J. Phys. Ther. Sci.
24: 725–729, 2012

Physical Fitness of Patients with Nonspecific Low Back Pain Who Performed a Progressive Four-week Fitness Exercise Program

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Abstract. [Purpose] The purpose of this study was to determine the physical fitness performance and health-related quality of life of patients with nonspecific low back pain (LBP) after a 4-week supervised fitness exercise intervention in addition to routine physical therapy. [Subjects] Twenty-four patients with nonspecific LBP participated in this study. [Methods] All participants completed either an additional supervised fitness exercise along with conventional physiotherapy twice a week for 4 weeks, or conventional physiotherapy only. Physical fitness, visual analogue scale of pain, the modified Roland–Morris Disability scale, and SF-36 assessments were made before and after the intervention. [Results] Significant improvements were found in physical fitness, including trunk flexors/extensors endurance, lower extensor strength, reaction time of the upper extremity, and the body pain domain of SF-36 after fitness exercise compared to the conventional physiotherapy alone. Decreases in pain intensity were found after treatment in both groups. [Conclusions] A 4-week supervised fitness exercise program was effective at reducing pain intensity and alleviating disability. It also improved trunk muscle endurance, lower extensor strength, and the body pain domain in health related quality of life of patients with nonspecific LBP.
Key words: Lower back pain, Physical fitness, Health-related quality of life

(This article was submitted Feb. 7, 2012, and was accepted Mar. 28, 2012)

INTRODUCTION

Low back pain (LBP) is a persistent disabling condition which impairs performance of daily activities resulting in physical inactivity. Compromised mobility and declines in physical fitness have detrimental effects upon physical, psychological, and social functions causing significant health, social, and economic costs[1–5]. Patients with LBP demonstrate deconditioning-related physiological changes—such as muscle atrophy, changes in metabolism, osteoporosis, and obesity—as well as functional changes, such as decrease in cardiovascular capacity and muscle strength, and impaired motor control[6]. Compared to the healthy normative population, evidence of reduced levels of aerobic capacity together with increased body fat percentages has been demonstrated in nonspecific LBP patients[7]. Moreover, increased LBP intensity is significantly associated with poor back muscle endurance, which is an important physical fitness component in the prevention of LBP[8]. Physical fitness has been demonstrated to be a risk indicator of increased LBP intensity[9]. The level of physical fitness of patients with LBP is comparable to the physical fitness of healthy but poorly conditioned subjects. The enhancement of patients' levels of physical fitness has been an important goal in rehabilitation treatment for LBP; based on the hypothesis that physical deconditioning contributes to LBP chronicity. For deconditioned patients with LBP, physical reconditioning is an essential component of their rehabilitation program.

Physical fitness can be described as a set of attributes related to an individual's ability to perform daily tasks or physical activities and it includes cardiorespiratory fitness, musculoskeletal fitness, motor fitness, and body composition. These attributes can also be classified as fitness components including cardiorespiratory endurance, muscular endurance, muscular strength, body composition, and flexibility and as skill = related components, such as agility, balance, coordination, speed, power, and reaction time[10, 11].

Current evidence supports the use of exercise-based treatments for chronic LBP. Staying active together with exercise therapy encourages the patient to assume an active role in their recovery, which can prevent recurrence, reduce pain, improve functional status, and decrease disability in patients with chronic back pain. Exercises such as stretching, strengthening, and aerobics[9] are included in the interventions for LBP management[12–14], and they have been demonstrated to alleviate pain intensity and disability, and improve flexibility[15]. A meta-analysis by Hayden and colleagues suggested that the most effective strategy for improving back pain was an individually designed exercise program that included home-based supervision and a relatively intensive exercise regimen[16]. It has been previously observed that supervised fitness programs in the management of moderately disabled patients with chronic LBP led to significant improvements after treatment in the Oswestry LBP disability index, pain reports, self-efficacy reports, and walking distance[17]. Carr et al. compared the effects of a group exercise program known as the "Back to Fitness program" with individual physiotherapy for patients with nonspecific LBP. They observed minor improvements in disability scores in the Back to Fitness group and the individual physiotherapy group at 3 months and 12 months, respectively[18]. Moreover, LBP patients undergoing exercise therapy showed statistically significant improvements in aerobic capacity as well as statistically significant decreases in pain and disability scores[19, 20].

Despite these data, there is no comprehensive analysis of the physical fitness of nonspecific LBP patients who have performed a 4-week supervised fitness exercise program in addition to conventional physical therapy. Therefore, the purpose of the present study was to investigate the effects of a short-term, 4-week, supervised fitness exercise program on the physical fitness of nonspecific LBP patients.

SUBJECTS AND METHODS

The participants of this study were patients with nonspecific LBP, aged between 20 and 65 years, who were referred to the outpatient physical therapy service of a medical center in Taiwan. Patients with back pain due to nerve root irritation, herniated disc, infection, spinal tumor, spine structure abnormalities (e.g., spondylolisthesis, idiopathic scoliosis, or fracture), pregnancy, upper motor neuron lesions, conditions affecting the ability to perform supervised fitness exercise, and inability to communicate satisfactorily were excluded from the study. Informed consent was obtained from the patients after the procedures had been fully explained. Appropriate ethical approval by the Institutional Review Board/ Chang Gung Memorial Hospital (IRB/CGMH) was also obtained prior to the commencement of the study.

The patients were allocated randomly to one of the following 2 groups: the supervised fitness exercise group in which participants performed 8 sessions of supervised fitness exercise combined with an individualized conventional physiotherapy program, or the control group in which participants performed an individualized conventional physiotherapy program alone.

The fitness program used in this study followed the Back to Fitness program reported by Moffett et al. in 2000[20]. The program consists of eight 1-h sessions over a 4-week period. The aims of the Back to Fitness program for the participants are as follows: (1) to improve physical function; (2) to increase confidence in using the spine normally; (3) to cope with the present episode and future relapses; and (4) to make participants independent of healthcare professionals. The exercises in the program are specifically aimed at strengthening and stretching the major muscle groups, particularly, the trunk muscles, and increasing cardiovascular fitness. The program starts with a warm-up and stretching and is followed by individual exercises, warm-down, and back care education messages as tips for the day; it ends with a relaxation session. All the components were demonstrated using figures and instructions. Participants were encouraged to work up to level 13, categorized as "somewhat hard" on the Borg perceived exertion scale, which was used as a guide for deciding on when to progress to the next level in the absence of increased back/leg pain or any other changes in neurological symptoms. The entire fitness program was supervised by a senior physiotherapist. In addition to the fitness program, each participant received conventional physiotherapy, such as thermotherapy, electrotherapy, traction, ultrasound, or laser as individually prescribed.

The outcome measures used in this study were as follows: a visual analogue scale (VAS) was used for pain intensity; the modified Roland–Morris Disability Questionnaire (RMDQ) was used for functional limitations[21]; and the Taiwan version Short Form-36 (SF-36) was used with permission for HRQoL. Physical fitness evaluation included cardiorespiratory fitness (a 3-minute step test as a physical endurance index of cardiorespiratory capacity); musculoskeletal fitness (muscle strength and endurance, trunk flexibility); motor fitness, such as the ruler drop-grasp reaction time; eye closed standing balance; and body composition (Body Mass Index, BMI) [10].

All study data were collected using a computerized database, and SPSS version 10.0 (SPSS Inc., Chicago, Illinois) was used for statistical analysis. Descriptive statistics are presented as mean (standard deviation). The χ^2 test was used to analyze the demographic data of both groups. The paired Student's t-test was used to analyze differences in outcome measures before and after treatment in both groups. The independent Student's t-test was used to compare changes in outcome measures before and after treatment between the groups. Statistical significance was as accepted for values of $p < 0.05$.

RESULTS

Twenty-seven patients were enrolled in this study. Three patients failed to complete the 4-week exercise intervention or did not complete the post-intervention assessments. The demographic data of the participants in this study are shown in Table 1. At baseline, there were no statistically significant differences between the fitness group and the control group in outcome measures, except for the straight leg raise. As presented in Table 2, VAS had improved significantly ($p<0.05$) after the intervention in both groups (from 5.7 to 3.0 cm in the fitness group; from 4.9 to 2.3 cm in the

Table 1. Subject demographics

	Fitness group (n = 13)	Control group (n = 11)
Age (years)	34.8 (12.3)	37.1 (9.9)
Height (cm)	165.1 (9.2)	165.1 (6.4)
Weight (kg)	61.0 (14.4)	62.7 (15.4)
Gender (M:F)	4:9	5:6
Regular physical activity (less than once per week)	9 (69.2%)	9 (81.8%)
Pain duration more than 3 months	9 (69.2%)	5 (45.5%)
Without radiating pain	8 (61.5%)	6 (54.5%)

Note: Values of age, height, and weight shown as mean (SD)

control group), while RMDQ only improved in the group with fitness intervention (p<0.05). Back and leg extensor strength, trunk flexor endurance, trunk extensor endurance, finger-to-floor distance, and ruler drop-grasp reaction time were significantly improved in the fitness group compared to the baseline after the intervention. There were significant differences in changes in trunk flexor endurance (sit-ups) as well as the ruler drop-grasp reaction time between the fitness group and the control group. The post-intervention functional capacity of the control group did not differ significantly from the baseline. On the SF-36 scale, bodily pain (BP) was the only domain that improved in the fitness group after the 4-week additional fitness intervention (p < 0.05); however, changes in the scores of the other SF-36 subdomains were not significantly different between the two groups as shown in Table 3.

DISCUSSION

In this study, individualized, supervised progressive fitness exercises were conducted for patients with nonspecific LBP for 4 weeks in addition to conventional physical therapy. Significant improvements were observed in musculoskeletal fitness in the fitness group (functional strength of the leg as lifting capacity, and trunk flexors and extensor muscle endurance and motor fitness as ruler drop-grasp reaction time), whereas the control group showed only a significant reduction in pain intensity. In our study, significant improvements were noted in pain intensity and RMDQ in both patient groups, i.e., those receiving the additional fitness program as well as the control group receiving conventional physical therapy alone. In both the groups, RMDQ improved by more than 2–3 points, i.e., a clinically important change was observed[22]. Among the HRQoL measures, only the BP domain scores improved in the group undergoing the additional fitness program, which might imply that as pain reduced, the perception of well-being improved.

Interestingly, improvements in the ruler drop-grasp reaction time in this study were observed. This is similar to the finding of Stacey et al. who demonstrated a significant

Table 2. Pain, disability, and physical fitness post-intervention

	Fitness group (n = 13)			Control group (n = 11)		
	Baseline	Post-intervention	Change (%)	Baseline	Post-intervention	Change (%)
VAS (cm)*† ‡	5.7 (2.4)	3.0 (1.9)	–43.1 (33.0)	4.9 (2.6)	2.3 (1.4)	–34.0 (56.6)
RMDQ*†	74.9 (8.8)	62.1 (14.6)	–16.1 (21.5)	78.6 (11.1)	66.0 (18.3)	–15.2 (22.8)
BMI	20.0 (3.6)	22.0 (3.3)	–0.0 (1.66)	22.8 (4.3)	22.6 (4.3)	–0.6 (1.41)
Grasp strength (kg)	30.5 (9.0)	31.9 (9.1)	6.0 (17.3)	34.0 (13.4)	34.1 (12.3)	2.0 (9.21)
Leg extensor strength (kg)*†	72.7(41.6)	81.8 (42.5)	16.1 (26.7)	95.3 (52.4)	100.2 (51.9)	6.77 (11.27)
Trunk flexor endurance (times per min)*†§	23.9 (10.4)	33.62 (11.0)	54.53(49.9)	23.7 (17.2)	23.9 (15.3)	–3.1(12.2)
Trunk extensor endurance (times per min)*†	27.9 (14.7)	33.62 (14.9)	50.3(102.9)	27.5 (20.5)	25.18 (22.49)	2.7 (62.9)
Lumbar flexion (degrees)	48.0 (13.3)	45.2 (14.2)	–5.3 (14.3)	47.5 (12.3)	45.3 (10.4)	–0.5(26.6)
Lumbar extension (degrees)	19.2 (11.9)	15.2 (10.3)	2.97 (83.1)	10.6 (4.4)	11.9 (3.6)	21.8 (46.2)
Left side flexion (degrees)	19.2 (3.4)	18.0 (5.2)	–6.1 (24.5)	17.6 (3.8)	16.1 (6.4)	–8.7(30.2)
Right side flexion (degrees)	19.5 (5.0)	17.6 (4.6)	–7.0 (22.4)	18.0 (3.5)	17.5 (3.6)	–1.0(20.5)
Left side rotation (degrees)	35.9 (12.9)	33.0 (8.2)	–2.2 (23.5)	33.0 (13.0)	31.6 (13.5)	–2.1(23.5)
Right side rotation (degrees)	31.7 (11.2)	30.3 (7.8)	3.9 (31.6)	30.3 (9.9)	31.4 (11.1)	8.0 (32.9)
Fingertip-to-floor (cm)*†	–5.0 (11.9)	–2.9 (11.5)	30.3(112.9)	–1.5 (12.2)	–0.9 (10.1)	–7.6(48.0)
SLR (degrees)*§‖	88.3 (9.6)	88.9 (10.8)	0.8 (8.99)	79.5 (8.2)	81.9 (8.6)	3.31 (6.7)
Reaction time (milli second)*†§	245.2 (109.5)	186.6 (23.0)	–18.2 (15.7)	194.2 (22.6)	194.0 (21.2)	0.4 (9.2)
One-leg standing (sec)	7.0 (4.4)	8.2 (3.3)	35.7 (55.9)	5.4 (3.2)	6.4 (7.7)	6.98 (46.5)
Cardiopulmonary endurance index	54.2 (6.3)	57.7 (12.2)	6.3 (18.6)	51.2 (17.2)	56.4 (19.5)	9.8 (15.5)

Note: Values represent mean (SD); * p<0.05. † Baseline vs. post-intervention in the fitness group. ‡ Baseline vs. post-intervention in the control group. § Post-intervention, between control and fitness groups. || Baseline, between control and fitness groups

Table 3. SF-36 scores of the fitness exercise group and the control group

	Fitness Group (n=13)		Control Group (n=11)	
	Baseline	Post-intervention	Baseline	Post-intervention
PCS	45.7 (6.2)	50.0 (9.1)	47.1 (6.8)	47.0 (7.8)
MCS	42.9 (11.4)	45.9 (10.0)	40.3 (13.4)	44. 5 (9.2)
PF	82.9 (10.9)	81.9 (12.5)	76.8 (18.2)	75.0 (20.4)
RP	50.0 (38.2)	76.9 (43.9)	61.4 (39.3)	63.6 (46.6)
BP*	48.7 (17. 7)	68.5 (17.6)	54.0 (21.5)	65.1 (12.9)
GH	54.0 (23.2)	58.9 (20.0)	53.6 (26.2)	52.3 (27.3)
VT	55.4 (17.9)	61.2 (15.3)	49.6 (22.2)	52.7 (23.1)
SF	68.3 (18.8)	76.0 (18.7)	67.1 (23.2)	76.1 (13.1)
RE	56.4 (43.85)	79.5 (34.80)	60.6 (46.7)	75. 8(36.8)
MH	62.5 (15.28)	62.8 (16.7)	54.2 (24.3)	57.8 (18.7)

Note: Values represent mean (SD); * indicates statistical difference between baseline and post-treatment in the fitness group, $p<0.05$. PCS: physical component summary score; MCS: mental component summary score; PF:physical functioning domain; RP: role-physical domain; domain; BP: bodily pain domain; GH: general health domain; VT: vitality domain; SF: social functioning domain; RE: role-emotional domain; MH: mental health domain

reduction in reaction time after 66 volunteers over fifty years of age from a fitness club had completed a 3-week fitness program[23]. Although this was not among the specific aims of the study, this finding indicates that the reaction time improved with motor fitness. Several studies have shown that pain influences the reaction time of patients suffering from LBP. Taimela et al. showed that patients with LBP had longer reaction times than healthy adults[24]. Moreover, Kusters reported that patients with chronic low back pain (CLBP) have worse motor task performance that provoked pain-related inhibitions which further worsened performance[25]. However, Luoto et al. demonstrated that patients with chronic low back pain have impaired psychomotor speed (reaction time) which could be successfully restored by an active, functional back rehabilitation program[26]. In the present study, we observed that patients in the supervised fitness exercise had shorter reaction times than those in the control group that could be attributable to a reduction in pain intensity.

The HRQoL scores assessed by SF-36 in this study did not significantly change in either of our groups, except for the BP score, which improved significantly in the fitness group. These results are similar to the results of Carr et al., who observed minor improvements in disability scores assessed by SF-12 in the Back to Fitness group and in the individual physiotherapy group at 3 months and 12 months, respectively. However, there were no statistically significant differences in the scores of the two groups for the primary outcome measures at 3 months[18]. Our present results show that 4 weeks of fitness training may significantly improve SF-36 scores for physical domains. The comparison of average SF-36 scores (Taiwan version)[27] revealed that LBP patients in the fitness exercise group showed improvements only in the PF, BP, and MH domains, whereas the control group showed improvements in the GH, VT, and SF domains, but there were no significant differences between the 2 groups, except in bodily pain. This result indicates that additional fitness exercises as an intervention strategy only affected HRQoL of LBP patients minimally in the short-term exercise program. Rainville et al. reported that there is substantial evidence to support the use of exercise as a therapeutic tool for improving impairments in back flexibility and strength, with improvements in global pain ratings after exercise programs[28]. Furthermore, previous studies reviewed by Rainville et al. concluded that exercise can improve behavioral, and cognitive effects, and disability aspects of chronic back pain syndromes[14]. However, the SF-36 used in this study is a generic questionnaire and may therefore not be sensitive enough to disease-specific changes[29] in the psychological domains measured in this investigation. In contrast, the LBP-specific Roland–Morris Disability scale showed statistically significant improvements in the fitness group that were not observed in the control group.

Bronfort et al.[30] showed that supervised exercise was significantly better than interventions such as chiropractic manipulation and exercise at home in terms of satisfaction with treatment and trunk muscle endurance and strength of CLBP patients, with consistent short-term (12 weeks) and long-term (52 weeks) differences between groups in patient-rated pain, disability, improvement, general health status, and medication use. However, these differences were relatively small and not statistically significant for individual outcomes. Although our study and intervention periods were rather short, only 4 weeks, the fitness group still showed statistically significant improvements in musculoskeletal fitness, lower trunk muscle endurance and strength compared to the control group.

The interpretation of this work is limited by the small sample size, though the results are statistically significant. Also, the reliability of measurements of the ruler drop test are not well established. In addition, the study was conducted only for a short duration (4 weeks) and it needs to be implemented as a large-scale randomized clinical trial. Such a study would be useful in evaluating the long-term effects of the intervention on the quality of life of nonspecific LBP patients.

ACKNOWLEDGEMENTS

This research study was supported in part by grant NSC95-2314-B182-046 from the National Science Council, Taiwan.

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