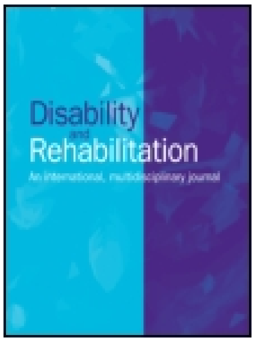

Taylor & Francis
Taylor & Francis Group

Disability and Rehabilitation

ISSN: 0963-8288 (Print) 1464-5165 (Online) Journal homepage: http://www.tandfonline.com/loi/idre20

Dynamic training of the lumbar musculature to prevent recurrence of acute low back pain: a randomized controlled trial using a daily pain recall for 1 year

Vincent M. Ciriello, William S. Shaw, Amanda J. Rivard & Mary Jane Woiszwillo

To cite this article: Vincent M. Ciriello, William S. Shaw, Amanda J. Rivard & Mary Jane Woiszwillo (2012) Dynamic training of the lumbar musculature to prevent recurrence of acute low back pain: a randomized controlled trial using a daily pain recall for 1 year, Disability and Rehabilitation, 34:19, 1648-1656, DOI: 10.3109/09638288.2012.656787

To link to this article: https://doi.org/10.3109/09638288.2012.656787

Published online: 01 Mar 2012.

Submit your article to this journal

Article views: 356

View related articles

Citing articles: 1 View citing articles

Full Terms & Conditions of access and use can be found at
http://www.tandfonline.com/action/journalInformation?journalCode=idre20

Disability & Rehabilitation, 2012; 34(19): 1648–1656
© 2012 Informa UK, Ltd.
ISSN 0963-8288 print/ISSN 1464-5165 online
DOI: 10.3109/09638288.2012.656787

informa
healthcare

RESEARCH PAPER

Dynamic training of the lumbar musculature to prevent recurrence of acute low back pain: a randomized controlled trial using a daily pain recall for 1 year

Vincent M. Ciriello, William S. Shaw, Amanda J. Rivard & Mary Jane Woiszwillo

Center for Physical Ergonomics, Liberty Mutual Research Institute for Safety, Hopkinton, MA, USA

***Purpose:* The purpose of this experiment was to quantify lumbar muscle endurance training for individuals with a recent episode of acute low back pain (LBP) (≥ moderate pain for ≥ 2 days) and to observe whether the training would reduce the rate and severity of recurrent LBP episodes. *Method:* Twenty-six participants who were pain-free at the time of the study were randomly divided into a high intensity back endurance (HIBE)-trained or a low intensity abdominal (LOAB)-trained (control) group. The HIBE-trained group performed preloaded maximum isokinetic exertions of the back extensors (five sets of 10 repetitions, 3 days a week for 4 weeks, totaling 12 sessions). The LOAB-trained group performed low intensity isometric contractions on their abdominals that had minimal effect on their back musculature. The two groups reported daily pain logs on a weekly basis on an interactive voice response telephone system for 1 year. *Results:* The HIBE-trained group experienced more pain days (p = 0.038) in the minor and moderate categories and more episodes of acute LBP than the LOAB-trained group. However, there was a trend of less pain in the severe, intense and excruciating categories in the HIBE-trained group. *Conclusions:* The results of this experiment did not provide evidence that short-term intense training of the low back musculature provides protection against future episodes of LBP.**

Keywords: Daily pain recall, exercise, low back pain, lumbar muscle endurance

Implications for Rehabilitation

- Short-term high intensity back endurance (HIBE) training of the back musculature did not provide protection against future episodes of acute low back pain compared to the low intensity abdominal (LOAB) – trained group.
- HIBE training may have sensitized the subjects to report significantly more minor and moderate pain and less pain-free days compared to the LOAB-trained group.
- There was a strong trend that the HIBE-trained group experienced less pain in the severe, intense and excruciating categories compared to the LOAB-trained group.
- Future studies in rehabilitation must require daily recall of pain and quick reporting in order to capture the subtle effects training can elicit from pain reporting.

Introduction

Functional restoration of chronic low back pain (LBP) patients has centered around exercise of the whole body musculature with major emphasis on the extensor group of the trunk. Mayer et al. [1,2] used this approach along with psychological support to functionally restore patients with chronic LBP. Hazard et al. [3] replicated the success of this approach in a different patient population and workers' compensation system. Modeling the approach of these programs, others have shown success in functionally restoring patients with chronic LBP [4–6] and decreasing pain [7]. In a more recent study, this theme has been extended to acute LBP. Hides et al. [8] studied the effects of specific spine stabilizing exercises on first-time acute LBP patients. The results revealed dramatic differences in recurrence rates after a 1-year retrospective recall in the treatment (30%) and control groups (84%).

The extensors of the spine have been shown to contain smaller fast twitch (FT) muscle fiber areas as compared to

Correspondence: Dr. Vincent M. Ciriello, Center for Physical Ergonomics, Liberty Mutual Research Institute for Safety, 71 Frankland Road, Hopkinton, MA 01748, USA. Tel: (508) 497-0251. Fax: (508) 435–8136. E-mail: vincent.ciriello@libertymutual.com

(Accepted January 2012)

slow twitch fibers both in low back surgery patients and normals [9]. Muscle densities of the extensors in a population of postoperative patients were also lower than controls [10]. This indicates that the patients' back muscles have considerable disuse atrophy and will respond dramatically to a training stimulus. With training, FT fibers of the back have been shown to hypertrophy [11] and training is necessary to restore the size of the multifidus after acute LBP since the normal course of recovery without exercise will not restore the size [12]. The important point is that endurance characteristics and strength factors of the back musculature have been reported to differ in back pain versus nonback pain groups [13–15].

In a short period of time, muscle training can dramatically increase strength [16–20] and submaximum endurance of the back musculature [16,20]. In training the low back pain patient, isokinetics has the advantage of administering accommodating concentric resistance for each repetition performed. Concentric contraction is needed for FT hypertrophy and maximum isometric strength development [21]. However, without an eccentric (preloaded) component to the training, the patient may be vulnerable to an eccentric injury [22]. Also, a preloaded modality (isotonics) has been shown to be superior to pure isokinetics in the production of strength and power output of knee extensors [23]. Ciriello and McGorry [24] revealed that the preloaded isokinetic group yielded superior gains in strength and endurance in lumbar extensors as compared to the pure isokinetic group with retention of gains for as long as 1 year.

Based on the improvement of strength and endurance in healthy controls, we hypothesize that preloaded isokinetic training could improve lumbar muscle endurance for individuals with a recent episode of acute LBP, and this effect might provide protection that would reduce the rate and severity of recurrent LBP episodes and improve their perceived functional capacity.

A recent study estimated recurrence rates based on patterns of medical care from 12% to 49% over 3 years and from 6% to 17% based on lost work time [25,26]. Studies with continuous monitoring of self-reported pain have estimated 1-year recurrence rates of 40% to 60% [27–30]. We propose that our exercise regime, administered between episodes, might be able to reduce the recurrence rate to levels similar to the treatment subjects of Hides et al. [8] and this rate would form the basis for gauging the efficacy of the training.

Methods

Experimental design

This study was a randomized control trial with training of the lumbar musculature as the independent variable. High intensity back endurance (HIBE) training represents level one; and low intensity abdominal (LOAB) training (control) represents level two of the variable. The dependent variables included: preloaded maximum isokinetic endurance, back pain diary (BPD) account of the number of acute LBP recurrent cases, the assessment of daily pain for 1 year after training, Back Pain Function Scale (BPFS), Back Activity Self-Efficacy (BASE) Scale, Fear-Avoidance Beliefs Questionnaire (FABQ) and a Descriptor Differential Scale (DDS) of pain intensity and unpleasantness. The description of these scales with appropriate references is presented in the scales section below. Outcome assessments of the scales occurred: at the time of initial recruitment, at the completion of the exercise training program (4–6 weeks) and at 1 year except for the BPD. The primary outcome measure was back pain recurrence. In order to improve the accuracy of pain recall, participants maintained a BPD and reported those results to researchers weekly by accessing an interactive voice response (IVR) system via telephone.

Subjects

Ten male and 16 female participants were recruited by newspaper advertisement (Table I). All subjects had experienced an acute episode or multiple episodes of LBP during the previous 12 months, but eligibility required no residual LBP at the time of recruitment and 0 level pain (no pain) for a 1-week period before training. Exclusion criteria included: history of chronic LBP (pain > 2 months), previous back surgeries, ruptured disc, sciatica, inguinal hernia, cardiovascular disease, emphysema, hypertension, significant respiratory disease, insulin-dependent diabetes and other current or past medical conditions that might make the exercise protocol unsafe or contraindicated. Each potential participant underwent a screening interview via telephone. Once cleared by the initial screening, each candidate signed a written informed consent, which was approved by our Institutional Review Board. The candidates were then required to pass a physical exam, administered by a physician assistant familiar with the intent of the study. The physical exam verified all the exclusion criteria listed previously in this section along with a specific back exam that included: inspection for scars, spinal alignment and posture; palpation for point tenderness, spinal alignment and pelvic alignment; range of motion of the back, hip, knee and ankle; strength of the hip, knee, ankle, including heel/toe walking; sensation test for light touch and pin prick; patellar and Achilles reflexes, and a straight leg raise. Recruiting the desired population that reported resolved episodes of acute LBP proved to be extremely difficult. Figure 1 contains the flow chart describing the recruitment procedure.

Pain and function scales

The BPD developed for use in this study was based on research methods employed in past studies of episodic health symptoms [31]. The goal of this measure was to assess both duration and frequency of LBP while reducing recall demands to 1 week or less. Previous studies have shown substantial underestimates of LBP when recall periods are as long as 4–16 months [32]. Using the BPD, participants were asked each week to enumerate days best described by one of six categories: level 0 ("no back pain or discomfort whatsoever"), level 1 ("occasional minor back ache or discomfort; but your daily activities were unaffected"), level 2 ("moderate pain; daily activities were still possible, but with some difficulty"), level 3 ("severe back pain that limited some of your daily activities"), level 4 ("intense, disabling pain that limited your ability to perform most daily activities") and level 5 ("excruciating pain; making it difficult to stand and walk"). The following outcome variables were

© 2012 Informa UK, Ltd.

Table I. Subjects' characteristics.

	Total group		Males		Females	
	Mean	SD	Mean	SD	Mean	SD
Age (years)						
HIBE-trained group	35.1	8.6	32.4	9.6	36.8	8.1
LOAB-trained group	40.9	6.3	38.2	9.8	42.6	2.1
Significance down	ns		ns		ns	
Weight (kg)						
HIBE-trained group	76.8	16.3	81.4	11.8	74.0	18.8
LOAB-trained group	77.1	13.5	81.1	15.7	75.1	13.0
Significance down	ns		ns		ns	
Height (cm)						
HIBE-trained group	172.5	12.9	184.9	9.4	164.7	7.4
LOAB-trained group	167.4	8.4	174.6	8.1	163.8	6.2
Significance down	ns		ns		ns	
Resting pulse (beats/min)						
HIBE-trained group	70.2	6.9	74.7	8.3	68.3	5.8
LOAB-trained group	67.4	6.4	64.8	4.4	70.7	7.5
Significance down	ns		ns		ns	
Systolic pressure (mmHg)						
HIBE-trained group	117.2	7.5	119.6	7.9	115.7	7.3
LOAB-trained group	115.7	10.6	118.4	9.6	114.0	11.6
Significance down	ns		ns		ns	
Diastolic pressure (mmHg)						
HIBE-trained group	76.9	5.4	76.4	5.2	77.2	5.8
LOAB-trained group	76.1	6.1	76.6	5.2	75.2	6.7
Significance down	ns		ns		ns	

HIBE, high intensity back endurance; LOAB, low intensity abdominal; ns, nonsignificant; SD, standard deviation.

generated from the BPD: number of pain days for each level of pain, number of pain days by grouping pain level and number of recurrent LBP episodes (≥ moderate pain for ≥2 days). Our definition of a recurrent LBP episode mirrors a recent expert panel's consensus definition of recurrent LBP [33].

The BPFS is a 12-item self-report measure that assesses difficulties in performing daily activities because of LBP. For each item, respondents were asked to rate their ability to engage in activities on a scale from 0 ("unable to perform activity") to 5 ("no difficulty"). Sample items include "standing for 1 hour" and "bending or stooping." The BPFS has been shown to have high internal consistency ($\alpha = 0.93$), high test-retest reliability ($r = 0.88$), good sensitivity to change and validity to differentiate among levels of work status and symptoms [34]. The score was the mean of all items.

The BASE Scale is a 16-item self-report measure that assesses the confidence with which individuals can comfortably perform a number of physical activities commonly affected by LBP. For each item, respondents reported their level of confidence from 0 ("not at all confident") to 10 ("totally confident"). Two items are dedicated to each of eight activity domains: lift, carry, sit, stand, push/pull, bend, climb and reach. Scale domains and items were developed based on typical problems in daily functioning reported by adults with LBP using qualitative research methods [35]. A total score was the mean of all items.

FABQ [36] is a 16-item self-report measure that assesses fear of pain associated with physical activity and work. For each statement, patients were asked to completely disagree or completely agree (0–6 scale) on how much physical activity or work affect their LBP. Waddell et al. [36] reported an internal consistency (alpha) of 0.77 when the physical activity portion was administered to patients with chronic LBP. This measure has also predicted individual variation in spinal isometric strength deficits [37]. The score was the mean of all items.

The DDSs of pain intensity and unpleasantness [38] are two brief pain self-report measures that were developed to detect small changes in pain intensity and unpleasantness with consistent ratio-scale properties using psychophysical methods. These measures have been shown to demonstrate similar item response patterns across divergent experimental and clinical samples. The patient reports his or her level of agreement on a 0–20 scale with descriptors for both intensity and unpleasantness. The score is the average of 0–20 scores.

The Job Requirements and Physical Demands (JRPD) scale [39] is a 37-item questionnaire asking how much time the subject spends performing tasks in his or her job or at school. Each item is rated from 0 time spent to more than 4 hours per day for activities. This measure has been used to assess back and upper extremity problems in both blue and white-collar workers [40,41]. The average of the 37 items defines the score.

Equipment

The HIBE training was assessed on a Polaris back extension machine (Spring Valley, CA) that was modified in order to evaluate preloaded maximum isokinetics. The Polaris back

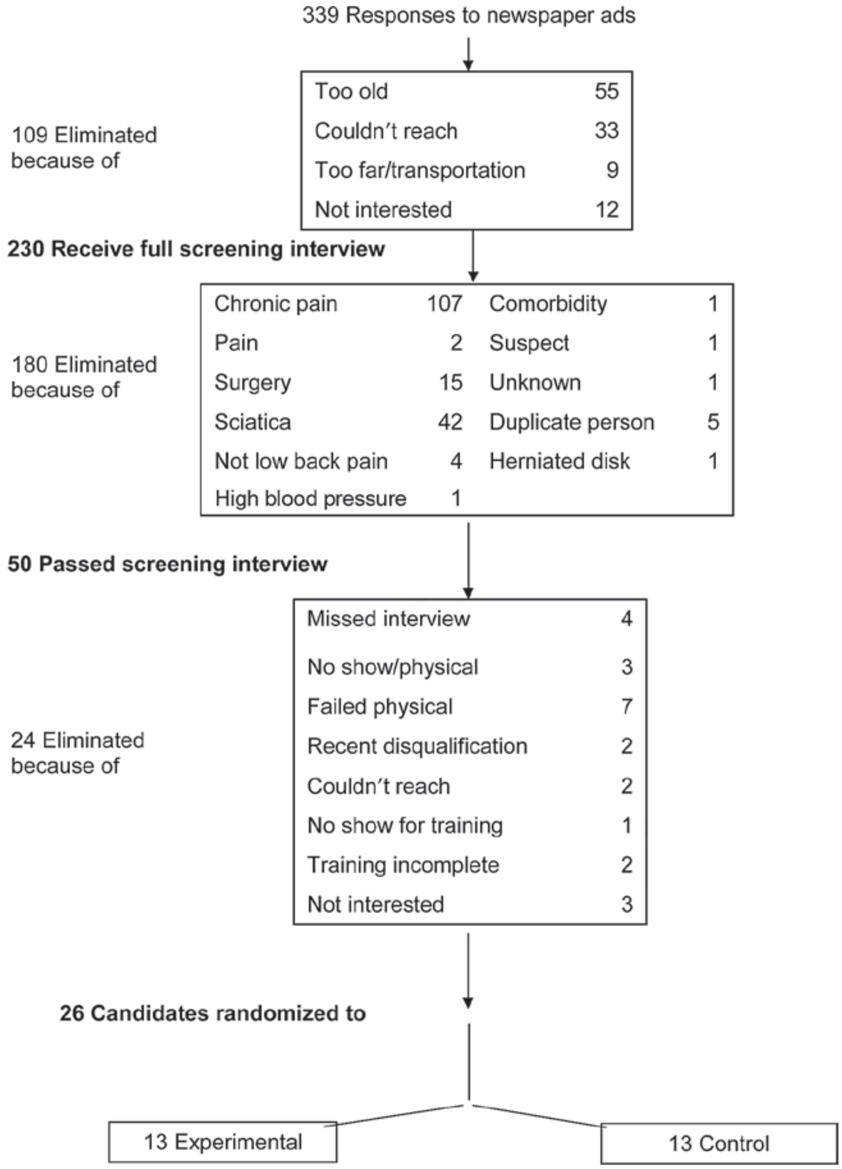

Figure 1. Recruitment procedure.

extension machine is a typical weight resistance machine, prevalent in health clubs and rehabilitation settings. Modification of the Polaris machine to achieve isokinetics involved the connection of a cable from the end of the Polaris weight stack to a one-way clutch. The one-way clutch was then attached to a cybex isokinetic dynamometer head (Lumex, Ronkonkoma, NY). The setup provided isokinetic resistance in the extension direction only. The top of the weight stack was fitted with a strain gauge that recorded linear force applied to the extension arm. The linear force was converted to torque by adjusting for the cam of the machine and the length of the extension arm. Torque values were continuously displayed on a video monitor during isokinetic extensions in order to provide feedback to the participant. The weight stack was preloaded with two plates, and the clutch had a counterweight, which provided a preload of 49 Nm. The modified Polaris described above was used successfully in a study investigating the effects of preloaded isokinetic versus pure isokinetic training on dynamic and static lumbar muscle strength and endurance [24,41].

Procedure

Each participant was randomly assigned to one of two groups: HIBE trained or LOAB trained (control). Both groups followed the same schedule. Each participant was required to attend 15 "training" sessions at the institute. Three visits per week were preferred, but at least 1 day of rest was required between each training day. For all participants, the first three visits were "conditioning" days where the protocol and mode of exercise were introduced and gradually increased to build up to the testing protocol. The remaining 12 visits were the training days and data collected during this time were used for analysis.

HIBE-trained group

During the training phase, the HIBE-trained group performed preloaded maximum isokinetic endurance training on the modified Polaris machine. The 12 training days consisted of five sets of 10 repetitions of preloaded maximum isokinetic extensions performed in a seated position. On each training

© 2012 Informa UK, Ltd.

day, the speed of the machine was set at 30° per second with a preload of 49 Nm. Fifty torque curves for each extension were averaged to obtain an endurance measure (EM). The footrest was adjusted in order to create a knee angle of approximately 135° and a restraining strap was secured across the hip flexors of the participant.

Participants were instructed to push against the extension arm "as hard as you can without hurting yourself" using the muscles of the lower back. Training began from a position of approximately 60° of hip flexion with arms crossed in front of the chest. Each set was initiated at 1-minute intervals and was completed in 30–45 seconds with a total training time of 4.5 minutes.

LOAB-trained group

During the training phase, the LOAB-trained group performed isometric abdominal contractions. The 12 training days consisted of the same frequency, duration and timing as the HIBE group. Participants were instructed to stand with backs against a wall by performing a posterior pelvic tilt with a knee angle of approximately 130°. Upon determination of knee angle, participants were then asked to collapse the lordotic curve of the spine. Contact between the entire back (shoulder blades to tailbone) was ensured and participants were then asked to "pull the belly-button toward the spine using the muscles of the abdomen. Do not simply 'suck in' the stomach." When the correct posture and execution of the exercise were determined, the first set was initiated. Audio cues and counts were given by the instructor to provide feedback to the participants to maintain the correct timing sequence. Rest breaks were taken between each set and participants were asked to stand up and relax. Each set was initiated at 1-minute intervals and was completed in 30 seconds with a total training time of 4.5 minutes, similar to the HIBE-trained group.

Posttraining and 1-year follow-up

At the end of the training, both groups were given 52 weekly pain diaries with entries for each day. They were instructed to call into the IVR system weekly using their personalized code to record the level of pain for each of the prior 7 days. If the subject did not respond at the end of the week, a team member would phone the subject to remind them to call the IVR system with their weekly report. Every effort was made to keep the record up-to-date in the shortest period of time. If the subject reported a level 2 pain for 2 days or more, they were contacted by phone to obtain the specific details of the LBP event. At 1-year follow-up, the subjects were sent a packet containing the five function and pain scales to document their status in those areas.

Data analysis

The number of pain days in all categories for each subject was treated as a rank score and was subjected to a nonparametric Mann-Whitney rank test and a median test. Between groups comparisons of the back function, pain avoidance and DDS surveys were also analyzed with the Mann-Whitney and Median tests. Within groups comparisons were analyzed with the Wilcoxon matched pairs test and the Sign test. The EMs were tested with a repeated measure analysis of variance. The two groups were compared on demographic data using independent t tests. Significance was accepted at the 0.05 level.

Results

Table II contains summaries of the diary reports for all categories of pain and combinations of pain ratings for all subjects for 1 year. The HIBE-trained group experienced more pain days in the minor and moderate categories ($p = 0.038$), more episodes of acute LBP and less pain-free days ($p = 0.033$) than the LOAB-trained group. The LOAB-trained group displayed a trend for reporting more pain days in the combined category of severe, intense and excruciating levels of pain. This trend was approaching significance ($p = 0.063$) in the combined category of intense and excruciating levels of pain.

Table III illustrates that both the BPFS and BASE function scores were lower ($p = 0.023$ and $p = 0.050$) and both the DDSs of pain intensity and unpleasantness were higher ($p = 0.050$) for the HIBE-trained group before training compared to the LOAB-trained group. The FABQ scale for jobs was higher ($p = 0.049$) in the LOAB-trained group before training compared to the HIBE-trained group. After training, both the BPFS and BASE function scales increased ($p = 0.009$) and both the FABQ surveys significantly decreased ($p = 0.054$ and $p = 0.016$) in the HIBE-trained group. Both DDS also decreased in the HIBE-trained group after training. This resulted in a nonsignificant difference between HIBE and LOAB-trained groups for all surveys after training and before the 365-day pain diary reporting began. At the end of 1-year diary reporting, there were no significant group differences. However, at the end of training, both JRPD scales in both HIBE and LOAB-trained groups reported decreases in scores ($p = 0.037$ and 0.057 respectively). Training produced gains in EM for both males ($p = 0.018$) and females ($p = 0.003$) and the whole HIBE-trained group ($p < 0.001$). Table IV displays the EM for the HIBE-trained group before and after training.

Discussion

In the present study, there was no evidence of a decrease in the number of pain days in the minor and moderate categories of pain or for the number of acute LBP episodes in the HIBE-trained group compared to the LOAB-trained group. Instead, the recordings of minor to moderate pain days were lower in the LOAB-trained group; likewise, the reporting of pain-free days was significantly more for the LOAB-trained group. Both these findings were contrary to the hypothesis of this study. However, in the pain categories of severe, intense and excruciating, both the number of subjects and the number of pain days were higher in the LOAB-trained group. This trend was stronger in the combined category of severe and excruciating levels of pain. Hides et al. [8] reported a dramatic difference in recurrence of acute LBP between core trained versus control groups, with the control group experiencing almost a three times greater recurrence rate (84% vs. 30%). In the present study, LOAB and HIBE-trained groups had recurrence rates

Table II. A 365-day pain diary reporting for the HIBE and LOAB-trained groups.

	HIBE-trained group	LOAB-trained group	Significance between groups (p value)
Level 1: minor pain			
Number of pain days	2237	1261	0.031
Mean (SD) pain days	172.1 (100.4)	97.0 (79.4)	
Subjects reporting pain	13	13	
Level 2: moderate pain			
Number of pain days	313	133	0.239
Mean (SD) pain days	24.1 (28.8)	10.2 (11.3)	
Subjects reporting pain	10	13	
Levels 1–2			
Number of pain days	2550	1394	0.038
Mean (SD) pain days	196.1 (108.7)	107.2 (85.1)	
Subjects reporting pain	13	13	
Level 2 or >2 for 2 or >2 days			
Number of acute episodes	60	35	0.695
Mean (SD) acute episodes	4.6 (6.3)	2.7 (3.1)	
Subjects reporting episodes	9	11	
Level 0: no back pain			
Number of pain-free days	2156	3285	0.033
Mean (SD) pain-free days	165.8 (109.3)	253.1 (82.8)	
Subjects reporting no pain	13	13	
Level 3: severe pain			
Number of pain days	34	55	0.694
Mean (SD) pain days	2.6 (4.8)	4.2 (11.1)	
Subjects reporting pain	6	7	
Level 4: intense pain			
Number of pain days	5	9	0.135
Mean (SD) pain days	0.38 (1.4)	0.69 (1.6)	
Subjects reporting pain	1	4	
Level 5: excruciating pain			
Number of pain days	0	2	0.141
Mean (SD) pain days	0 (0)	0.15 (0.39)	
Subjects reporting pain	0	2	
Levels 3–5			
Number of pain days	39	66	0.431
Mean (SD) pain days	3.0 (5.0)	5.1 (12.2)	
Subjects reporting pain	6	8	
Levels 4–5			
Number of pain days	5	11	0.063
Mean (SD) pain days	0.38 (1.39)	0.85 (1.68)	
Subjects reporting pain	1	5	

HIBE, high intensity back endurance; LOAB, low intensity abdominal; SD, standard deviation.

of 85 % versus 69 %, respectively, for at least one acute LBP episode in the year, 46% versus 54%, respectively, for two or more acute LBP episodes in the year. The total number of acute episodes in the year was 35 and 60 respectively for LOAB and HIBE-trained groups. The differences in findings might be attributed to differences in data collecting, as Hides et al. [8] used only single 1-year recall of pain episodes rather than daily pain histories.

The males in our study increased 38% in EM. However, their EM at the end of training was still 13% below the starting EM of LBP-free subjects from two experiments using the same training regime and equipment [24,42]. Our trained group starting numbers were 62% of the EM of the LBP-free subjects. This remarkable difference in endurance has been noted elsewhere but without the precise quantification [20]. The question still remains whether endurance factors are lessened by repeated episodes of acute LBP or whether the intrinsic endurance of symptom-free individuals protect them from acute nonspecific LBP.

The endurance attained by our subjects however did not protect them from multiple episodes of acute LBP. A recent systematic review of controlled trials investigating prevention of episodes of LBP found exercise interventions effective [43]. However, the review did not distinguish studies of acute LBP in the resolved state (similar to our candidates) from chronic LBP studies.It is possible that the intense

© 2012 Informa UK, Ltd.

Table III. Back function, fear-avoidance, pain intensity and physical demands scales before and after training and at 1 year for the HIBE and LOAB-trained groups.

	Before training		After training			1 Year		
	Mean	SD	Mean	SD	Sign across	Mean	SD	Sign across
Back Pain Function Scale								
HIBE-trained group	4.2	0.40	4.7	0.32	p = 0.009	4.6	0.37	ns
LOAB-trained group	4.6	0.36	4.7	0.32	ns	4.7	0.36	ns
Sign down	p = 0.023		ns			ns		
Back Activity Self-Efficacy Scale								
HIBE-trained group	7.8	1.6	9.1	0.77	p = 0.009	9.1	0.73	ns
LOAB-trained group	8.8	1.0	9.1	1.1	ns	8.6	1.1	ns
Sign down	p = 0.050		ns			ns		
Fear-Avoidance Beliefs Questionnaire (activity)								
HIBE-trained group	3.2	0.89	2.5	1.6	p = 0.054	2.5	1.6	ns
LOAB-trained group	2.5	1.4	2.8	1.2	ns	3.1	1.4	ns
Sign down	ns		ns			ns		
Fear-Avoidance Beliefs Questionnaire (job)								
HIBE-trained group	1.7	1.6	1.2	1.6	p = 0.016	1.5	1.6	ns
LOAB-trained group	2.0	1.0	1.6	1.2	ns	1.4	1.1	ns
Sign down	p = 0.049		ns			ns		
Descriptor Differential Scale of pain intensity (intensity)								
HIBE-trained group	5.6	3.2	4.4	3.4	ns	4.2	2.2	ns
LOAB-trained group	4.0	3.6	3.4	3.0	ns	3.6	3.4	ns
Sign down	p = 0.050		ns			ns		
Descriptor Differential Scale of pain intensity (unpleasantness)								
HIBE-trained group	5.0	3.6	3.8	3.6	ns	3.6	2.2	ns
LOAB-trained group	2.6	3.4	3.0	3.0	ns	3.2	3.0	ns
Sign down	p = 0.050		ns			ns		
Job Requirements and Physical Demands Scale								
HIBE-trained group	1.2	0.64				0.83	0.56	p = 0.037
LOAB-trained group	1.0	0.52				0.74	0.31	p = 0.059
Sign down	ns					ns		

HIBE, high intensity back endurance; LOAB, low intensity abdominal; ns, nonsignificant; SD, standard deviation.

Table IV. Effects of preloaded maximum isokinetic training on endurance measure.

	Before training (n = 13)		After training (n = 13)		Percent difference	Significance level (p value)
	Mean	SD	Mean	SD		
Preloaded maximum isokinetic endurance (Nm)[a]						
Males and females combined	109.2	24.7	146.9	43.0	35%	0.0001
Males	126.9	25.8	175.7	51.8	38%	0.0183
Females	98.2	17.5	128.8	26.0	31%	0.0028

SD, standard deviation.
[a]Average of 50 torque curves (five sets of 10 repetitions).

short-term endurance training in our experiment-sensitized subjects to report more minor to moderate LBP, and our training might not be of sufficient duration to evoke protective mechanisms in the musculature [44]. The LOAB-trained subjects, on the other hand, reported lower levels of minor to moderate pain. Therefore, this treatment had greater benefit than intended. The LOAB training, although essentially only a postural maneuver, may have instilled a sense of consciousness about core tightness and control which translated into postural behaviors that may have alleviated the minor and moderate pain levels [45,46]. Another possibility is that the LOAB training, unlike the HIBE training protocol, inadvertently provided a self-management strategy that required no supervision or machinery, perhaps with psychological benefit.

For the HIBE-trained group, training improved BPFS, BASE, and both FABQ positively and significantly and improved both DDS positively for back health. The LOAB-trained group reported positive changes in most scales but none were statistically significant. For both groups, the BPFS, BASE, FABQ and the DDS remained constant for 1 year, indicating no profound escalation of chronic LBP in either group. The JRPD scale did, however, drop significantly in both groups. This decrease may reflect a reduction in activity or physical exposure in response to recurrent pain episodes or heightened awareness to LBP due to study participation.

Conclusions

Although we acknowledge that the sample size was small and may limit the interpretation, the results of this experiment did not provide evidence that short-term HIBE training of the low back musculature provides protection against future episodes of acute LBP as defined by this study or reduction of pain levels in the minor and moderate category. However, there was a strong trend that indicates that the HIBE-trained group experienced less pain in the severe, intense and excruciating levels. The LOAB-trained group reported significantly less pain days in the minor and moderate category and reported significantly more pain-free days than the HIBE-trained group.

***Declaration of Interest*:** The authors report no conflict of interest.

References

1. Mayer TG, Gatchel RJ, Kishino N, Keeley J, Capra P, Mayer H, Barnett J, Mooney V. Objective assessment of spine function following industrial injury. A prospective study with comparison group and one-year follow-up. Spine 1985;10:482–493.
2. Mayer TG, Gatchel RJ, Mayer H, Kishino ND, Keeley J, Mooney V. A prospective two-year study of functional restoration in industrial low back injury. An objective assessment procedure. JAMA 1987;258:1763–1767.
3. Hazard RG, Fenwick JW, Kalisch SM, Redmond J, Reeves V, Reid S, Frymoyer JW. Functional restoration with behavioral support. A one-year prospective study of patients with chronic low-back pain. Spine 1989;14:157–161.
4. Bendix AF, Bendix T, Labriola M, Boekgaard P. Functional restoration for chronic low back pain. Two-year follow-up of two randomized clinical trials. Spine 1998;23:717–725.
5. Mayer T, McMahon MJ, Gatchel RJ, Sparks B, Wright A, Pegues P. Socioeconomic outcomes of combined spine surgery and functional restoration in workers' compensation spinal disorders with matched controls. Spine 1998;23:598–605; discussion 606.
6. Mitchell RI, Carmen GM. The functional restoration approach to the treatment of chronic pain in patients with soft tissue and back injuries. Spine 1994;19:633–642.
7. Risch SV, Norvell NK, Pollock ML, Risch ED, Langer H, Fulton M, Graves JE, Leggett SH. Lumbar strengthening in chronic low back pain patients. Physiologic and psychological benefits. Spine 1993;18:232–238.
8. Hides JA, Jull GA, Richardson CA. Long-term effects of specific stabilizing exercises for first-episode low back pain. Spine 2001;26:E243–E248.
9. Mattila M, Hurme M, Alaranta H, Paljärvi L, Kalimo H, Falck B, Lehto M, et al. The multifidus muscle in patients with lumbar disc herniation. A histochemical and morphometric analysis of intraoperative biopsies. Spine 1986;11:732–738.
10. Mayer TG, Vanharanta H, Gatchel RJ, Mooney V, Barnes D, Judge L, Smith S, Terry A. Comparison of CT scan muscle measurements and isokinetic trunk strength in postoperative patients. Spine 1989;14:33–36.
11. Rissanen A, Kalimo H, Alaranta H. Effect of intensive training on the isokinetic strength and structure of lumbar muscles in patients with chronic low back pain. Spine 1995;20:333–340.
12. Hides JA, Richardson CA, Jull GA. Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain. Spine 1996;21:2763–2769.
13. Biering-Sørensen F. Physical measurements as risk indicators for low-back trouble over a one-year period. Spine 1984;9:106–119.
14. Holmström E, Moritz U, Andersson M. Trunk muscle strength and back muscle endurance in construction workers with and without low back disorders. Scand J Rehabil Med 1992;24:3–10.
15. Lee JH, Hoshino Y, Nakamura K, Kariya Y, Saita K, Ito K. Trunk muscle weakness as a risk factor for low back pain. A 5-year prospective study. Spine 1999;24:54–57.
16. Graves JE, Pollock ML, Foster D, Leggett SH, Carpenter DM, Vuoso R, Jones A. Effect of training frequency and specificity on isometric lumbar extension strength. Spine 1990;15:504–509.
17. Mayer TG, Smith SS, Keeley J, Mooney V. Quantification of lumbar function. Part 2: Sagittal plane trunk strength in chronic low-back pain patients. Spine 1985;10:765–772.
18. Pollock ML, Leggett SH, Graves JE, Jones A, Fulton M, Cirulli J. Effect of resistance training on lumbar extension strength. Am J Sports Med 1989;17:624–629.
19. Tucci JT, Carpenter DM, Pollock ML, Graves JE, Leggett SH. Effect of reduced frequency of training and detraining on lumbar extension strength. Spine 1992;17:1497–1501.
20. Mooney V, Kron M, Rummerfield P, Holmes B. The effect of workplace based strengthening on low back injury rates: a case study in the strip mining industry. J Occup Rehabil 1995;5:157–167.
21. Mayhew TP, Rothstein JM, Finucane SD, Lamb RL. Muscular adaptation to concentric and eccentric exercise at equal power levels. Med Sci Sports Exerc 1995;27:868–873.
22. Ploutz-Snyder LL, Tesch PA, Dudley GA. Increased vulnerability to eccentric exercise-induced dysfunction and muscle injury after concentric training. Arch Phys Med Rehabil 1998;79:58–61.
23. Kovaleski JE, Heitman RH, Trundle TL, Gilley WF. Isotonic preload versus isokinetic knee extension resistance training. Med Sci Sports Exerc 1995;27:895–899.
24. Ciriello VM, McGorry RW. Effects of preloaded isokinetic versus pure isokinetic training on dynamic and static lumbar muscle strength and endurance. J Occup Rehabil 2000;10:257–269.
25. Wasiak R, Pransky G, Verma S, Webster B. Recurrence of low back pain: definition-sensitivity analysis using administrative data. Spine 2003;28:2283–2291.
26. Wasiak R, Pransky GS, Webster BS. Methodological challenges in studying recurrence of low back pain. J Occup Rehabil 2003;13:21–31.
27. Bergquist-Ullman M, Larsson U. Acute low back pain in industry. A controlled prospective study with special reference to therapy and confounding factors. Acta Orthop Scand 1977;supplement 170:1–117.
28. Biering-Sørensen F. A prospective study of low back pain in a general population. I. Occurrence, recurrence and aetiology. Scand J Rehabil Med 1983;15:71–79.
29. Von Korff M, Deyo RA, Cherkin D, Barlow W. Back pain in primary care. Outcomes at 1 year. Spine 1993;18:855–862.
30. Carey TS, Garrett JM, Jackman A, Hadler N. Recurrence and care seeking after acute back pain: results of a long-term follow-up study. North Carolina Back Pain Project. Med Care 1999;37:157–164.
31. Burton C, Weller D, Sharpe M. Are electronic diaries useful for symptoms research? A systematic review. J Psychosom Res 2007;62:553–561.
32. Carey TS, Garrett J, Jackman A, Sanders L, Kalsbeek W. Reporting of acute low back pain in a telephone interview. Identification of potential biases. Spine 1995;20:787–790.
33. Stanton TR, Latimer J, Maher CG, Hancock MJ. A modified Delphi approach to standardize low back pain recurrence terminology. Eur Spine J 2011;20:744–752.
34. Stratford PW, Binkley JM, Riddle DL. Development and initial validation of the back pain functional scale. Spine 2000;25:2095–2102.
35. Shaw WS, Huang YH. Concerns and expectations about returning to work with low back pain: identifying themes from focus groups and semi-structured interviews. Disabil Rehabil 2005;27:1269–1281.
36. Waddell G, Newton M, Henderson I, Somerville D, Main CJ. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. Pain 1993;52:157–168.
37. Al-Obaidi SM, Nelson RM, Al-Awadhi S, Al-Shuwaie N. The role of anticipation and fear of pain in the persistence of avoidance behavior in patients with chronic low back pain. Spine 2000;25:1126–1131.
38. Doctor JN, Slater MA, Atkinson JH. The Descriptor Differential Scale of Pain Intensity: an evaluation of item and scale properties. Pain 1995;61:251–260.
39. Marcotte A, Barker R, Joyce M et al. Preventing work-related musculoskeletal illnesses through ergonomics: the Air Force PREMIER Program volume 2: Job Requirements and Physical Demands Survey methodology guide (field version). Brooks Air Force Base, Texas: Occupational and Environmental Health Directorate; 1997.
40. Dane D, Feuerstein M, Huang GD, Dimberg L, Ali D, Lincoln A. Measurement properties of a self-report index of ergonomic exposures for use in an office work environment. J Occup Environ Med 2002;44:73–81.
41. Daniels C, Huang GD, Feuerstein M, Lopez M. Self-report measure of low back-related biomechanical exposures: clinical validation. J Occup Rehabil 2005;15:113–128.

© 2012 Informa UK, Ltd.

42. Ciriello VM, Snook SH. The effect of back belts on lumbar muscle fatigue. Spine 1995;20:1271–8; discussion 1278.
43. Bigos SJ, Holland J, Holland C, Webster JS, Battie M, Malmgren JA. High-quality controlled trials on preventing episodes of back problems: systematic literature review in working-age adults. Spine J 2009;9:147–168.
44. MacDonald D, Moseley GL, Hodges PW. Why do some patients keep hurting their back? Evidence of ongoing back muscle dysfunction during remission from recurrent back pain. Pain 2009;142: 183–188.
45. Crum AJ, Langer EJ. Mind-set matters: exercise and the placebo effect. Psychol Sci 2007;18:165–171.
46. Rasmussen-Barr E, Ang B, Arvidsson I, Nilsson-Wikmar L. Graded exercise for recurrent low-back pain: a randomized, controlled trial with 6-, 12-, and 36-month follow-ups. Spine 2009;34: 221–228.