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ARTICLE *in* JOURNAL OF BACK AND MUSCULOSKELETAL REHABILITATION · JANUARY 2008

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Journal of Back and Musculoskeletal Rehabilitation 21 (2008) 263–272
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Effects of balneotherapy with exercise in patients with low back pain

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Abstract. Low back pain (LBP) is an important clinical, social, and public health problem. Balneotherapy is a type of therapy by hot or warm waters containing minerals. The aim of this study was to investigate the effects of balneotherapy with exercise on pulmonary functions, aerobic exercise capacity, resting metabolic rate, body fat %, psychosocial condition and its efficiency on therapy in patients with LBP. Balneotherapy and exercise program were applied to group 1 (14 female, 9 male). Only an exercise program was applied to group 2 (13 female, 8 male). The measurements of maximal oxygen consumption, resting metabolic rate, pulmonary function tests, body fat %, Oswestry disability index, visual analog scale, quality of life measure, symptom checklist-90-revised, the hospital anxiety and depression scale, spine joint mobility tests from all participants were performed before and after the treatment. An improvement was found in pulmonary function test (maximal volunteer ventilation), aerobic exercise capacity, pain and disability scores, spine mobility (extension distance), quality of life, and all psychiatric symptoms (except anxiety) in group 1 following therapy period. Also some improvements were observed in body fat percentage, pulmonary function tests (forced vital capacity, forced expiratory volume in 1 second, forced expiratory flow at 25% to 75% vital capacity and peak expiratory flow), and other spine joint mobility tests before and after therapy in group 1, though they were not statistically significant. Balneotherapy with exercise could be alternative therapy methods in patients with LBP.

Keywords: Low back pain, balneotherapy, exercise, aerobic capacity, pulmonary function

1. Introduction

Low back pain (LBP) is an important clinical, social and public health problem, affecting the populations worldwide [32]. LBP represents an important factor of disabling chronic pain and low quality of life in the adult population, and a devastating problem of public health because of its tremendous medical and social cost [25]. LBP poses an economic burden to society, mainly in terms of the large number of work days lost (indirect costs) and less so by direct treatment costs [28]. Given the association of comorbidities and cost for patients with LBP, management approaches that are effective across chronic illnesses may prove to be beneficial for high cost patients identified with LBP [42].

LBP is still one of the most common causes of sickness absence, long-term incapacity and early retirement, yet there is no absolute medical reason why this should be so [54]. The etiology of LBP is complex and the causes are not clearly known; although some risk factors are implicated. For instance, trunk and lower extremity loss of muscle mass and central obesity may

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ISSN 1053-8127/08/$17.00

be risk factors for chronic LBP [47]. Primary targets for treatment of LBP should be an increase in physical fitness and the self-management of the problem by the patient [7]. Clinical belief holds that patients with chronic LBP have low fitness levels because of inactivity because of pain [57]. The relation between physical fitness and LBP have been explored by examining such measures of physical fitness including flexibility, aerobic capacity, strength, muscle endurance, and body composition [50].

Balneotherapy is a therapy type by hot or warm waters containing minerals and having physical and chemical characteristics which is applied as bathing and it generates mechanical, chemical and physical effects when it is applied. Thermo-mineral waters occurring by natural circulation reach certain temperature level underground and contain dissolved minerals and materials to some extent in them as well as having special chemical composition [22]. Thermo-mineral waters arise from underground to the surface either spontaneously or via artificial methods by drilling.

Balneotherapy has been used empirically in treating various musculoskeletal disorders since many years. The therapeutic value of thermal spring water has been linked to its composition, mineral concentration and the temperature [15,55]. Several studies suggest a beneficial effect of balneotherapy on degenerative and inflammatory joint diseases, as well as offering an adjuvant therapy in the treatment of various chronic health conditions [15,55]. Afyonkarahisar is one of the spa centers in Turkey and there are many balneotherapy units and the natural spring waters with varying properties [11].

Exercises aim to improve lung function and muscle performance. Resistance exercise training prevents lower-back pain and affects resting metabolic rate (RMR) and body fat positively [56].

Obviously, to improve body functions is important for successful treatment. Therefore, we intended to clarify the effects of balneotherapy and exercise on LBP together with body functions in patients with LBP.

The study aimed to investigate the effects of balneotherapy with exercise on respiratory functions, aerobic exercise capacity, basal metabolism, body fat % and psychosocial condition in patients with mechanical low back pain and its efficiency on therapy.

2. Methods

2.1. Study design

This study was performed in the Physical Medicine and Rehabilitation Clinic of Research and Application Hospital at AKU. The patients who were referred to Physical Medicine and Rehabilitation Clinic and diagnosed with a mechanical LBP were enrolled.

Initially a total of 60 patients were planned to enroll for this study. However, only a total of 54 patients participated for the study during the first phase of planned period of investigation, and only a total of 44 of them to the second assessment phase.

The patients were divided into two groups (group 1 and group 2) randomly with toss-up method. Balneotherapy and exercise program were applied to the group 1, only exercise program was applied to the group 2. In Group 1 ($n = 23$), there was 14 female, 9 male patients, whereas in Group 2 ($n = 21$) there was 13 female, and 8 male patients.

2.2. Subjects

The study was approved by the local IRB (School of Medicine Medical Ethics Committee). All participants gave their informed consent before participation. All patients had radiological and routine laboratory examination before the study.

Inclusion criteria were as follows: having mechanical LBP for at least 3 months and having no exercise risk.

Exclusion criteria were the followings: major musculoskeletal problems and previous spinal operation, having inflammatory LBP and arthritis, having elevated acute phase reactant and red flag findings for LBP, acute infection, pregnancy for women, liver diseases, epilepsy and other neurological illnesses, psychiatric, metabolic (hyper/hypothyroidism, etc.), and cardiovascular disorders, use of drugs affecting basal metabolism, diabetes mellitus and other systemic diseases.

2.3. Balneotherapy

Balneotherapy was continued for 3 weeks (except weekends), a total of 15 sessions, each of which took 20–25 minutes. Balneotherapy was performed with natural spring water which contains sodium, bicarbonate, sulfate, calcium, magnesium, iron, aluminum, chlorine, metasilicate and its temperature was about 36–38°C.

Patients were instructed to take bath in mineral water pool as their whole bodies up to the head being sunken in the water.

2.4. Exercise programs

Group 1 and 2 patients performed same exercise program for 3 weeks under surveillance by a physiotherapist who doesn't know the patients' group (if they belong to group 1 or 2).

Each exercise program included the following ones: Williams flexion exercise, spinal stabilization exercise, McKenzie extension exercise, abdominal strength exercise, and spinal stretching exercise [5,41]. These exercises were applied 10 times for each session and subjects took a rest for 2 minutes between each exercise.

2.5. Tests and measurements

Following the physical examination of the all participants in the study, they were subjected to the following tests and questionnaires: Oswestry Disability Index (ODI), Visual Analog Scale (VAS), Quality of Life Measure (SF36), Symptom Checklist-90-Revised (SCL-90-R) and The Hospital Anxiety and Depression Scale (HAD), Spine Joint Mobility Tests. Spine Joint Mobility Tests were carried out as described previously [35,39].

Also, for all participants test of respiratory functions, an exercise test, basal metabolism levels and subcutaneous fat measurements were done in the lab of the Department of Physiology. Prior to the measurements, all patients were informed about tests and measurements.

The measurements of subcutaneous fat thicknesses, maximal oxygen consumption (VO_2max), RMR and pulmonary function tests (PFTs) were performed in the laboratory of the Department of Physiology. Once the therapy period is finished, all measurements were repeated once more. The devices were calibrated prior to each test.

2.5.1. Body fat percentage

The skinfold thicknesses were measured by the same physician using skinfold caliper (Holtain, Holtain Ltd., UK). Abdomen, triceps, thigh and subscapular skinfold thickness measurements were done twice. When the differences between the two measurements were more than 5%, the measurements were repeated and the second measurements were used. Body densities were calculated with the Behnke Wilmore (BW) formula for both men and women [37].

BW formula for calculation of body density for men was:

Body density = 1.08543–0.00086 (abdomen skinfold)–0.0004 (thigh skinfold)

BW formula for calculation of body density for women was:

Body density = 1.06234–0.00068 (subscapular skinfold)–0.00039 (triceps skinfold)–0.00025 (thigh skinfold)

Body fat percentage was calculated from body density with Siri formula, which is [37]:

Body fat percentage = (4.95/body density–4.5)*100

2.5.2. Aerobic exercise capacity

Measuring aerobic exercise capacity was preferred for patients with LBP because aerobic capacity is affected not only by exercise therapy but also by daily physical activity of patients. VO_2max measurements were carried out using Astrand exercise protocol. Prior to implementation of exercise test, the assessment of exercise risk for subjects were carried out according to American College of Sports Medicine criteria and only appropriate subjects were enrolled for the Astrand test [4]. The tests were performed in the same order and conditions by the same person. The subjects were taken into the laboratory in convenient clothes. The subjects were instructed to avoid food intake two hours before the test, and taking beverages or foods containing caffeine or alcohol. The Astrand test was performed on a computerized cycle ergometer (Monark 839E, Monark Exercise AB, Sweden). The heart rate was monitored with chest belt telemetry system (Polar CR2032, CE0682, Monark Exercise AB, Sweden). The subjects were asked to perform a 6-min submaximal exercise test reaching a steady state heart rate. The VO_2max was determined from heart rate and workload by Astrand test [31].

2.5.3. Resting metabolic rate

RMR was measured with portable indirect calorimeter (BodyGem, HealtheTech Inc., USA) as follows: The subjects were instructed to avoid food intake for 12 hours, not smoke for 2 hours and not perform exercise for 24 hours before the test. The tests were performed at the same hours (08:30 am–10:30 am) of the day. After resting for 15 minutes, the measurements were applied to the subjects in laboratory that was silent, lightless and at room temperature. The subjects were put on mouthpiece and nose clip, seated and instructed not to move arms and legs during the measurement. They hold the device during the measurement and were supported their arm on the armrest of the chair. RMR was measured indirectly in 5 to 10 minutes with a metabolic sensor in the device by analysis of respired gases (O_2). BodyGem uses standard metabolic formulas in which oxygen consumption per day is used to calculate RMR [36].

Table 1
Body weight, body mass index (BMI) and body fat percentage before and after therapy of groups

		Before therapy	After therapy	P
Body weight (kg)	Group 1	76.8 ± 10.8	76.3 ± 11.1	0.186
	Group 2	77.4 ± 12.5	77.2 ± 11.9	0.353
BMI (kg/m^2)	Group 1	28.7 ± 4.1	28.6 ± 4.3	0.467
	Group 2	29.1 ± 5.5	29.2 ± 5.5	0.802
Body fat (%)	Group 1	26.1 ± 8.7	25.6 ± 7.9	0.160
	Group 2	27.3 ± 11.5	25.9 ± 10.4	0.004

All values represent means ± standard deviation.

2.5.4. Pulmonary function tests

PFTs were measured with a spirometer (Spirolab, SDI Diagnostics, USA). The subjects performed a practice for adaptation to the spirometer before PFTs. A forced expiratory maneuver was performed. After wearing a nose clip subjects were instructed to inhale completely before inserting the mouthpiece, then exhale forcefully into the spirometer for as much as they could. Forced vital capacity (FVC), forced expiratory volume in 1 second (FEV_1), forced expiratory flow at 25% to 75% vital capacity (FEF_{25-75}), peak expiratory flow (PEF) were measured, FEV_1/FVC ratio was determined. Maximal voluntary ventilation (MVV) was measured using another spirometry maneuver. Subjects were asked to exhale maximal volume during 12 seconds of forced breathing into the spirometer and MVV was calculated for one minute. Acceptability and reproducibility criteria of American Thoracic Society were applied to all patients [1].

2.6. Statically analyses

All parametric results were expressed as mean ± standard deviation for each group. Shapiro-Wilks test was performed to check the normality of the data before running tests. The results were evaluated statistically using paired samples t-test, independent samples t-test, Wilcoxon signed-ranks test, Mann-Whitney U test and chi-square test. A p-value less than 0.05 were considered to be statistically significant.

3. Results

There was no statistical significance in terms of gender in group 1 (14 female, 9 male) and group 2 (13 female, 8 male) ($p = 0.944$). Mean illness durations and smoking in group 1 (81.4 ± 69.0 month and 13.8 ± 11.9 packed-year) and in group 2 (72.0 ± 61.0 month and 16.9 ± 8.6 packed-year) were also not different ($p = 0.571$ and $p = 0.541$, respectively). There was no significant difference before therapy in terms of body weight ($p = 0.855$) and BMI ($p = 0.739$) between two groups. There was no significant difference after therapy in terms of body weight ($p = 0.795$) and BMI ($p = 0.272$) between groups. The fat percentage was found lower after therapy than the one before therapy in the group 2 (Table 1).

An increase was found in VO_2max levels in group 1 following the therapy period, but, there was no difference in group 2. Following the therapy period, an increase in RMR was observed in group 2 (Table 2).

FEV_1/FVC and FEF_{25-75} values were lower after therapy than the ones before therapy in group 2, whereas MVV value was higher after therapy than the one before therapy in group 1 (Table 3).

Table 4 shows the mean values for HAD, SCL-90-R and SF 36 scores before and after therapy of groups. A decrease was observed in depression scores after therapy for both in group 1 and group 2 (Table 4). The average decreases in depression scores after therapy were -2.3 ± 2.7 and -1.1 ± 1.8 for group 1 and group 2 respectively. However, these differences were not statistically significant ($p = 0.119$).

A decrease was observed in SCL-90-R scores after therapy for both in group 1 and group 2 (Table 4). The average decreases in depression scores after therapy were -1.2 ± 2.6 and -2.3 ± 2.7 for group 1 and group 2 respectively. However, these differences were not statistically significant ($p = 0.185$).

An increase was observed in quality of life components scores after therapy for both in group 1 and group 2 (Table 4). The average increases in physical component scores after therapy were 3.4 ± 6.7and 4.8 ± 6.1 for group 1 and group 2 respectively. However, these differences were not statistically significant ($p = 0.469$). The average increases in mental component scores after therapy were 4.9 ± 7.9and 5.2 ± 7.3 for group 1 and group 2 respectively. However, these differences were not statistically significant ($p = 0.904$).

Table 5 shows the mean values for VAS and ODI scores before and after therapy of groups. A decrease

Table 2
Maximal oxygen consumption (VO_2max) and resting metabolic rate (RMR) before and after therapy of groups

		Before therapy	After therapy	P
VO_2max(L/min)	Group 1	1.69 ± 0.42	1.86 ± 0.39	0.049
	Group 2	2.09 ± 0.46	1.96 ± 0.46	0.084
RMR (kcal/day)	Group 1	1584.8 ± 343.8	1535.7 ± 284.1	0.253
	Group 2	1492.9 ± 262.9	1653.8 ± 265.4	0.04

All values represent means ± standard deviation
L: Liter

Table 3
Pulmonary function tests (PFTs) before and after therapy of groups

PFTs		Before therapy	After therapy	p
FVC (L)	Group 1	3.68 ± 0.99	3.75 ± 1.05	0.638
	Group 2	3.59 ± 0.86	3.59 ± 0.83	0.903
FEV_1(L)	Group 1	3.23 ± 0.78	3.26 ± 0.90	0.106
	Group 2	3.10 ± 0.67	3.09 ± 0.60	0.715
FEV_1/ FVC (%)	Group 1	0.87 ± 0.04	0.87 ± 0.07	0.837
	Group 2	0.87 ± 0.06	0.86 ± 0.06	0.049
FEF_{25-75}(L)	Group 1	3.83 ± 1.01	3.90 ± 1.02	0.426
	Group 2	3.70 ± 0.81	3.49 ± 0.83	0.015
PEF (L)	Group 1	7.22 ± 2.42	7.76 ± 2.03	0.08
	Group 2	7.01 ± 1.93	7.24 ± 1.76	0.14
MVV (L)	Group 1	125.9 ± 33.7	132.7 ± 37.3	0.035
	Group 2	125.7 ± 33.5	129.7 ± 32.8	0.192

All values represent means ± standard deviation
L: Liter

Table 4
The hospital anxiety and depression scale (HAD), symptom checklist revised (SCL-90-R) and quality of life quality of life measure (SF 36) scores before and after therapy of groups

		Before therapy	After therapy	P
HAD (Anxiety)	Group 1	7.7 ± 3.9	7.0 ± 4.2	0.314
	Group 2	6.3 ± 2.6	6.7 ± 2.1	0.576
HAD (Depression)	Group 1	7.3 ± 3.8	5.0 ± 3.5	0.02
	Group 2	5.9 ± 2.9	4.7 ± 2.7	0.013
SCL-90-R	Group 1	8.9 ± 5.5	7.7 ± 4.5	0.033
	Group 2	9.5 ± 4.9	7.2 ± 4.2	0.001
SF 36 (Physical component)	Group 1	49.5 ± 9.9	52.8 ± 11.0	0.024
	Group 2	48.8 ± 9.4	53.6 ± 9.9	0.002
SF 36 (Mental component)	Group 1	44.4 ± 10.7	49.4 ± 9.9	0.014
	Group 2	43.6 ± 5.6	48.8 ± 6.9	0.004

All values represent means ± standard deviation

was observed in rest, mobility and nocturnal VAS after therapy for both in group 1 and group 2 (Table 5). The average decreases in rest VAS scores after therapy were -2.2 ± 2.9 and -1.8 ± 2.7 for group 1 and group 2 respectively. However, these differences were not statistically significant ($p = 0.712$). The average decreases in mobility VAS scores after therapy were -2.7 ± 2.3 and -2.7 ± 2.2 for group 1 and group 2 respectively. However, these differences were not statistically significant ($p = 0.974$). The average decreases in nocturnal VAS scores after therapy were -2.9 ± 2.6 and -2.8 ± 2.7 for group 1 and group 2 respectively. However, these differences were not statistically significant ($p = 0.896$).

A decrease was observed in ODI scores after therapy for both in group 1 and group 2 (Table 5). The average decreases in rest VAS scores after therapy were -9.6 ± 13.4 and -6.2 ± 10.2 for group 1 and group 2 respectively. However, these differences were not statistically significant ($p = 0.356$).

Table 6 shows the mean values for spine joint mobility before and after therapy of groups. An increase was observed in extension distance after therapy for both in group 1 and group 2 (Table 6). The average

Table 5
Visual analog scale (VAS) and Oswestry disability index (ODI) scores before and after therapy of groups

		Before therapy	After therapy	P
VAS (Rest)	Group 1	3.0 ± 2.9	0.8 ± 1.6	0.003
	Group 2	4.8 ± 3.5	2.9 ± 2.9	0.01
VAS (Mobility)	Group 1	6.1 ± 2.1	3.4 ± 2.2	< 0.001
	Group 2	7.3 ± 1.6	4.5 ± 2.7	< 0.001
VAS (Nocturnal)	Group 1	4.5 ± 3.2	1.5 ± 1.9	< 0.001
	Group 2	5.3 ± 2.9	2.4 ± 2.9	0.001
ODI(%)	Group 1	27.2 ± 16.4	17.7 ± 13.4	0.002
	Group 2	28.1 ± 13.8	21.9 ± 12.4	0.011

Table 6
Spine joint mobility before and after therapy of groups

		Before therapy	After therapy	P
Flexion (cm)	Group 1	58.6 ± 9.8	59.2 ± 10.1	0.666
	Group 2	58.4 ± 16.5	62.2 ± 8.0	0.061
Extension (cm)	Group 1	14.9 ± 4.8	18.0 ± 3.2	0.013
	Group 2	12.8 ± 4.2	15.6 ± 3.9	0.011
Right lateral flexion (cm)	Group 1	13.5 ± 4.2	15.9 ± 5.3	0.057
	Group 2	13.7 ± 5.1	17.6 ± 4.2	0.001
Left lateral flexion (cm)	Group 1	13.9 ± 3.6	15.2 ± 4.3	0.243
	Group 2	12.6 ± 5.5	16.0 ± 6.0	0.001
Lomber Schober (cm)	Group 1	14.8 ± 0.9	15.1 ± 0.75	0.119
	Group 2	15.5 ± 0.75	15.6 ± 0.76	0.452
Fingertip to floor distance (cm)	Group 1	4.2 ± 5.2	2.7 ± 3.6	0.070
	Group 2	6.0 ± 5.0	3.1 ± 4.2	0.001

increases in physical component scores after therapy were 3.1 ± 5.2 cm and 2.9 ± 4.5 cm for group 1 and group 2 respectively. However, these differences were not statistically significant ($p = 0.878$).

4. Discussion

LBP is one of the most prevalent musculoskeletal disorders affecting a large proportion of the population during their lifetime [2]. LBP has lifetime prevalence of 60–85% [32]. Incidence of recurrent or chronic LBP at 3 months, 6 months, and 12 months ranges from 35% to 79% [32]. LBP are essentially a manageable health problem [54]. Disability implies interference with daily activities and impairment implies loss of physical function [53]. A significant disruption of daily activities including sex and sleep has been reported [16]. LBP is a major public health problem and because of disability and incapacity, patient's daily life and their psychological, economic and work status might be difficult. They might lose quality of life, productivity, social status and happiness. Filho et al. claimed that performance and disability were more consistent in evaluating LBP [14]. And to evaluate the efficiency of therapeutic approaches in low back pain we need reliable information concerning patient health status in its physical and psychosocial dimensions [21]. We aimed to investigate the effects of balneotherapy on some body functions and its efficiency on therapy. We found that aerobic exercise capacity and MVV were higher after therapy than before therapy in group 1. Also, pain and disability (VAS, ODI), spine mobility (extension distance), quality of life and the most of psychiatric symptoms were found to be improved in group 1.

LBP is a multifactorial disorder with many possible etiologies [32]. Individual risk factors are heredity, age, sex, posture, height, weight, smoking, physical fitness and physical activities [32]. Risk factors could be important for treatment of the patients with LBP. Toda et al. claimed that trunk and lower extremity loss of muscle mass and central obesity might be risk factors for chronic LBP [47]. Han et al. found that there are no significant interactions between waist and height, or waist to hip ratio and body mass index on LBP symptoms [18]. Celan and Turk studied 122 male bus drivers and claimed that nutritional status, body build, constitution and muscular development are not associated with the incidence of LBP [6]. Brox et al. claimed that deconditioning was more related to psychophysical measures of abdominal and back muscle endurance than to cardiovascular fitness in patients with sub-acute or chronic LBP [3]. Saur et al. found that physical capacity (cardiovascular endurance) in disabled patients with

LBP is substantially reduced in comparison to persons who do not suffer from back pain [43]. Consequently, many possible causes were investigated as risk factors in patients with LBP. In this respect, our study also might enlighten this issue on the basis of some body functions improved with balneotherapy and exercise in patients with LBP.

We measured aerobic capacity with Astrand test in the patients with LBP. Macsween showed the reliability and validity of the Astrand test for deriving VO_2max from submaximal exercise data [31]. The reliability was found to be acceptable for Astrand test, as evaluated by the critical difference in patients with chronic LBP and healthy individuals [24]. Smeets et al. performed a modified Astrand submaximal cycling test in 108 chronic LBP patients, calculated VO_2max, and compared with normative data [46]. Both men and women with chronic LBP patients had significant lower VO_2max than the healthy referents [46]. van der Velde and Mierau stated that the percentile rank of aerobic capacity for the patients with LBP was statistically significant and lower than those measures for the controls [50]. It was also found that anaerobic power and anaerobic capacity which are more sensitive to disability than aerobic capacity were lower in patients with chronic LBP than healthy controls [48]. McQuade et al. evaluated ninety-six persons with chronic LBP with a battery of physical disability measures and basic physical fitness tests [34]. They found that greater overall physical fitness was significantly correlated with less physical dysfunction [34]. Nevertheless, some studies found opposite results about VO_2max as follows: Filho et al. claimed that aerobic capacity might not be a primary concern for patients with LBP [14]. Hurri et al. found that there were no significant changes in the VO_2max in any of the intervention in patients with chronic LBP [20]. In current study, we compared aerobic capacity pre and post treatment in patients with LBP (Table 2). It might be claimed that VO_2max increased significantly after treatment because of improvement of group 1 patients with balneotherapy and exercise. VO_2max might be elevated in group 1 because of increased physical activity level which depends on the improvement in pain, disability, quality of life and other symptoms. These results support above studies [34, 46,50] that they found a relation between aerobic capacity and illness. On the other hand, VO_2max has not changed significantly in group 2 following the treatment; since usually it was aimed better flexibility, muscular strength, and co-ordination with exercise program in patients with LBP. Therefore, aerobic capacity might not be changed in exercise only group. Also we found that exercise therapy is effective in group 1, but VO_2max has not changed after therapy because of the fact that daily physical activity level might not have increased.

RMR measured at basal conditions is the component of energy expenditure that explains the largest proportion (70–80%) of an individual's total daily energy expenditure [17,52]. The BodyGem provides valid and reliable measurements of RMR [33]. BodyGem gives accurate and reproducible oxygen consumption and RMR measurements for nonobese and obese, male and female individuals [36]. Liou et al. stated that RMR obtained using the BodyGem has a high degree of reproducibility and an acceptable validity compared to the Deltatrac Metabolic Monitor in Taiwanese women [30]. In this study, RMR increased significantly after treatment in group 2, but not in group 1 (Table 2). Resistance training reduces body fat, increase basal metabolic rate, improve functional capacity, and relieve LBP [27]. Exercise is a factor that increases RMR [17]. Total muscle mass and muscle metabolism can be enlarged by regular exercise programs. That is why exercise might increase RMR in group 2. However, in group 1, in which RMR also expected to be elevated, this was not the case. This could be because of the fact that balneotherapy might have a restricting effect on RMR. Balneotherapy activates the parasympathetic system [44]. Parasympathetic system decreases many functions of body organs and systems, so an increase in RMR might have prevented in group 1. Body fat percentage was decreased in group 2 after treatment and this finding is appropriate with increased RMR. Other factors such as nutrition might have played a role in decreased body fat percentage in group 2 after treatment. Body weight, BMI and body fat percentage not statically different before and after therapy in group 1. This results show that body composition was not affected from balneotherapy with exercise in patients with LBP.

Pulmonary function tests; MVV was increased in group 1 after treatment (Table 3). This result might have resulted from increased respiratory muscles performance in group 1 and are relevant to increased VO_2max. FEV_1/FVC and FEF_{25-75} measurements of PFTs were decreased in group 2 after treatment and these might be because of the negative or unexpected effects of exercise on pulmonary function as exercise may induce bronchospasm for some people [49]. However, balneotherapy containing hot water might remove this negative effect in group 1. Nevertheless, it was the fact that all PFTs did not exceed normal limits before and after treatment in both groups, and also some of them not statistically were different before and after treatment. This situation implies that PFTs were not affected strongly from exercise and balneotherapy in LBP patients.

Shutov and Panasiuk stated that pain relieved and psychovegetative status improved in patients with LBP can be treated with balneopelotherapy [45]. In this study, an improvement was observed in quality of life and the majority of psychiatric symptoms except anxiety in both groups (Table 4). Anxiety was not removed after therapy in both groups; this state might be expected in patients with LBP since anxiety is minor symptom than depression. Balneotherapy activates the parasympathetic system and accordingly increased accumulation of acetylcholine in the central nervous system may be a factor of its sedative effect [44]. During balneotherapy, releasing of beta-endorphin plays a role in producing sedation [29]. However, improvements in the symptoms of LBP, decreasing stress level and feeling well might have a positive effect on psychological status of patient with LBP. Furthermore, this psychologic improvement might lead to success in patients' social life.

There is encouraging evidence suggesting that balneotherapy may be effective for treating patients with LBP [38]. The data from the systematic reviews and meta-analysis suggest significant differential effects in favor of balneotherapy for reducing low back pain [23, 40]. Balogh et al. demonstrated that balneotherapy itself can alleviate LBP, by the analgesic efficacy (VAS) and improvement of mobility (flexion-extension and rotation of the spine and Schober's index) accomplished by the use of mineral water is significantly superior to that afforded by hydrotherapy with tap water [2]. On the other hand Konrad et al. treated 35 patients with LBP for 4 weeks and they found that pain score (VAS) was significantly reduced but no significant change occurred in spinal motion (flexion, extension and lateral flexion) tests [26]. Evaluations of ODI for Low Back Pain: The score 0-20 % is minimal disability; 21–40 % is medium disability; 41-60 % is serious disability; 61–80 % is handicapped [12,13]. In current study, group 1 was in medium disability before therapy, but the same group was in minimal disability after therapy (Table 5). In this study, VAS (rest, mobility and nocturnal) scores decreased significantly after therapy in both groups (Table 5). These results show that balneotherapy is an effective treatment for LBP as reported above [2,26, 38]. The common action mechanism of balneotherapy is to increase pain threshold by affecting sensory and muscle nerve endings. Beta-endorphin releasing and washing out the pain mediators by peripheral vasodilatation also play a role in producing analgesia [29]. Extension distance was increased after therapy in both groups (Table 6). But other spine joint mobility tests not significantly changed in group 1 after therapy as reported above [26]. Because balneotherapy center was outside of the city center, group 1 patients might have affected negatively by cold weather.

Exercise is safe for individuals with back pain, because it does not increase the risk of future back injuries or work absence [41]. Fitness programmes comprise exercises for flexibility, aerobics, coordination, muscular strength and endurance [28]. Exercise can be useful for improving impairments in function that are frequently present in patients with chronic LBP, including reduced back flexibility, strength and cardiovascular endurance [41]. There is modest evidence to suggest that the regular performance of exercise may directly reduce back pain intensity [8]. Similarly, in our study, in agreement with above reports, exercise treatment had an improvement shown by questionnaires (VAS, ODI, HAD-depression, SCL-90-R, SF36) and spine joint mobility tests (extension, right and left lateral flexion, lomber Schober, fingertip to floor distance) (Tables 4, 5 and 6). It also increased RMR and decreased body fat percentage in group 2 (Tables 1 and 2). Therefore, exercise therapy which is cheap and easy appears to be effective at relieving pain and improving some body functions in patients with LBP [8,19].

LBP is one of the most frequent symptoms and its chronicity causes considerable socioeconomic costs in many countries [21]. Patients with LBP are a significant concern for both health care professionals and employers [9]. Physical and mental health co-morbidities and measures of analgesic use were associated with chronicity, healthcare utilization and costs [42]. In its various forms, LBP is a devastating individual, social, and economic burden with costs estimated at $20 billion per year annually in the United States, and about 10% of that amount per year in the United Kingdom [26]. The 29.4% of workers who perceive to have LBP, which limits their daily activities substantially is, however a point of concern for this specific industry [51]. Galukande et al. show that back pain was a significant cause of disability particularly affecting the productive middle years of adult life [16]. This has social and economic implications, as well as economic loss to the worker, employer and society. The ultimate effects of LBP are that the individual's ability for competitive employment and opportunity are lessened [16]. Importance of suitable treatment is evident when we consider high prevalence of LBP, health problems, work and economic loss from LBP. Suitable treatment means useful, effective and cheap therapy for patients with LBP. In this study, balneotherapy with exercise that decreased pain (VAS), disability (ODI) and psychiatric symptoms (depression), while it increased spine mobility (extension distance), quality of life (SF 36), SCL-90-R), aerobic exercise capacity (VO_2max) and pulmonary function (MVV) in patients with LBP. So, it could be one of the alternative therapy methods. Especially, the countries having widespread thermal sources can utilize this alternative therapy much cheaper. In Turkey, it could be concluded that nearly all forms of spa therapy and balneotherapy used for the treatment of rheumatic diseases including LPB are effective [23]. Given the fact that there are many licensed balneotherapy centers in Turkey [10]; balneotherapy might contribute a lot to manage LBP treatment that is most important public heath problem.

4.1. Study limitations

Initially a total of 60 patients were planned to enroll for this study. Numbers of LBP patients who were referred to Physical Treatment and Rehabilitation Clinic in the study period not reached to 60 due to time limit. However, since only a total of 54 patients were referred for the study during the planned period of investigation, and some patients (10 out of 54) also didn't participate in last assessments, a total of 44 patients were studied at the end and the data were obtained only for them. Secondly, the study was performed during the cold climate season which might have affected balneotherapy patients because balneotherapy center was about 10–15 km outside of the city center.

In conclusion, only exercise therapy or balneotherapy with exercise improve the most symptoms of LBP but only balneotherapy with exercise increased aerobic exercise capacity and respiratory muscles performance which they imply an elevated daily physical activity level in LBP patients. Balneotherapy with exercise could be alternative treatment in patients with LBP.

Acknowledgments

This study was supported by Kocatepe University the Committee of Scientific Research Projects (Project No: 042.TIP.16).

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