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The influence of whole body cryotherapy on the functional efficiency in patients with spondyloarthritis of the lumbar spine

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The influence of whole body cryotherapy on the functional efficiency in patients with spondyloarthritis of the lumbar spine

Abstract

Background: Osteoarthritis (OA) is considered as the most common disease affecting mankind. The aim of the study was to present the impact of whole body cryotherapy (WBCT) together with kinesiotherapy (KT) and with KT alone on functional efficiency in patients with OA. Material and methods: The study group consisted of 120 patients. They were randomly divided into two groups. Patients from the study group underwent a series of WBCT combined with KT, while patients from the control group underwent KT alone. Each patient was examined before and after the therapy by VAS, ODI and functional tests. Results: After the therapy the VAS decreased by 33% in both study groups. Functional efficiency improved by 17% (ODI) in the study group, while in the control group by 10% ($p < 0.0001$). The Schöber test result increased after the therapy in the study group by 0.32 ± 0.1 cm, while in the control group by 0.4 ± 0.1 cm. In the Thomayer test spinal ROM increased after the therapy by 3.09 ± 0.1 cm in the study group and increased by 2.63 ± 0.1 cm in the control group ($p < 0.0001$). Conclusion: WBCT as well as kinesiotherapy decreases LBP and slightly increases lumbar spine ROM. Improvement in functional efficiency measured by ODI was higher in patients after WBCT combined with kinesiotherapy.

Keywords

osteoarthritis, low back pain, functional efficiency

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Authors' Contribution:

- A Study Design
- B Data Collection
- C Statistical Analysis
- D Data Interpretation
- E Manuscript Preparation
- F Literature Search
- G Funds Collection

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abstract

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Results: After the therapy the VAS decreased by 33% in both study groups. Functional efficiency improved by 17% (ODI) in the study group, while in the control group by 10% ($p < 0.0001$). The Schöber test result increased after the therapy in the study group by 0.32 ± 0.1 cm, while in the control group by 0.4 ± 0.1 cm. In the Thomayer test spinal ROM increased after the therapy by 3.09 ± 0.1 cm in the study group and increased by 2.63 ± 0.1 cm in the control group ($p < 0.0001$).

Conclusions: WBCT as well as kinesiotherapy decreases LBP and slightly increases lumbar spine ROM. Improvement in functional efficiency measured by ODI was higher in patients after WBCT combined with kinesiotherapy.

Key words: osteoarthritis, low back pain, functional efficiency, whole body cryotherapy.

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INTRODUCTION

Osteoarthritis (OA) is considered as the most common disease affecting mankind. The incidence of spondyloarthritis in the US is estimated at 40–85% of the population aged 65 and over (27 million people) [1–3]. Spinal pain associated with this disease occurs in 80% of the American population. Similar occurrence of spinal pain was noted in the Polish population. Experts estimate that 70% of the population over 30 years of age had one or more incidents of lower back pain (LBP), while among people over 40 years, the incidence of the symptoms of LBP affected about 66% of men and 30% of women [4].

According to the American College of Rheumatology (ACR), the diagnosis of osteoarthritis based on fundamental symptoms of the disease, such as the occurrence of LBP, morning stiffness (lasting up to 30 minutes), creaks during movement, limitation of ranges of spinal motion (ROM) and reduction of muscle strength. The occurrence of degenerative spine disease leads to limitation of patients functional efficiency [2].

There are many methods of LBP treatment including: pharmacological and surgical procedures, as well as systems of therapeutic exercises, manual and physiotherapeutic procedures [5]. Transcutaneous electrical nerve stimulation (TENS), ultrasound therapy (UD), iontophoresis, diadynamic currents (DD), interference currents, magnetotherapy, laser therapy, hydrotherapy, massage, as well as heat therapy, local and whole body cryotherapy (WBCT) are commonly used to manage LBP [6–14].

Low temperatures applied in cryochamber produces many physiological changes in the organism. The described effects of WBCT include: analgesic, anti-inflammatory, anti-swelling, relaxing effects and improvement in the spine ROM [15,16]. In addition to physiotherapeutic procedures, healing exercises are of significant importance in the rehabilitation of patients with spondyloarthritis. Physiotherapy procedures used in the treatment of LBP resulted in the reduction of the burden on articular surfaces, increase in the strength and muscle mass of the abdominal and lumbar muscles in maintaining spinal motion, as well as in the correction of posture. Reduction in the load on articular surfaces could be achieved by a decrease in body weight in overweight patients. An important element of kinesiotherapy should be sensorimotor exercises [17–18].

The aim of the study was to present the impact of WBCT together with kinesiotherapy and kinesiotherapy alone on functional efficiency and subjective pain feeling in patients with OA of the lumbar spine.

MATERIAL AND METHODS

120 patients with diagnosed spondyloarthritis of the lumbar spine participated in the study. Patients were randomly divided into two groups: group A and group B. Patients from group A underwent a series of WBCT followed by a series of therapeutic exercises, while patients from group B underwent a series of therapeutic exercises only. The mean age in both study groups was similar (59 ± 8 years in group A and 60 ± 8 years in group B). A positive opinion of the Bioethical Commission of the Jagiellonian University was obtained (KBET/147/B/2014).

Before and after the series of WBCT and a series of therapeutic exercises, each patient completed a questionnaire using the visual-analog scale (VAS) and the functional efficiency index such as: Oswestry Disability Index (ODI). Functional tests were used to examine the lumbar spine range of motion in both study groups (Thomayer test, Schöber test).

RESULTS

The results of statistical analysis using the Wilcoxon test indicate that after a series of WBCT combined with therapeutic exercises (patients from group A), as well as after a series of therapeutic exercises without WBCT (patients from group B), the average point value of subjective lumbar spine pain expressed as VAS decreased in comparison to the value obtained before the therapy by 33% in respondents from both groups. In both groups, the median value (median) of back pain was 6 ± 2 points before the therapy, and after the therapy it was reduced to 4 ± 1 points (Fig. 1).

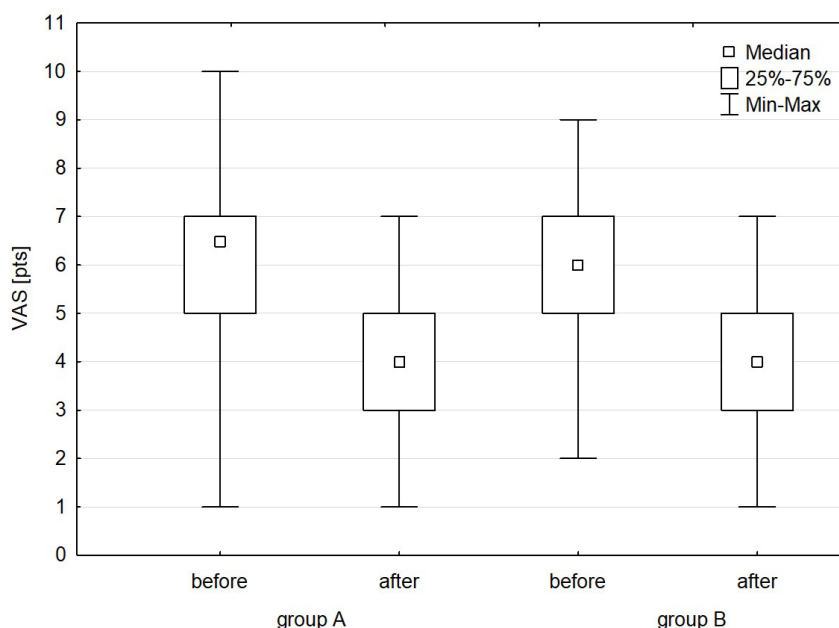


Fig. 1. The subjective feeling of low back pain expressed in the VAS before and after the a series of WBCT combined with therapeutic exercises (group A) and therapeutic exercises used without WBCT (group B)

The results of the examinations determining the functional efficiency of patients with back pain carried out with ODI indicate that after the physiotherapeutic procedure, the functional capacity of the respondents from both groups improved. The beneficial effects of the treatments were expressed as a decrease in the total ODI values measured after the end of the therapy as compared to the baseline values noted in patients from both study groups, with a slightly higher improvement in group A obtained with WBCT and therapeutic exercises.

In group A, the ODI index decreased from 30 ± 9 points before a series of WBCT to the value of 25 ± 8 points after the treatment. In group B this value decreased from 31 ± 11 points before the series of therapeutic exercises to 28 ± 9 points after kinesiotherapy alone (Fig. 2).

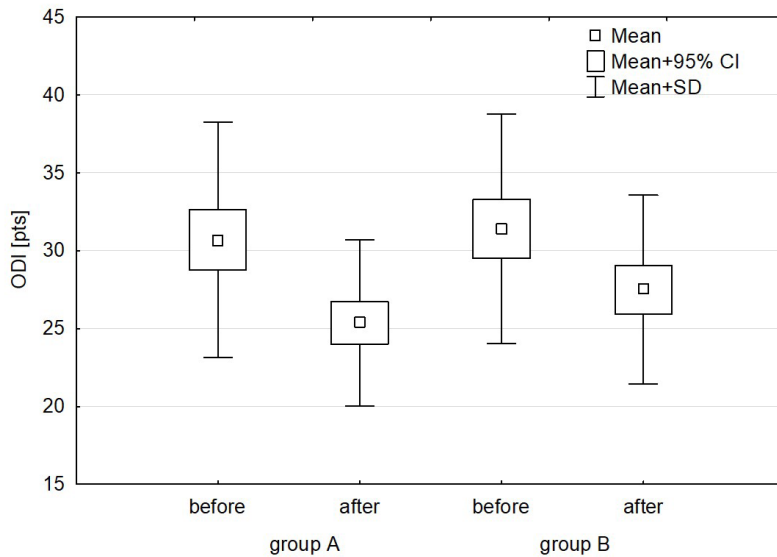


Fig. 2. Point values of the ODI index before and after a series of WBCT combined with therapeutic exercises (group A) and therapeutic exercises without whole body cryotherapy (group B)

In group A, patients improved their functional efficiency by 17%, while in group B by 10%. In both groups, these changes were statistically significant (p-value was less than 0.0001).

In patients from group A, the average lumbar spine flexion range assessed by the Schöber test before WBCT combined with therapeutic exercises was 2.16 ± 0.2 cm, whereas after treatment this value increased to 2.48 ± 0.1 cm. In group B, the mean range of lumbar spine flexion before the series of therapeutic exercises was 1.9 ± 0.1 cm, and after kinesiotherapy - 2.3 ± 0.1 cm (Fig. 3).

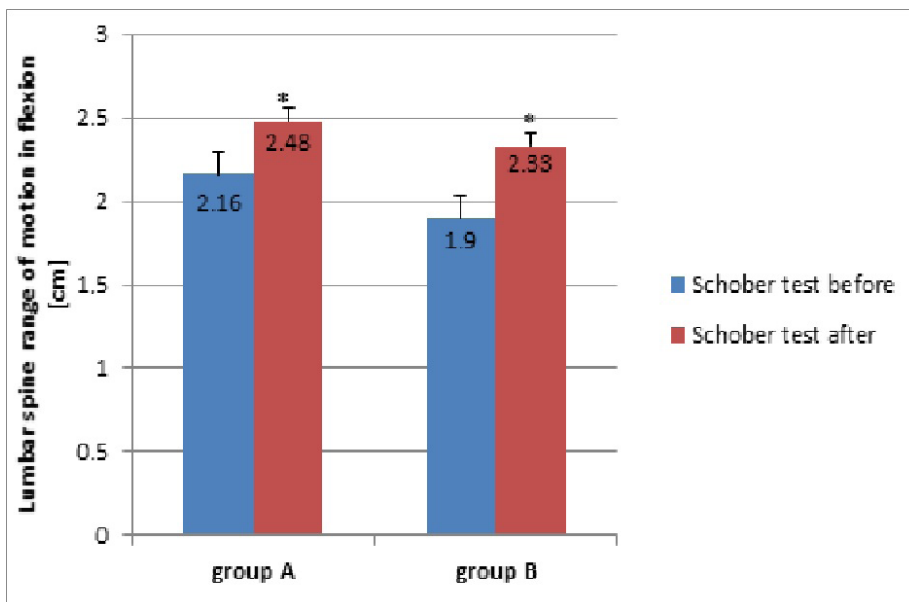


Fig. 3. The average range of lumbar spine flexion is assessed by the Schöber test before and after a series of WBCT combined with therapeutic exercises (group A) and therapeutic exercises used without WBCT (group B)

In group A, the mean value of the extension of lumbar spine before WBCT combined with therapeutic exercises was 1.28 ± 0.1 cm, while after the therapy this value increased to 1.75 ± 0.1 cm. The mean numerical value for spine extension measured in patients from group B before kinesiotherapy was 1.15 ± 0.1 cm, while after a series of therapeutic exercises this extension averaged 1.45 ± 0.1 cm (Fig. 4).

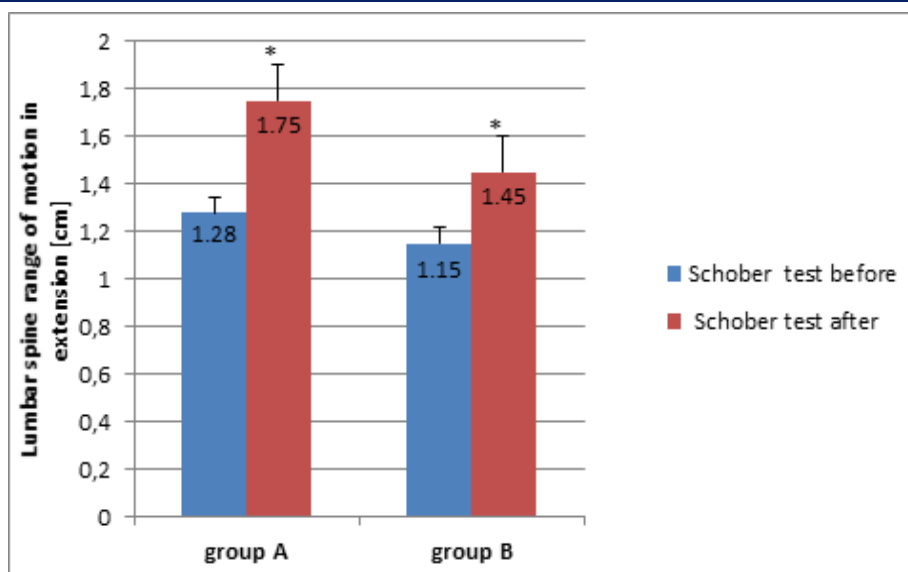


Fig. 4. The average range of lumbar spine extension is assessed by the Schöber test before and after the series of WBCT combined with therapeutic exercises (group A) and therapeutic exercises used without WBCT (group B)

The abovementioned slight improvement in the ranges of flexion and extension of the lumbar spine measured in standardized conditions in patients from both groups (A and B) was statistically significant ($p \leq 0.05$).

After a series of WBCT combined with therapeutic exercises (group A) and after a series of therapeutic exercises without WBCT (group B), an increase in the spine range of motion measured by the Thomayer test (f-f test) was observed. In group A, the average value of the finger tips distance from the floor before the series of WBCT was 10.97 ± 0.2 cm, while after the therapy it decreased to 7.88 ± 0.1 cm. In patients from group B the average distance of the fingers tips from the floor was 9.48 ± 0.2 cm before kinesiotherapy, while after a series of exercises it decreased to 6.85 ± 0.1 cm (Fig. 5). In both study groups, the improvement in the range of spinal motion was highly statistically significant ($p < 0.0001$).

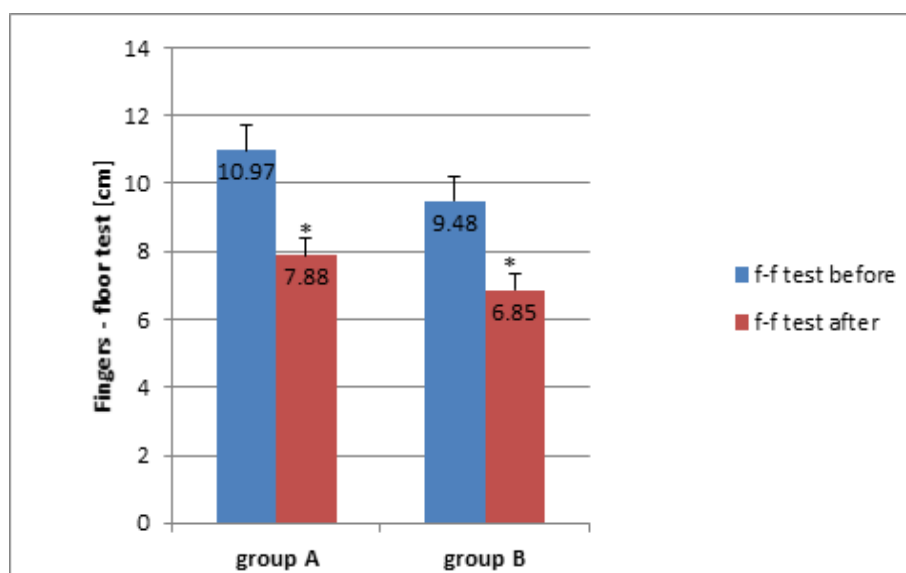


Fig. 5. Average distance measured by the Thomayer test before and after a series of WBCT combined with therapeutic exercises (group A) and therapeutic exercises used without WBCT (group B)

DISCUSSION

The results of the present study have proved that WBCT is a therapeutic treatment that effectively reduces pain in degenerative disease of the lower spine. The level of subjective feeling of back pain assessed with the VAS scale decreased by 33% after the applied physiotherapeutic treatment in patients undergoing WBCT combined with kinesiotherapy. However, similar pain reduction of 33% was also observed in patients of group B, in whom only therapeutic exercises were used. This observation is in agreement with previous results of our study, which have indicated that, in patients with LBP, treatment with WBCT reduced the pain intensity in 38% of respondents [19].

Studies comparing the effectiveness of systemic cryotherapy combined with kinesiotherapy in the treatment of osteoarthritis of peripheral joints indicate that these treatments significantly reduced the pain of joints, increased the range of spine motion and improved functional efficiency [17]. Confirmation of such beneficial effects of systemic cryotherapy in patients with osteoarthritis of the lumbar spine can be found in previous publications [20, 21].

It was observed in current studies that after a series of WBCT, LBP was reduced, which was accompanied with an improvement in functional efficiency, assessed by ODI. Pain in the spine associated with everyday activities, appeared less frequently, and its severity decreased after WBCT. This improvement was noted in both groups of patients; in these undergoing WBCT combined with therapeutic exercises, as well as in patients with therapeutic gymnastics alone. Between these groups of patients there were no statistically significant differences regarding the effects of physical procedures. Based on these results, it can be assumed that both WBCT and the therapeutic exercises themselves had a positive effect on the functional efficiency in the subjects with osteoarthritis of the lumbar spine. The beneficial effect of WBCT regarding the reduction of LBP in these patients was also documented in publications of other authors [19].

WBCT as well as therapeutic exercises caused a reduction of back pain occurring during everyday activities and limiting the efficiency of patients. To assess this functional efficiency, the ODI questionnaire was used as a reliable tool mentioned in previous scientific publications [22, 23]. The results of the present study indicated that after the WBCT treatment, a significant reduction in lower back pain occurred, and activities such as walking, lifting weights, standing were performed without such pain. Nocturnal back pain was also significantly reduced. Similar efficacy of WBCT with respect to improvement of the functional efficiency of patients with spondyloarthritis was also documented in our previous studies [19, 24].

In the current studies, it was found that in group A patients (subjected to systemic cryotherapy combined with therapeutic exercises) improvement in functional efficiency measured by ODI was 17%, while in group B (in which the kinesiotherapy was applied), the improvement was lower and was 10%. The beneficial effects of low temperatures on the body are related to the direct impact of these temperatures on diseased tissues and excessively strained muscles. It has been proved that exposure to cryogenic temperatures leads to a decrease in neuromuscular spindles excitability and to a reduction in muscle tone [25].

During the research it was observed that after a series of WBCT treatments and a series of therapeutic exercises, there was also a slight improvement in the ranges of lumbar spine mobility assessed by the Schöber test and the fingers-to-floor test. This improvement could be associated with the relaxation of excessively tensed paraspinal muscles and as the result of reduction in LBP. The beneficial effects of WBCT with respect to the improvement of the spine range of motion and the associated reduction in pain was also documented in the numerous publications of other authors [10-12, 20, 25-28].

In patients with spondyloarthritis, there was a significant improvement in the spine range of motion and statistically significant pain reduction assessed by the NRS scale and the Modified Laitinen Pain Rating Questionnaire as a result of a series of WBCT and therapeutic exercises [25]. Patients with ankylosing spondylitis have also demonstrated the effectiveness of WBCT in terms of improving the range of motion and the fight against back pain. It was observed that systemic cryotherapy combined with therapeutic exercises is more effective than the kinesiotherapy itself in these patients [10, 29, 30].

CONCLUSIONS

In patients with OA of the lumbar spine, WBCT in a cryochamber combined with therapeutic exercises, as well as kinesiotherapy used as an independent form of treatment caused a decrease in low back pain and an increase of lumbar spine ranges of motion.

Reduction of pain occurring during various daily activities and a higher improvement in functional efficiency of patients has been observed in patients undergoing WBCT in combination with kinesiotherapy.

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REFERENCES

- [1] Allen DK, Golightly YM. Epidemiology of osteoarthritis: state of the evidence. *Curr Opin Rheumatol.* 2015;27(3):276-283. <https://doi.org/10.1097/BOR.0000000000000161>
- [2] Goode AP, Carey TS, Jordan JM. Low back pain and lumbar spine osteoarthritis: how are they related? *Curr Rheumatol Rep.* 2013;15(2):305. <https://doi.org/10.1007/s11926-012-0305-z>
- [3] Wenham CY, Conaghan PG. New horizons in osteoarthritis. *Age Ageing.* 2013;42(3):272-278. <https://doi.org/10.1093/ageing/aft043>
- [4] Depa A, Drużbicki M. Ocena częstości występowania zespołów bólowych lędźwiowego odcinka kręgosłupa w zależności od charakteru wykonywanej pracy [Assesment of the frequency of lumbalgia occurrence with relations to the character of performer work]. *Prz Med Uniw Rzesz.* 2008;1:34-41. Polish.
- [5] Rajadurai V, Murugan K. Spinal manipulative therapy for low back pain: A systemic review. *Phys Ther Rev.* 2009;14(4):260-271. <https://doi.org/10.1179/108331909X12488667116934>
- [6] Giemza C, Czech P, Paluszak A, Bieć E, Borzucka D, Kuczyński M. Acute effects of cryotherapy on postural control. *Neurosci Lett.* 2013;536:6-9. <https://doi.org/10.1016/j.neulet.2012.12.037>
- [7] Giemza C, Matczak-Giemza M, Ostrowska-Bieć E, Dolińska M. Effect of cryotherapy on the lumbar spine in elderly men with back pain. *Aging Male.* 2014;17(3):183-188. <https://doi.org/10.3109/13685538.2013.863860>
- [8] Grabiańska E, Leśniewicz J, Pieszynski I, Kostka J. Comparison of the analgesic effect of interferential current (IFC) and TENS in patients with low back pain. *Wiad Lek.* 2015;68(1):13-19.
- [9] Lim TK, Ma Y, Berger F, Litscher G. Acupuncture and neural mechanism in the management of low back pain - an update. *Medicines (Basel).* 2018;5(3):63. <https://doi.org/10.3390/medicines5030063>
- [10] Li Y, Cui X, Liu S, Zhang S, Zhao Y. Neuromuscular electrical stimulation for treating postpartum low back pain *Medicine (Baltimore)* 2018;97(28):e11426. <https://doi.org/10.1097/MD.00000000000011426>
- [11] Stanek A, Sieroń A. Współczesna krioterapia ogólnoustrojowa w odnowie biologicznej [Contemporary whole-body cryotherapy in wellness]. *Ann Acad Med Siles.* 2012;66(4):64-70. Polish.

- [12] Ku B, Jun M, Lee J, et al. Short-term efficacy of pulsed radiofrequency thermal stimulation on acupoints for chronic low back pain: A preliminary study of a randomized, single-blinded, placebo-controlled trial. *Evid Based Complement Alternat Med*. 2018;2018:4510909. <https://doi.org/10.1155/2018/4510909>
- [13] Cuenca-Martínez F, Cortés-Amador S, Espí-López GV. Effectiveness of classic physical therapy proposals for chronic non-specific low back pain: a literature review. *Phys Ther Res*. 2018;21(1):16-22. <https://doi.org/10.1298/ptr.E9937>
- [14] Bleakley CM, Bieuzen F, Davidson GW, Costello JT. Whole-body cryotherapy: empirical evidence and theoretical perspectives. *Open Access J Sports Med*. 2014;10(5):25-36. <https://doi.org/10.2147/OAJSM.S41655>
- [15] Ward MM, Deodhar A, Akl AE, et al. American College of Rheumatology/Spondylitis Association of America/Spondyloarthritis Research and Treatment Network 2015 Recommendations for the Treatment of Ankylosing Spondylitis and Nonradiographic Axial Spondyloarthritis. *Arthritis Rheumatol*. 2016;68(2):282-298. <https://doi.org/10.1002/art.39298>
- [16] Rymaszewska J, Ramsey D, Chłodzińska-Klejna S. Whole-body cryotherapy as adjunct treatment of depressive and anxiety disorders. *Arch Immunol Ther Exp*. 2008;56(1):63-68. <https://doi.org/10.1007/s00005-008-0006-5>
- [17] Strojek K, Radziwińska A, Sęk-Kamińska D, Bułatowicz I, Kaźmierczak U, Piekorz Z, Siedlaczek M, Żukow W. An assessment of the effectiveness of cryotherapy is associated with kinesiotherapy in the treatment of osteoarthritis knee joints. *J Health Sci*. 2014;4(10):383-390.
- [18] Szczepańska-Gieracha J, Borsuk P, Pawik M. Mental state and quality of life after 10 session whole body cryotherapy. *Psychol Health Med*. 2014;19(1):40-46. <https://doi.org/10.1080/13548506.2013.780130>
- [19] Barłowska-Trybulec M, Zdunek K, Szklarczyk J, Jaworek J. Wpływ krioterapii ogólnoustrojowej na stan funkcjonalny odcinka lędźwiowego kręgosłupa u pacjentów z chorobą zwyrodnieniową. [The influence of whole body cryotherapy on the functional status of lumbar spine in patients with osteoarthritis]. *Medycyna Manualna*. 2016; 20 (3-4): 9-18. Polish.
- [20] Pasek J, Pasek T, Sieroń A. Krioterapia miejscowa i ogólnoustrojowa u pacjentów ze zmianami zwyrodnieniowymi stawów [Local and whole body cryotherapy in patients with osteoarthritis]. *Rehab Prakt*. 2009;2:32-34. Polish.
- [21] Stanek A, Cieślak G, Sieroń A. Terapeutyczne zastosowanie krioterapii w praktyce klinicznej [Therapeutic application of cryotherapy in clinical practice]. *Baln Pol*. 2007;49(1):37-45. Polish.
- [22] Fairbank J, Pynsent P. The Oswestry Disability Index. *Spine*. 2000;25(22):2940-2953. <https://doi.org/10.1097/00007632-200011150-00017>
- [23] Topolska M, Sapuła R, Topolski A, Marczewski K. Ocena skuteczności krótkoterminowej efektywności rehabilitacji kobiet z przewlekłymi bólami dolnego odcinka kręgosłupa z wykorzystaniem kwestionariuszy niepełnosprawności Oswestry i Roland-Morris'a [Evaluation of the effectiveness of short-term rehabilitation of women with chronic low back pain using the Oswestry and Roland-Morris Disability Scales]. *Ortop Traumatol Rehab*. 2011;13(4):353-360. Polish. <https://doi.org/10.5604/15093492.955723>
- [24] Barłowska-Trybulec M, Samborska B, Jaworek J. The influence of whole body cryotherapy on functional status of patients with spondyloarthritis. *WUJ Kraków*, 2014: 266-282.
- [25] Daniszewska P, Kroc A, Barocha M, Kikowski Ł. Evaluation of therapeutic effects of cryotherapy in patients with cervical pain syndrome. *Acta Balneol*. 2014;56;2(136):100-105.
- [26] Lubkowska A, Dołęgowska B, Szyguła Z. Whole body cryostimulation - potential beneficial treatment for improving antioxidant capacity in healthy men - significance of the number of sessions. *PloS One*. 2012;7(10):e46352. <https://doi.org/10.1371/journal.pone.0046352>
- [27] Sarver DC, Sugg KB, Disser NP, Sibilsy Enselman ER, Awan TM, Mendias CL. Local cryotherapy minimally impacts the metabolome and transcriptome of human skeletal muscle. *Sci Rep*. 2017;7: 2423. <https://doi.org/10.1038/s41598-017-02754-5>
- [28] Jurecka A, Woźniak A, Mila-Kierzenkowska C, Wesołowski R, Sutkowy P. Dlaczego kriostymulacja ogólnoustrojowa stanowi skuteczną metodę fizjoterapii sportowej? [Why whole body cryostimulation is effective method of sport physiotherapy?]. *Wiosna młodych fizjoterapeutów*. Wyd. WSG, Bydgoszcz 2013;(1):39-49. Polish.
- [29] Braun K, Brookmann-Amisshah S, Geissler K. Whole-body cryotherapy in patients with inflammatory rheumatic disease. A prospective study. *Med Klin* 2009;104(3):192-196. <https://doi.org/10.1007/s00063-009-1031-9>
- [29] Lange U, Uhlemann Ch, Muller-Ladner U. Serial whole-body cryotherapy in the criostream for inflammatory rheumatoid diseases. A pilot study. *Med Klin*. 2008;103(6):383-388. <https://doi.org/10.1007/s00063-008-1056-5>

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