

# COMPARISON OF THE EFFECTS OF LAND-BASED AND WATER-BASED THERAPEUTIC EXERCISES ON THE RANGE OF MOTION AND PHYSICAL DISABILITY IN PATIENTS WITH CHRONIC LOW-BACK PAIN: SINGLE-BLINDED RANDOMIZED STUDY

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**SUMMARY** – The aim of the study was to compare the effect of water-based exercise in thermal mineral water *versus* land-based exercise therapy on the lumbar spine range of motion and physical disability in adult patients with chronic low back pain. Out of 72 patients hospitalized for inpatient treatment in a special rehabilitation hospital, 36 patients performed a 3-week standardized program of group water-based exercises and the other 36 performed a program of group land-based exercises. All patients were also treated with electro analgesic therapy and underwater massage. The patients were assessed for lumbar spine motion using standardized measures with flexible tape, while physical disability was measured by the Physical Disability Index. Evaluations were performed at the beginning and at the end of treatment. Compared with baseline, a statistically significant improvement was detected in both groups regarding both primary outcome measures. At the end of treatment, there was no statistically significant difference between the two exercise treatments in any parameter of interest ( $p < 0.01$ ). In conclusion, in our sample of patients with chronic low back pain, exercise treatment improved lumbar motion and decreased the level of physical disability. However, comparison of land-based exercises and water-based exercises in thermal mineral water did not demonstrate any significantly different result.

**Key words:** *Exercise; Hydrotherapy; Low back pain, chronic; Range of motion, articular; Physical disability*

## Introduction

Low back pain (LBP) is a common symptom affecting more than 80% of the population over lifetime<sup>1</sup>. It is the most frequent cause of disability in people un-

der 45 years of age and represents a relevant social and economic problem in developed countries<sup>2</sup>. Chronic low back pain (CLBP) is usually defined as symptoms persisting for more than 12 weeks<sup>3</sup>. The management of CLBP comprises a range of different intervention strategies, including surgery, drug therapy and non-medical interventions<sup>4</sup>. Patients who suffer from LBP rarely can avoid periods of rest when their symptoms become worse, which leads to reduced function of the spine as well as atrophy of the ventral and dorsal muscles of the trunk. These weakened muscles cannot

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Received January 21, 2013, accepted March 29, 2013

stabilize the spine and the patient develops an ever-worsening condition. That is why exercise therapy is the base of treatment and rehabilitation of CLBP<sup>5-8</sup>.

Hydrotherapy or exercise in water has a long history of use as a treatment for musculoskeletal conditions. The benefits of aquatic exercise are thought to result from the water's unique characteristics including warmth that reduces pain and muscle spasm, buoyancy that decreases loading of joints, resistance to movement through turbulence and hydrostatic pressure, and the equal pressure from all directions applied to an immersed object at a given depth<sup>9</sup>.

Although these findings suggest the potential benefits of aquatic exercise, only a few published studies have examined the effects of water-based exercises on people with CLBP, particularly in comparison to land-based exercise<sup>10-13</sup>.

The aim of this study was to compare the effects of water-based exercise in thermal mineral water and land-based exercise therapy on the range of motion in lumbar spine and physical disability in adult patients with CLBP included in stationary rehabilitation.

## Patients and Methods

A total of 72 patients with CLBP without leg pain, hospitalized for inpatient treatment in a Special Rehabilitation Hospital (Croatia), were included in this prospective cohort study. The inclusion criteria were CLBP without radicular pain in adult patients lasting for more than 3 months. The exclusion criteria were acute organic neurologic deficit; neoplastic or inflammatory lesion; decompensated cardiovascular disease; unstable hypertension; uncontrolled endocrine disease; acute febrile infections; skin suppuration; unstable epilepsy; decompensated psychosis/neurosis; incontinence; and pregnancy.

An informed consent was obtained before the examination and approval for the study was granted by the local ethics committee.

Patients (36 men, mean age  $48.42 \pm 9.60$  years and 36 women, mean age  $48.81 \pm 6.44$  years) were randomized into two groups, equally divided according to gender. Thirty-six patients (half in each gender group) were allocated to the group to perform three-week standardized program of water-based exercises, while the other 36 patients performed the program of group

land-based exercises, both supervised by physiotherapist. Both exercise programs included 15 sessions, five times *per week* (Saturday and Sunday excluded). The duration of each session was 45 minutes.

Water-based exercise program was conducted in groups of 9 patients in an indoor swimming pool. Temperature of mineral water, consisting mainly of calcium (125 mg/L), sodium (95 mg/L), hydrogen carbonate (463 mg/L) and sulfate (181 mg/L), was 36 °C. The program included warming up by walking forwards, sideways and backwards through the water in the pool; active range of motion of the joints of the upper and lower extremities; stretching of the neck, trunk and extremities; strengthening exercises for hips, knees, arms, elbows and wrists; and cooling-down (slow walking, squatting and standing).

Land-based exercise program included warming up; flexion (sitting-up straight and with rotation to the right and left); extension (prone trunk extension); stretching (raising the legs, double-knee-to-chest in back lying position, lifting the left arm/right leg and right arm/left leg alternately), strengthening major muscle groups of upper and lower limbs; and cooling-down (slow walking, squatting and standing). Each exercise was performed with 10 repetitions.

Both groups underwent additional adjunctive electrotherapy (5 times *per week*) under standardized conditions (transcutaneous electrical nerve stimulation, TENS: frequency 80-100 Hz, duration 20 min; interferential currents: frequency 90-100 Hz, duration 10 min) and underwater massage (twice a week).

No pain-killers (paracetamol, tramadol, non-steroidal anti-inflammatory drugs) were allowed to be changed during the study.

The evaluation prior and after the treatment was done by experts (V.B., D.V.M.) without knowing which patient was assigned to which group.

Maximal range of lumbar motion in standing position was assessed using standardized measures (flexible tape) and included modified Schober's test (in mm), left and right lateral flexion (distance fingers-floor in mm) and trunk flexion (distance fingertips-floor in mm).

Physical disability was measured by the Physical Disability Index (PDI). It is an observer-administered, performance-based instrument that contains fifty-four items in four subscales encompassing range

Table 1. Baseline sociodemographic and anthropometric characteristics

Variable		Group 1 (n=36)	Group 2 (n=36)	P
Sex (n)	Male	18	18	0.598
	Female	18	18	
Age (yrs) <sup>a</sup>		49.61 (±7.98)	41.61 (±8.24)	0.299
Weight (kg) <sup>a</sup>		81.92 (±12.53)	77.39 (±11.91)	0.421
Height (cm) <sup>a</sup>		171.11 (±8.21)	169.58 (±7.81)	0.121
Level of formal education, degree <sup>b</sup>	No school	1	1	0.554
	Primary school	9	9	
	Secondary school	24	25	
	College	2	0	
	Master/Doctorate	0	1	

Group 1 = land-based exercise group; group 2 = water-based exercise group; <sup>a</sup>independent sample T-test (mean and standard deviation); <sup>b</sup> $\chi^2$ -test

of motion, strength, balance and mobility, as well as summary PDI scores, each with a range of 0-100. PDI details have been published elsewhere<sup>14</sup>.

Statistical analysis was performed using the SPSS for Windows 13.0 software program.

The means and standard deviations were given as descriptive statistics. The level of significance was set at  $P < 0.01$ . The mean percentage values of the changes calculated for both groups were compared using the Mann-Whitney U test. The paired T-test was used for comparison of pre- and post-treatment values within groups.

Table 2. Patient distribution and difference between land-based and water-based exercise groups – baseline results

Variable	Group	N	Mean	Standard deviation
Modified Schober (mm)	1	36	24.58	7.31
	2	36	25.83	7.02
Left lateral flexion (mm)	1	36	597.78	46.54
	2	36	582.22	49.05
Right lateral flexion (mm)	1	36	590.00	41.54
	2	36	581.11	49.73
Trunk flexion/fingertips-floor distance (mm)	1	36	401.39	120.67
	2	36	393.06	116.83
Physical Disability Index	1	36	6.50	1.42
	2	36	5.92	1.27

Group 1 = land-based exercise group; group 2 = water-based exercise group

Repeated measures ANOVA was used to examine whether there was any improvement after treatment and any differences between the results of water-based and land-based exercise programs.

## Results

There were no statistically significant differences in baseline sociodemographic and anthropometric characteristics between the two groups (Table 1). In both groups, there was a statistically significant improvement in lumbar mobility and physical disability compared with initial values (Tables 2 and 3). Results showed improvement due to the treatment (significant main effect of the treatment) but not significant interaction effects between the types of exercise therapy tested before and after the treatment, indicating that improvement did not depend on the exercise program (Table 4).

At the end of treatment, the two exercise programs resulted in improvement in all tested variables but there was no significant difference between the two regimens ( $P < 0.01$ ).

No side effects were observed during the study.

## Discussion

In our study, exercise programs, along with other rehabilitation treatments, improved spinal mobility and decreased the level of physical dis-

Table 3. Patient distribution and difference between land-based and water-based exercise groups – final results

Variable	Group	N	Mean	Standard deviation
Modified Schober (mm)	1	36	29.44	7.05
	2	36	31.11	6.98
Left lateral flexion (mm)	1	36	574.17	50.28
	2	36	554.72	47.48
Right lateral flexion (mm)	1	36	566.39	44.22
	2	36	551.67	45.76
Trunk flexion/fingertips-floor distance (mm)	1	36	372.50	122.65
	2	36	350.08	122.64
PDI	1	36	4.83	1.63
	2	36	4.41	1.40

Group 1 = land-based exercise group; group 2 = water-based exercise group

ability in patients with CLBP hospitalized in a rehabilitation institution, but with no difference between the land-based and water-based programs.

It has been recognized that exercising in water can be an effective and useful mode of therapeutic exercise, especially for the individuals who have difficulties with the weight-bearing components while performing land exercise<sup>9</sup>. It seems that it may be more suitable for aerobic based exercise programs than the land-based exercise<sup>15</sup>. There is a moderate quality level of evidence supporting the notion that water-based exercise can improve pain, function, self-efficacy,

joint mobility, strength and balance outcomes for people with any disability<sup>16</sup>.

Hydrotherapy provides a favorable environment and it can be beneficial for patients with low back pain, too, although there are difficulties in their comparison since they vary in their setting, definition of treatment, outcomes of interest, and often the lack of details, especially regarding exercise program. Group hydrotherapy can reduce pain and improve the quality of life of patients with CLBP<sup>17</sup>. In their pilot study, Smit and Harrison found significant improvement in thoraco-lumbar range after four-week hydrotherapy treatment, but the beneficial effects disappeared after a three-month period<sup>18</sup>.

On the other hand, in the study by Yozbaritan *et al.*, the supervised aqua fitness programs had effects similar to those based on land fitness programs on physical fitness level in CLBP patients<sup>19</sup>. McIlveen and Robertson's study demonstrated that a four-week program of hydrotherapy provided no benefit in pain, disability, or lumbar range of motion in 95 patients with CLBP and sciatica<sup>10</sup>. For patients after lumbar discectomy surgery, a 12-week program of aquatic backward locomotion exercise, twice *per week*, was as beneficial as progressive resistance exercise for improving lumbar extension strength<sup>20</sup>. Ariyoshi *et al.* studied 35 patients with CLBP who were managed with aquatic exercises for more than six months. Those

Table 4. Results of testing for the main treatment effect and interaction effect between land-based exercise and water-based exercise programs (group) before and after treatment (time) (repeated measures ANOVA)

Variable	Significance of the main treatment effect		Significance of the interaction effect	
	Time (before/after)		Group x Time	
	F	p<	F	p
Modified Schober (mm)	348.63	0.000	0.59	0.445
Left lateral flexion (mm)	153.06	0.000	0.87	0.350
Right lateral flexion (mm)	137.37	0.000	1.66	0.202
Trunk flexion/fingertips-floor distance (mm)	71.86	0.000	2.76	0.101
Physical Disability Index	90.25	0.000	0.64	0.428

patients who had performed exercises twice or more in a week showed a more significant improvement in the physical score than those who performed exercises only once a week, suggesting the importance of such a program intensity<sup>11</sup>.

Sjogren *et al.* compared group hydrotherapy, performed twice a week for six weeks, with a land-based treatment program in 60 patients with CLBP. Both groups improved significantly in functional ability and in decreasing pain levels, but not in thoracolumbar mobility<sup>12</sup>. There was no significant difference between the two types of treatment, so the authors concluded that both treatments were equally effective. Similar was the study by Dundar *et al.* in 65 patients with CLBP, where land-based exercise program was performed at home<sup>13</sup>. Significant improvements were detected in all outcome variables (spinal mobility, pain, disability, and quality of life) in both groups, but water-based exercises produced better improvement in disability and quality of life.

In their systematic review, Waller *et al.* found therapeutic aquatic exercise to be potentially beneficial for patients suffering from CLBP and pregnancy-related LBP<sup>21</sup>. In their more recent review, Kamioka *et al.* concluded that aquatic exercise had a small but statistically significant effect on pain, function, quality of life and mental health, and was more effective for the treatment of musculoskeletal diseases, as compared with balneotherapy, which involves passive immersion. However, it must be noted that this was an immediate and not the long-term effect<sup>22</sup>.

It was shown that balneotherapy, underwater traction bath and underwater massage equally reduced the pain score and prescription of analgesics in CLBP outpatients, but without significant changes in spinal motion and the straight leg raising test after four-week treatment<sup>23</sup>.

Regarding comparison of thermal medicinal and tap water in patients with CLBP, Kulisch *et al.* found that, after three-week treatment, improvements in pain score and spinal motion in the group treated with thermal water occurred earlier and lasted longer<sup>24</sup>. The beneficial effects of balneotherapy/spa-therapy were also shown in the two most recent studies in patients with CLBP. Tefner *et al.* demonstrated a significantly better effect of balneotherapy with thermal mineral water *versus* tap water on clinical parameters, along

with improvements in the quality of life<sup>25</sup>, while in the study by Kesiktas *et al.* balneotherapy combined with exercise therapy had advantages over therapy with physical modalities plus exercise in improving the quality of life and flexibility<sup>26</sup>.

The strength of our study was a relatively homogeneous group of patients regarding the inclusion criteria (patients with sciatica were excluded) and the fact that allocation of subjects was adjusted according to gender. As it is well known that appropriate professional supervision is important for the efficacy of exercise programs, both groups in our study performed exercise under the supervision of a physiotherapist, which created assurance of compliance, good technique and positive role of therapist reinforcement. Furthermore, physical disability was measured by PDI, an instrument that utilizes precise continuous units of measurement rather than nominal or ordinal scores used in other common measures<sup>14</sup>.

The main limitation of our study was the absence of follow-up, so we could not assess long-term effects of treatment. Furthermore, we studied only physical and not psychological and social components of CLBP, which are known to be important in this condition.

## Conclusions

In our sample of middle-aged patients with CLBP without leg pain, water-based and land-based exercise programs, along with other rehabilitation treatments (electrotherapy, underwater massage), improved spinal mobility and decreased the level of physical disability. However, comparison of water-based exercises in thermal water and land-based exercise demonstrated no statistically significantly different results. Nevertheless, as they are safe, well-tolerated and an enjoyable form of exercises, water-based exercises may be considered as the initial part of an exercise therapy program to get particularly disabled patients with CLBP introduced to training. The optimal type of exercise, its duration, frequency and overall time-frame need to be established in future studies.

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## Sažetak

## USPOREDBA UČINAKA TERAPIJSKIH VJEŽBI NA SUHOM I TERAPIJSKIH VJEŽBI U VODI NA OPSEG POKRETA I FIZIČKU NESPOSObNOST U BOLESNIKA S KRONIČNOM KRIŽOBOLJOM: JEDNOSTRUKO SLIJEPA RANDOMIZIRANA STUDIJA

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Terapijske vježbe su temelj liječenja i rehabilitacije bolesnika s kroničnom križoboljom. Cilj ove studije bio je usporediti ishod opsega pokreta slabinske kralježnice i stupanj funkcionalne nesposobnosti jednog ciklusa terapijskog vježbanja u termomineralnoj vodi i vježbanja provedenog na suhom u bolesnika s kroničnom križoboljom. U studiju je bilo uključeno 72 bolesnika s kroničnom križoboljom hospitaliziranih u cilju stacionarne rehabilitacije u specijalnoj bolnici za medicinsku rehabilitaciju. Tridesetšestoro bolesnika je provelo 3-tjedni standardizirani program grupnih terapijskih vježbi u vodi, a drugih 36 program grupnih terapijskih vježbi na suhom. U svih je bolesnika primijenjena elektroanalgetska terapija i podvodna masaža. Mjerenje opsega pokreta slabinske kralježnice provedeno je standardnim mjerenjem uz uporabu savitljive centimetarske vrpce, dok je fizička nesposobnost mjerena uporabom upitnika *Physical Disability Index*. Evaluacije su provedene na početku i na kraju liječenja. U usporedbi s početnim vrijednostima utvrđeno je poboljšanje u objema skupinama glede oba primarna ishoda. Na kraju liječenja u parametrima od interesa nije bilo statistički značajne razlike između dviju skupina terapijskih vježbi ( $p < 0,01$ ). Zaključno, u našem uzorku bolesnika s kroničnom križoboljom terapijske vježbe, zajedno s drugim metodama koje se primjenjuju u fizikalnoj medicini i rehabilitaciji, poboljšale su opseg pokreta slabinske kralježnice i snizile stupanj nesposobnosti. Međutim, usporedbom rezultata za bolesnike koji su provodili terapijske vježbe na suhom i u termomineralnoj vodi nije nađena značajna razlika.

Ključne riječi: *Vježbe; Hidroterapija; Križobolja, kronična; Opseg pokreta, u zglobu; Fizička nesposobnost*