own and on an outpatient basis.

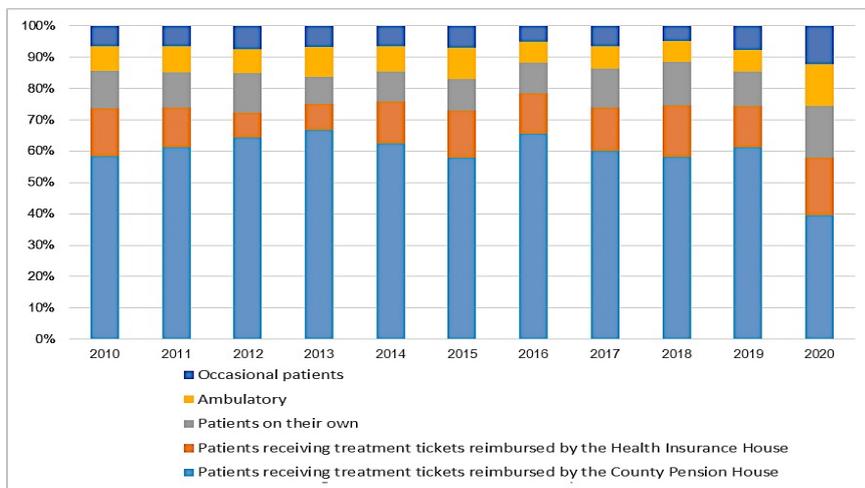


Fig. 3. Categories of patients per type of treatment tickets at the Spa Treatment and Work Capacity Recovery Company from Băile 1 Mai

As an environment of origin of patients, there is a high share of those from urban areas (61%). As an area of origin, probably due to the “shady” position towards Băile Felix, which has the status of an international resort, the patients from Băile 1 Mai come mostly from Romania.

The pyramid of the ages and gender of patients treated at the Company for Spa Treatment and Recovery of Work Capacity from Băile 1 Mai (fig. 4), indirectly highlights a link between the age of the patients and the pathologies treated with thermo-mineral waters.

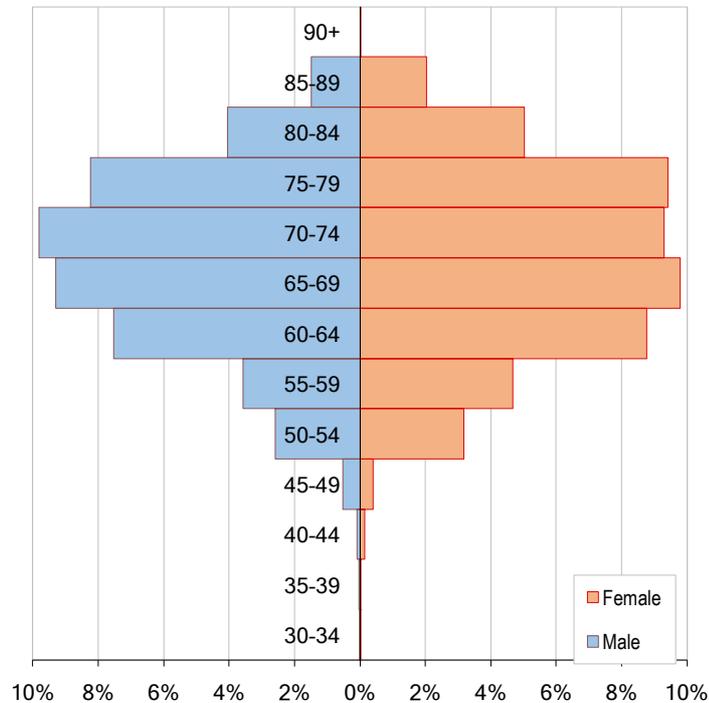


Fig. 4. Age and gender pyramid of patients per type of treatment tickets at the Spa Treatment and Work Capacity Recovery Company from Băile 1 Mai

Similar to the age pyramid for Romania (<https://chart-studio.plotly.com/~andreiste/25.embed>) resulted in a bell-shaped pyramid (urn) with a base of ages in compression and thickening of the tip. This pyramid belongs to the descending type, dominated by the elderly (exactly the adult age group that often needs interventions for spa or other treatment). The highest share belongs to the age group 65-69 years for women (26.51%) and 70-74 years for men (29.61%). It is also noted that there are age groups in the category of mature-young population (30-40 years old) who resort to spa treatments, but their number is very low.

The pathologies treated with spa procedures at the Company for Spa Treatment and Recovery of Work Capacity in Băile 1 Mai are grouped into several categories. Of these, osteoarthritis (degenerative rheumatic diseases) are the most common

(52% of the total) and metabolic diseases are the least common (1%) (Fig. 5). Of the types of osteoarthritis treated at the Company for Spa Treatment and Recovery of Work Capacity in Băile 1 Mai, the most common is knee osteoarthritis (31%), followed by spondylodiscartrosis (30%) (Fig. 6)

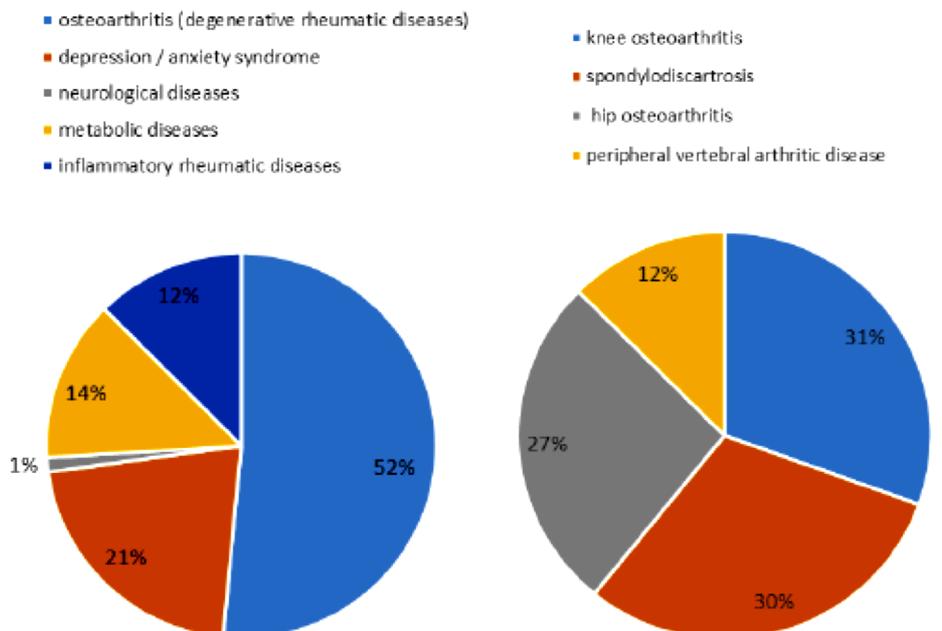


Fig. 5. Categories of pathologies treated at the Company for Spa Treatment and Recovery of Work Capacity in Băile 1 Mai

Fig. 6. Types of arthrosis treated at the Company for Spa Treatment and Recovery of Work Capacity in Băile 1 Mai

3.4. The positive effects of balneotherapy on arthritis

Balneotherapy is one of the most commonly used non-pharmacological approaches to osteoarthritis in many European countries. It is a complementary therapy that generally uses mineral and/or thermal waters from natural springs, peloids and other traditional remedies, for the treatment of various pathological diseases (Cheleschi, 2020). Several clinical studies have reported beneficial effects of this approach for the prevention, treatment, and rehabilitation of various rheumatic conditions, such as osteoarthritis (Forestier et al. 2010; Masiero et al. 2018), fibromyalgia (Naumann and Sadaghiani 2014; Fioravanti et al. 2018), back pain (Karagülle and Karagülle 2015; Yücesoy et al. 2019), rheumatoid arthritis (Santos et al. 2016) and other chronic inflammatory rheumatic diseases (Cozzi et al. 2018).

Osteoarthritis continues to be one of the leading causes of “years of disability” worldwide, a public health problem that is likely to increase in the future as the population ages (Forestier et al., 2016). It is a chronic disease that affects the joints, such as the hands,

knees and hips, causing considerable pain, increased disability and progressive degeneration of cartilage (Bijlsma et al., 2011). Being the most common type of arthritis, osteoarthritis is the leading cause of decreased function and quality of life (Wu et al., 2019). The incidence of osteoarthritis is increasing due to the aging population, but also due to the increased occurrence of obesity (Bijlsma et al., 2011).

According to the World Health Organization (2013), a total of 9.6% of men and 18.0% of women over the age of 60 suffer from symptomatic osteoarthritis. Combination therapy is recommended for the treatment of osteoarthritis, using both pharmaceutical and non-pharmaceutical measures, which aim to relieve pain, slow the progression of the disease and improve or compensate for impaired movement function (Bruyère et al., 2014). The most commonly recommended non-pharmaceutical treatment measures are: physiotherapy, weight correction, orthopedic or technical measures, electrostimulation or treatment with other physical agents (Cutolo et al. 2015; McAlindon et al. 2014).

Natural factors such as balneotherapy have been increasingly mentioned in the literature as a treatment for musculoskeletal disorders (Karagülle and Karagülle 2015, Verhagen et al. 2015). Studies show that balneotherapy is usually prescribed for osteoarthritis in the clinical practice of many countries in Europe and the Middle East (Bouvier, 2013; Lieber, 2013).

The multicentre study of Forestier et al. (2010) found more patients with knee osteoarthritis with a clinically relevant improvement after balneotherapy and home exercise than after home exercise alone (Forestier, 2014). The results were similar for a subgroup of patients with generalized osteoarthritis (Forestier, 2014). The improvement was significant for pain and functionality at 3, 6, and 9 months (Forestier et al., 2016). The treatment consisted of hot mineral water baths, mud therapy, hot showers and sometimes supervised massage and exercise in the water.

Fioravanti et al. (2012) found that a mineral water bath was superior without treatment (waiting list) at 2 weeks and 3 months for pain, functionality and quality of life for knee osteoarthritis. In a previous study, Fioravanti et al. (2010) also showed the beneficial effects of crenobalneotherapy (mud baths and mineral water bath) for pain, functionality, stiffness and quality of life for knee osteoarthritis. They observed a significant improvement in all parameters assessed at the end of the spa therapy cycle, which persisted throughout the follow-up period (9 months).

The persistence over time of the beneficial effects of balneotherapy was also demonstrated in the study of Karagülle et al. (2007) showing a superiority for the mineral water bath over the usual drug treatment under the doctor's evaluation at 12 and 24 weeks. These positive results could be partly explained by a surprising deterioration in the control group, which only used prescription drugs.

The effects of balneotherapy on hip osteoarthritis show improvements in pain, physical function and quality of life (Kovacs et al. 2016; Hanzel et al. 2019). Thus, Kovacs et al. (2016) shows that patients who received balneotherapy combined with physical therapy for 3 weeks, 3 times a week, obtained a significantly better functional score than those who followed only a physical therapy program. Stiffness and pain decreased in all patients, but the difference was large between the two

groups. After 12 weeks, the quality of life index was significantly higher in the group that also benefited from balneotherapy. The mineral water used in the study is one of the mineral waters with the highest sulphur ion content (13.2 mg /l) in Hungary. Hanzel et al. (2019), conducted a study in which patients received a 30-minute treatment with thermal water (34° C) in a bathtub, 5 times a week for 3 weeks. At the end of the study period, joint mobility increased in all directions of movement, pain decreased significantly, functional index increased and quality of life index improved significantly. The improvements were both short-term and long-term.

Regarding the effects of balneotherapy on arthritis of the hand, spine, shoulder joints, revised studies reported that thermal water, mineral water, spa therapy combined with physiotherapy significantly reduces pain, improves functionality, increases muscle strength and range of motion in the short term and long-term (Matsumoto, 2018).

Despite the beneficial effects of balneotherapy, demonstrated by studies, in patients with osteoarthritis, the mechanisms of action of the related methods remain unclear. The positive effects of thermal and mineral waters are related to their physical and chemical properties, such as temperature, salt composition and concentrations, osmotic pressure and electrical conductivity (Fioravanti et al. 2017; Morer et al. 2017). These particular characteristics make it difficult to understand the mechanisms of action of balneotherapy and to analyze the biological role of the various components. It has been shown that the organic components of hot springs have biological effects contributing to the healing mechanisms, but their medical significance is not yet fully understood (Varga, 2012).

Thermal water is generally used at a temperature between 34° C and 36° C (Becker 2009; Gutenbrunner et al., 2010). The most important mechanisms that explain the effectiveness of balneotherapy in the treatment of patients with osteoarthritis are the thermal, mechanical and chemical effects. The thermal effect is a consequence of the heat. The application of heat causes increased blood flow and vasodilation, resulting in a supply of fresh blood and the elimination of nociceptive elements and oxygen free radicals. As a result, heat improves the repair of inflamed tissue (Nasermoaddeh Kagamimori, 2005). The heat induces sedation and muscle relaxation and increases joint mobility. Maintaining the analgesic effect is also due to muscle relaxation (Kuczera and Kokot, 1996).

The hydrostatic force brings relative pain relief by reducing the load (Becker 2009), the water reducing the severity in the painful and rheumatic joints. This mechanical effect increases as the water becomes more concentrated. Heat and water buoyancy can block nociception by acting on thermal receptors and mechanoreceptors (Bender et al., 2005). In addition, the hydrostatic pressure generates fluid movement from the extremities to the trunk, causing hemodilution and diuresis. Apart from these chemical, mechanical and thermal mechanisms, the psychological mechanisms of the spa environment should not be underestimated. Associated mental relaxation may also play a role in relieving pain (Brosseau et al., 2002).

The same has been observed in previous studies (Forestier, 2010; Bender et al. 2014; Péter et al. 2017; Fioravanti et al. 2018), where it was also stated that

balneotherapy has some beneficial effects on antioxidant status and metabolic and inflammatory parameters. Also, Tianwen et al., (2021), highlights that thermal mineral water therapy has been widely used to treat various joint diseases and has been reported in clinical trials of osteoarthritis of the knee, hip and hand.

Following the analysis of the patient registry and the centralization of balneotherapy procedures used in the resorts of Bihor County, it was found that thermo-mineral water has beneficial effects in degenerative and inflammatory rheumatic pathologies, post-traumatic musculoskeletal disorders, neurological and metabolic disorders, but the largest share they have it in degenerative rheumatic diseases.

4. CONCLUSIONS

The therapeutic character of the thermo-mineral waters from the studied locations is determined by the biological effects of the physico-chemical properties that contribute to the healing mechanisms.

Both the balneotherapeutic procedures used in accordance with the particular characteristics of the resort and the endowments of the treatment facilities are factors that contribute to the improvement of the quality of life for patients with osteoarthritis, through the analgesic effects and an improvement of the articular function. The most common pathologies treated through bathing procedures are degenerative rheumatic diseases, of which those located at the knees (knee osteoarthritis), followed by spondylodiscarthrosis and hip osteoarthritis are the most noteworthy.

Achieving the positive effects of balneotherapy depends on the type and intensity of the stimuli applied, on the body's reactivity, individual sensitivity, the presence of other diseases and genetically determined enzyme systems. Thermal mineral water therapy is a safe way to relieve pain, improve physical function and quality of life in patients with osteoarthritis.

The beneficial effects of balneotherapy on osteoarthritis are reported by studies that have shown a clinically relevant improvement after balneotherapy. This also results from the large number of patients with this pathology in the period 2010-2020, treated at the Society for Spa treatment and recovery of work capacity in Băile 1 Mai resort.

During this period, the number of patients treated at the Company for Spa Treatment and Recovery of work capacity in Băile 1 Mai resort was relatively similar (between 12,179 and 13,515 patients), with the exception of 2020, when the number of patients treated plummeted (5,252 patients) due to the pandemic situation of COVID-19, which led to a state of emergency and/or alert that required serious restrictions on travelling, meetings between groups of people, social distancing, and etc.

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