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A Wide Variety of Exercise Programs Improve Pain and Disability in Chronic Low Back Pain Populations

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Abstract

Background: LBP has an ongoing prevalence of 60-85% globally. CLPB patients display poor trunk muscular endurance and decreased proprioception and spinal stability. Based on the pathology of CLBP, it has been proposed that exercise training of the lumbar spine will improve clinical outcomes in these patients. There is still much debate around what type of exercise is most beneficial for patients with CLBP.

Methods: The PubMed database was searched on August 8, 2016 to identify studies relevant to this review. The database search combined terms from three themes: 1) LBP patients 2) exercise programs and 3) pain or function. This search yielded 197 articles for screening, with no duplicates. Abstract screening yielded 70 articles that potentially met the inclusion criteria. A total of 24 articles were included in the final review.

Results: Core stabilization and strengthening programs as well as general exercise programs improve clinical outcomes in chronic low back pain patients without evidence of lumbar disc degeneration. Core stabilizing and strengthening exercises are more effective at increasing lumbar stability than general exercises. The CORE and Godelieve Denys-Struyf programs, McKenzie protocol, Back School method, motor control, and graded activity programs, as well as yoga, general exercise, stretching, Pilates, Tai Chi, pedometer driven walking, high intensity aerobic exercise, resistance exercise training, and sling exercise training can improve pain and disability in chronic low back pain populations.

Conclusion: A wide variety of exercise therapies have been demonstrated to effectively improve pain and disability in chronic low back pain populations. Exercise therapy should be part of routine management of chronic low back pain. Exercise prescription should be tailored to each individual patient's lifestyle and preferences to enhance compliance.

Keywords: Chronic low back pain; Exercise therapy; Core muscle strengthening

Abbreviations: LBP: Low Back Pain; CLBP: Chronic Low Back Pain; RCT: Randomized Controlled Trial; CE: Combined Exercise; CSE: Core Stabilizing Exercise; TBR: Total Body Resistance; MCE: Motor Control Exercise; SBEE: Static Back Extensors Endurance; DBEE: Dynamic Back Extensors Endurance; SB: Supine Bridge; PB: Prone Bridge: CMS: Core Muscle Strengthening

Introduction

Low back pain (LBP) has an ongoing prevalence of 60-85% globally, with its incidence increasing in developed countries [1]. It is a great source of social and economic losses in the form of time off work and health care expenses [1]. The most common cause of LBP is injury to low back structures [2]. It can be difficult to properly diagnose LBP and to identify the causal factor in individual cases and recurrence is very common [2]. Chronic LBP (CLBP) patients display weaker and unbalanced deep lumbar muscles, poor trunk muscular endurance, and decreased proprioception and spinal stability, compared to people without LBP [3]. Based on the pathology of CLBP, it has been proposed that exercise training of the lumbar spine will improve clinical outcomes in these patients [4]. There is still much debate around what type of exercise is most beneficial for patients with CLBP [4]. It is also pragmatic to consider the lifestyle and preferences of the patient when deciding what exercise program to prescribe. The failure of exercise programs to maintain a state of recovery from CLBP, or to prevent recurrences, is largely due to discontinuation of these programs by patients [5]. Therefore, it is reasonable to assume that an exercise program that the individual is capable of performing in the short term recovery phase, and likely to sustain in the long term maintenance phase, will most likely provide the highest patient adherence and best long term outcome. This review of the literature will attempt to answer the research question: Do a wide variety of exercise programs significantly improve pain and disability scores in patients with CLBP?.

Literature Review

The PubMed database was searched on August 8, 2016 to identify studies relevant to this review. The database search combined terms from three themes: 1) LBP patients, 2) exercise programs, and 3) pain or function. Filters used were: randomized controlled trial (RCT), full text, 2011-2016, and human species. This search yielded 197 articles for screening, with no duplicates. Abstract screening yielded 70 articles that potentially met the inclusion criteria. A total of 24 articles were included in the final review.

Inclusion criteria

To be included in the systematic review of this study, all articles had to meet the following criteria: 1) RCT; 2) CLBP population; 3) exercise therapy as intervention; 4) traditional conservative treatment or alternative exercise therapy as comparison; and 5) pain or function as an outcome measure. CLBP was defined as LBP of more than 8 weeks duration and exercise therapy as any physical activity.

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Exclusion criteria

Articles were excluded if published prior to 2011 and/or were not published in English.

Results

Core strengthening and stabilization exercise

Articles reviewed in this section are summarized in Table 1.

Core stabilization and strengthening programs for CLBP patients and their outcomes: A 6 week trunk stability exercise (TSE) program compared to a combined exercise (CE) program demonstrated a larger decrease in sway length compared to the CE group ($p<0.05$) and visual analogue scores of both groups decreased significantly ($p<0.05$) [2]. An 8 week general exercise plus core stability exercise (CSE) program was compared to a general exercise (GE) only program; both groups demonstrated significantly decreased translation and rotation of the lumbar vertebra, except for L3 translation in the GE only group [4]. The mean values of translation of the L4 ($p=0.04$) and L5 ($p=0.00$) and rotation of L5 ($p=0.00$) had significantly decreased in the CSE group compared to the GE only group [4]. A 10 week core stabilization program for CLBP patients with lumbar disc degenerative changes seen on MRI was compared to control; no between group differences were observed for any outcomes at any time points ($p=0.08$-0.9), however all participants together demonstrated a small significant improvement in pain ($p = 0.004$) and disability ($p=0.00$) [6]. An 8 week course of supine bridge (SB) exercise, supine bridge on Swiss ball (SBSB) exercise, and prone bridge (PB) exercise were compared to each other; all groups showed statistically significant improvement in lumbar flexion and extension joint position sense, as well as disability scores [3]. The SB group demonstrated a greater improvement in lumbar flexion, extension, and ODI score compared to the PB group [3]. The SBSB group demonstrated a greater improvement in lumbar extension and ODI compared to the PB group [3]. A 4 week core muscle strengthening (CMS) program was compared to control; both groups demonstrated a decrease in pain levels, however the CMS group experienced a greater decrease in pain ($p<0.01$) [7]. Both groups demonstrated a significant reduction in anterior/posterior and medial/lateral sway; the CMS group showed a larger reduction in anterior/posterior sway than control ($p=0.04$) [7]. A 4 week core stabilizing exercise (CSE) program was compared to spinal flexibility exercise; the CSE group demonstrated a 28.8% reduction in disability ($p<0.05$) while the SFE group demonstrated an 8.3% reduction in disability ($p<0.05$) [8].

Rehabilitative systems and motor control exercise

Articles reviewed in this section are summarized in Table 2.

Motor control and rehabilitative programs for CLBP patients and their outcomes: A 4 week CORE exercise program was compared to control; the CORE exercise group demonstrated improvements in pain at rest and with movement compared to control ($p<0.05$) [9]. The CORE exercise group also demonstrated an improvement in pain

References	Population	Intervention and control	Outcome measures	Effect of intervention
Hwangbo G et al., [2]	30 CLBP patients, mean age 34.3 years	a. TSE bridge and crunch exercise 60 min sessions, 3x/week, 6 weeks. b. CE muscle resistance and fast walking exercise 60 min sessions, 3x/week, 6 weeks.	VAS Postural sway (Bio-rescue)	Significantly decreased sway length and sway area and VAS in both groups TSE group had greater decrease in sway length compared to CE group
Javadian Y et al., [4]	30 NSCLPB patients, mean age 31.2 years	a. Treatment, general exercise plus core stability exercise, 60 min sessions, 3x/week, 8 weeks plus at home daily. b. Control, general exercise, 60 min sessions, 3x/week, 8 weeks plus at home daily.	translation and rotation of lower 3 lumbar vertebrae in sagittal plane	Mean translation and rotation significantly decreased in both groups, except for L3 translation in control group Mean values of translation of L4, L5 and L5 rotation significantly lower in treatment group compared to control
Jensen RK et al., [6]	96 CLBP with modic changes, mean age 46 years	a. Treatment group, stabilizing exercises in groups of 10 maximum, 1 hour/week for 10 weeks, supervised at home 3x/week. b. Control groups no exercise. After 10 weeks, both groups encouraged to be physically active.	11 point NRS RMDQ EQ5D	No differences between groups for any outcomes after treatment at any time point
Kong YS et al., [3]	38 CLBP patients, mean age 41.3 years	a. Supine bridge group. b. Supine bridge on swiss ball group. c. Prone bridge group. Each group performed 3 sets/day, 3x/week for 8 weeks, supervised.	Trunk propioception (Zebris) ODI	Statistically significant decrease in ODI scores for all groups. Statistically significant improvement in trunk flexion and extension joint position sense in all groups. No improvement in trunk lateral flexion or rotation joint position sense in any group. Greater improvement in lumbar flexion, extension, and ODI in Supine bridge compare to prone bridge group. Greater improvement in lumbar extension and ODI in supine bridge on swiss ball compared to prone bridge group.
Rhee HS et al., [7]	42 CLBP patients, mean age 51.4 years	a. Exercise group, exercises performed in lab 3x/week for 4 weeks plus 5x/week at home. b. Control group, medical management booklet.	million VAS ODI balance sway	pain decreased significantly in both groups, but greater decrease in exercise group ODI scores increased in both groups decreased sway in both groups, greater decrease in A/P sway in exercise group
Sung PS, [8]	46 CLBP patients, mean age 50.4 years	a. Core stabilization. b. Spinal flexibility. Both groups 20 min sessions, 1x/week for 4 weeks supervised in lab, plus at home 5x/week.	ODI EMG (Sorensen prone fatigue test)	Disability significantly decreased in both groups, greater decrease in stabilization group compare to flexibility group. No changes in EMG observed in either group

Table 1: Core stabilization and strengthening programs for CLBP patients and their outcomes.

Reference	Population	Intervention and control	Outcome measures	Effect of intervention
Cho HY et al., [9]	30 CLBP patients, mean age 37 years	a. CORE program 30 min sessions, 3x/ week for 4 weeks. b. Routine care control.	VAS 10cm PPT with algometer aROM with inclinometer	CORE group significantly greater improvement in VAS at rest and during movement compared to control. CORE group PPT significantly increased compared to control. CORE aROM of trunk flexion significantly increased compare to control
DiazArribas MJ et al., [10]	461 subacute and CLBP patients, mean age 47 years	a. GDSG group – 11 sessions in groups of 1012 participants, two 50 min sessions/ week for 5.5 weeks. b. GDSI group-Same sessions as GDSG group plus four 50 min manual therapy sessions over 7.5 weeks. c. Routine care + physical therapy control (including standard exercise).	11 point NRS RMDQ	GDSG group had higher improvement in disability than control. GDSI and control had similar improvement in disability. GDSG group had greater improvement in referred pain down the leg.
Garcia AN et al., [11]	148 CLBP patients, mean age 53.9 years	a. McKenzie group supervised 1 hour sessions/week over 4 weeks and at home daily. b. Back School group 4 sessions, 1 hour/ week.	11 point NRS RMDQ	Pain intensity and disability reduced in both groups after 1 month treatment. Greater reduction in disability in McKenzie group. No difference in pain reduction between groups.
Mbada CE et al., [12]	67 CLBP patients, mean age 51.8 years	a. McKenzie protocol. b. McKenzie plus static endurance exercise. c. McKenzie plus dynamic endurance exercise. All group sessions 3045 min, 3x/week, for 8 weeks.	SF36	All groups showed significant improvement. McKenzie plus static and dynamic endurance exercise groups had significantly greater improvement in SF36 compared to McKenzie only at week 4 and 8 respectively. McKenzie plus dynamic endurance exercise had greater improvement than static endurance group on some SF36 domains at week 8.
Macedo LG et al., [13] & Macedo LG et al., [14]	172 CNSLPB patients, mean age 49.1 years	a. motor control exercises, contract trunk muscles in specific manner. b. graded activity, increase activity tolerance and address negative behaviours, pain related anxiety. Both groups received individually supervised 1 hour sessions, 14 sessions in total over 8 weeks plus at home exercise and 2 booster sessions at 4 and 10 months.	11 point NRS PSFS	No statistically significant difference between groups for any outcomes at any time points. Motor control group had better function outcomes at 12 months than graded activity in patients with self-reported clinical instability. Graded activity group had better function outcomes at 12 months than motor control group in patients with no self-reported clinical instability.

Table 2: Motor control and rehabilitative programs for CLBP patients and their outcomes.

pressure threshold of the quadratus lumborum ($p < 0.05$) compared to control [9]. The CORE exercise group experienced an increase in active range of motion of trunk flexion while the control demonstrated no change in range of motion ($p<0.05$) [9]. A 5.5 week group Godelieve Denys-Struyf (GDS) program was compared to a 7.5 week individual GDS plus manual therapy program and to control; the group GDS program demonstrated a greater decrease in disability compared to the control ($p=0.024$), however the individual GDS program and control had similar improvements in disability [10]. The group GDS program had a larger improvement in referred pain down the leg compared to the individual GDS program ($p=0.01$) [10]. A 4 week McKenzie program was compared to a 4 week Back school program; both groups demonstrated a decrease in pain intensity and disability; however the McKenzie group experienced a larger decrease in disability [11]. An 8 week McKenzie protocol was compared to an 8 week McKenzie protocol plus static back extensors endurance (SBEE) exercise as well as to an 8 week McKenzie protocol plus dynamic back extensors endurance (DBEE) exercise; all groups showed significant improvement in health-related quality of life (HRQoL) ($p < 0.05$) [12]. The McKenzie protocol plus SBEE and DBEE exercise groups demonstrated significantly greater improvements in SF-36 compared to McKenzie protocol only at week 4 and 8 respectively ($p < 0.05$), and the McKenzie protocol plus DBEE exercise group had greater improvement than SBEE exercise group on some SF-36 domains at week 8 ($p=0.001$) [12]. An 8 week motor control exercise (MCE) program was compared to an 8 week graded activity (GA) program; there were no statistically significant differences between groups for any outcomes at any time points, both groups demonstrated similar improvements in pain, disability, and function [13,14]. Patients with self-reported clinical instability demonstrated better function outcomes at 12 months in the MCE program compared to the GA exercise group [14]. Patients with no self-reported clinical instability had better function outcomes at 12 months in the GA exercise group compared to the MCE group [14].

General exercise

The articles reviewed in this paper are summarized in Table 3.

General exercise programs for CLBP patients and their outcomes: A 6 week medical yoga (MY) program was compared to a 6 week exercise therapy (ET) program and to a self-care control (SC) group; the MY group demonstrated a larger improvement in HRQoL when compared to the SC group ($p = 0.031$) [15]. There was no significant difference in HRQoL improvement between the MY and ET groups ($p=0.574$) [15]. A 12 week yoga program was compared to a 12 week stretching program and a control self-care group; all groups demonstrated a decrease in disability, the yoga group demonstrated greater improvements in disability at 12 and 26 weeks compared to the self-care group, and the stretching group showed greater improvements in disability at 6 and 26 weeks compared to the self-care group [16]. A 6 week mat Pilate's program was compared to equipment based Pilate's program; there were no significant differences between groups for any outcome, however both groups demonstrated improvement in pain and disability [17]. The equipment based Pilates group demonstrated a greater improvement in disability compared to the mat based Pilates group ($p<0.01$) [17]. A 6 week Pilates exercise program was compared to control; the Pilates group demonstrated greater improvements

Reference	Population	Intervention and Control	Outcome Measures	Effect of intervention
Aboagye E et al., [15]	159 NSLBP patients, mean age 4447 years	a. Medical yoga 2x/week for 6 weeks in groups, after 6 weeks selfpractice 2x/week for 12 months. b. Strength training 2x/week selfled for 12 months. c. Selfcare advice oral and written control.	EQ5D	Yoga group scored significantly higher than selfcare group. Yoga and strength training group scores not significantly different.
Sherman KJ et al., [16]	228 CLBP patients, mean age 48.7 years	a. yoga, 75 min classes 1x/week for 12 weeks plus daily at home. b. stretching, 75 min classes 1x/week for 12 weeks plus daily at home. c. selfcare, book on back pain causes and advice.	RMDQ 11 point bothersomeness scale	Disability decreased in all groups. Yoga group had greater improvement in disability than selfcare at 12 and 26 weeks. Stretching group had greater improvement in disability than selfcare at 6, 12, and 26 weeks. No difference in outcomes between yoga and stretching groups.
Da Luz Jr MA et al., [17]	86 CLBP patients, mean age 41 years	a. Pilates on mat, 1 hour sessions, 2x/week for 6 weeks. b. Pilates on resistance machines, 1 hour sessions, 2x/week for 6 weeks.	11 point NRS RMDQ	No difference between groups at 6 weeks follow up however clinically significant improvement for both groups. Resistance machine groups better outcomes at 6 months follow up.
Miyamoto GC et al., [18]	86 CNSLBP patients, mean age 39.5 years	a. Pilates plus education, 1 hour session, 2x/week for 6 weeks. b. Education only.	11 point NRS RMDQ	Pilates group had greater improvement in pain and disability at 6 weeks. At 6 months follow up no between group differences for any outcomes.
Patti A et al., [19]	38 CNSLBP, mean age 41.5 years	a. Pilates, no NSAIDS, 50 min classes, 3x/week for 14 weeks. b. Control group usual activity, NSAIDS.	ODI postural sway	Significant improvement in pain and disability for both groups, greater in pilates group. Improvement in postural sway Pilates group, no improvement in control group.
Hall AM et al. [20]	160 subjects with persistent NSLBP, mean age 44.4 years	a. Tai Chi 40 min sessions, 18 sessions over 10 weeks. b. Control group.	11 point NRS RMDQ	Tai chi group had greater reduction in pain and disability than control. Tai chi participants reported improvement while control subjects reported no improvement.
Krein SL et al., [21]	229 CLBP patients, mean age 51 years	a. Intervention group, pedometer, website with goal setting and feedback, targeted messages, educational materials, ecommunity. b. Control group, pedometer, and no website resources.	RMDQ MOS	RMDQ scores improved in both groups; intervention group scores lower but not statistically significant at 12 months. No statistically significant difference in MOS between groups. Decreased pain severity in both groups but no difference between groups.
McDonough SM, et al., [22]	56 CNSLBP patients, mean age 49.5 years	a. Walking plus education, one 1 hour session with physiotherapist, pedometer and walking diary for 8 weeks. b. Education only, one 1 hour session with physiotherapist.	ODI	Walking group had greater improvement in functional disability than education only group at 6 months.
Murtezani A et al., [23]	101 CLPB patients, mean age range 2867 years	a. Aerobic exercise, 3045 min session, 3x/week for 12 weeks. b. Passive modalities, 3x/week for 12 weeks.	ODI VAS 10 cm HADS	Significant improvement in pain and disability in exercise group. No improvement in passive modality group.
Vincent HK et al., [24] & Vincent HK et al., [25]	49 CLBP obese patients, 6085 years of age	a. Total body resistance exercise. b. Isolated lumbar extension resistance exercise. c. Control – no exercise. Exercise groups had one on one training sessions 3x/week for 4 months.	ODI RMDQ	Total body resistance group had greatest improvement in disability compared to isolated lumbar and control groups. Pain with walking decreased (increased walking endurance) in total body and isolated lumbar groups compared to control.
You YL et al., [26]	12 CLBP patients, mean age 27.6 years	a. Stabilization exercise with sling, 30 min sessions, 3x/week for 6 weeks. b. Control – No exercise.	ODI (Chinese version) VAS 10 cm	Disability significantly improved in exercise group, no change in control group. Significant reduction in pain in exercise group, no change in control group.

Table 3: General exercise programs for CLBP patients and their outcomes.

in pain and disability at 6 weeks post treatment compared to the control group [18]. There were no between group differences at 6 months follow up for any outcomes [18]. A 14 week Pilates exercise program was compared to control; the Pilates group demonstrated significant decreases in postural sway under both eyes open and closed conditions ($p<0.05$), while the control group showed no changes in sway [19]. Both groups demonstrated an improvement in pain and disability post intervention, with a larger improvement seen in the Pilates group ($p<0.001$) [19]. A 10 week Tai Chi exercise program was compared to control; the Tai Chi exercise group demonstrated greater improvements in pain and disability compared to the control [20]. A 12 month pedometer and website based walking program was compared to a 12 month pedometer walking program; both groups demonstrated an improvement in disability at 6 and 12 months follow-up, however the website group showed a larger improvement at 6 months and there were no between group differences at 12 months [21]. Both groups demonstrated improvements in function and pain but there were no significant between group differences [21]. An 8 week pedometer driven walking program was compared to control; the pedometer walking group demonstrated a mean improvement of 8.2% points in disability at 6 months compared with 1.6% points in the control [22]. The pedometer walking group also demonstrated a larger improvement in pain ($d=0.4$) and a larger increase in physical activity ($d=0.59$) at 6 months follow-up [22]. A 12 week aerobic exercise program was

compared to a course of treatment with passive modalities; the exercise group demonstrated significant improvements in pain and disability at 12 weeks follow-up ($p<0.001$) while there were no changes observed in the passive modalities group [23]. A 4 month total body resistance (TBR) exercise intervention was compared to a lumbar extensor exercise intervention and control. The TBR group demonstrated the largest improvement in disability. The exercise groups showed significantly decreased pain with walking compared to the control [24,25]. A 6 week sling exercise training program was compared to control; the sling exercise group demonstrated a significant improvement in pain intensity and disability at 6 weeks post treatment ($p<0.05$), while the control did not show any significant improvement [26].

Discussion

This review attempted to answer the question: Do a wide variety of exercise programs significantly improve pain and disability scores in patients with CLBP? The general collective consensus of articles included in this review support the proposed hypothesis that a wide variety of exercise programs significantly improve pain and disability in CLBP patients [3,7-8]. Only one article concluded that exercise could not benefit their CLBP study population, however these patients had imaging evidence of disc degeneration and their results should not be generalized to most common forms of LBP [6]. The remaining articles reviewed agree that any type of exercise form will improve pain and disability; however exercises that are more targeted to training the endurance and function of trunk core muscles may be more beneficial [3,7-8]. While some researchers were interested in establishing the most effective and specific exercises for CLBP therapy, other researchers were interested in the effects of general activities on CLBP clinical indicators [14,18-19]. Several studies addressed the topic of different subgroups of CLBP patients; different subgroups may respond better to different types of exercise therapy, however in general all exercise therapy is beneficial [2,9]. The articles reviewed also suggest that the frequency of exercise and the level of involvement of the exercise are important factors that determine how beneficial an exercise therapy will be for an individual [21].

Many of the articles reviewed had a large proportion of females in their study sample; this may have had some effect on the results [3,12,21]. As well, most of the study samples had a mean age around 40-55 years; therefore the results of this review may not extend to younger or elderly populations. 10 of the articles reviewed had sample sizes less than n=50; the results of these articles may not be as strong as the results from the larger sample size studies; however the collective results are not conflicting [26]. While it appears that more specific and targeted exercises have more benefit on CLBP clinical indicators than general exercise forms, these exercise protocols may have lower compliance rates. General exercise may be less effective at improving pain and disability in CLBP patients, but these exercise forms may have a higher compliance rate. For example, it may be difficult for an individual to remember how to perform a series of core stabilizing exercises correctly, but it would be relatively easier to take a daily 20 minute walk. Prescribing an exercise protocol that a patient has difficulty remembering and/or performing alone at home will likely result in no exercise performed by the patient at all. It is possible that patients can attend supervised exercise sessions at therapy centres, but it would be costly and inconvenient for most patients to do so long term. Since this review has demonstrated that a wide range of exercise forms are beneficial for CLBP patients, the author of the paper suggests that patient lifestyle and preference should be a major factor of consideration when deciding what exercise therapy should be prescribed.

Limitations and Conclusion

Limitations of the search strategy include searching only one database (PubMed), only one source of information is used (database), only data published in English from 2011-2016 is included, and only one reviewer reviewed the abstracts. The major limitation of this review is the broad nature of the research question; it encompasses and attempts to compare many different types of interventions as well as data collection methods. Future research may consider comparing multiple interventions in a single randomized controlled trial with multiple arms to allow for better comparison across CLBP clinical outcome measures. Future studies may also consider studying different age groups that are gender balanced.

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