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Original article

A tailored exercise program versus general exercise for a subgroup of patients with low back pain and movement control impairment: A randomised controlled trial with one-year follow-up

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Abstract

Background: Exercise is an effective treatment for patients with sub-acute and chronic non-specific low back pain (NSLBP). Previous studies have shown that a subgroup of patients with NSLBP and movement control impairment (MCI) can be diagnosed with substantial reliability. However, which type of exercises are most beneficial to this subgroup is still unknown.

Objectives: The effectiveness of a specific exercise treatment to improve movement control was tested in this study.

Methods: Using a multicentre randomised controlled trial (RCT), we compared exercises that targeted MCI (MC) with a general exercise (GE) treatment. After randomisation, patients in both groups (MC = 52; GE = 54) were treated in eight private physiotherapy practices and five hospital outpatient physiotherapy centres. Follow-up measurements were taken at post-treatment, six months and 12 months. The primary outcome measurement was the Patient Specific Function Scale (PSFS).

Results: PSFS showed no difference between groups after treatment, or at six months and 12 months. Secondary outcome analysis for pain and disability, measured with the Graded Chronic Pain scale and the Roland Morris Disability Questionnaire respectively, showed that a small improvement post-treatment levelled off over the long term. Both groups improved significantly (p < 0.001) over the course of one year.

Conclusion: This study found no additional benefit of specific exercises targeting MCI.

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1. Introduction

Sixty to eighty percent of the adult population suffers from low back pain (LBP) at some point during life (Airaksinen et al., 2006). A previous episode of back pain is highly predictive of future episodes (Stanton et al., 2008; Kolb et al., 2011). In most cases, according to guidelines, a specific diagnosis is not possible and the complaints are labelled as non-specific low back pain (NSLBP) (Waddell, 1987; Airaksinen et al., 2006).

Evidence shows that exercise in general is an effective treatment for patients with sub-acute or chronic NSLBP (Hayden et al., 2005). Due to the great heterogeneity of this patient group, clinicians and researchers have tried to identify subgroups of NSLBP that respond positively to and benefit most from a specific exercise treatment (Foster et al., 2011; Karayannis et al., 2012). One potential subgroup are patients with movement control impairment (MCI), as classified by O’Sullivan (O’Sullivan, 2005). Patients with MCI present with mechanically induced pain in static postures together with visible
movement abnormalities, such as decreased or increased movement of parts of the lumbar spine, or discrepancies in the proportion of hip, leg and spine movements. It is assumed that these movement abnormalities are influenced by current pain, previous pain episodes and the belief that pain provoked by movement is harmful (O’Sullivan, 2005). The classification of MCI is based on the observation of aberrant movements accompanied by postural pain (O’Sullivan, 2005). A further sub-classification of MCI identifies the specific movement direction in which control is reduced (Dankaerts et al., 2006; Dankaerts and O’Sullivan, 2011). The sub-classification categories are flexion, active extension, passive extension, lateral shift or multidirectional MCI (O’Sullivan, 2005).

Many MCI test procedures have been developed in recent years, (Sahrman, 2002; O’Sullivan, 2005; Carlsson and Rasmussen-Barr, 2013). In order to define MCI subgroups more clearly, several tests have been evaluated by Luomajoki with a set of 6 MCI tests showing substantial intra-rater and inter-rater reliability (Luomajoki et al., 2007). MCI tests were shown to effectively distinguish healthy persons from patients with LBP (Luomajoki et al., 2008, 2010).

On the assumption that MCI patients would show better outcomes from treatment targeted at the individual MCI sub-classification, specific exercises were developed that aimed at relearning normal movement patterns (Luomajoki et al., 2010). These exercises were performed with increasing levels of difficulty (Luomajoki, 2010). Patients performed initial, easy, low load exercises, e.g. the positioning of the spine in a neutral position, and progressed to increased load and more complex functional requirements. Finally, unconscious application of the learnt movement patterns in daily activities was trained. These MCI subgroup specific exercises were targeted at the functional movement problems of the individual patient. However, it remains unclear as to whether individually-tailored treatment leads to superior outcomes.

To date, the proposed mechanisms and treatment of local stabilising muscles, such as multifidi and transversus abdominis, have received considerable attention in spinal control research. Two recent meta-analyses measuring pain and disability outcomes compared specific motor control exercises with other forms of exercises but obtained different results. Both papers showed favourable outcomes on both pain and disability for motor control over other forms of exercise in the short and intermediate term. They also agreed that no long term benefit on pain was seen. However, there was disagreement regarding the long term effect on disability (Bystrom et al., 2013; Smith et al., 2014). An RCT assessing the effectiveness of exercises and behavioural treatment for MCI, as proposed by O’Sullivan, showed some evidence of improved disability and pain when compared with manual therapy and exercise (Vibe Fersum et al., 2013). However, the latter study is regarded of moderate quality due to the substantial loss of patients in follow-up and to a lack of intention to treat analysis. Furthermore, the question remains unanswered as to which was responsible for the difference: the exercises or the behavioural approach.

To clarify, which exercise approach is superior for patients in the MCI subgroups, movement control (MC) exercises were compared with general exercises (GE) in this current study. A clearly described general exercise programme was selected for the control group to allow for a realistic treatment option. A previous study, in which patients were not assessed for subgroups, had found a better short term effect on disability in patients with LBP with this exercise regime than lumbar stabilising exercise plus general exercise (Koumantakis et al., 2005). We studied the effects of specific movement control exercises versus general exercise in a multicentre RCT. This article reports on the results at the six-month and 12 months follow-up and demonstrates the effect on disability and pain of specifically-tailored, active exercise treatment compared with general exercise treatment in patients with NSLBP and MCI.

2. Methods and material

2.1. Trial design

A parallel-group RCT with follow-ups at six months and 12 months was performed in five hospital outpatient departments and eight private practices in Switzerland. Patients were recruited from referring hospitals and resident physicians, as well as through advertising amongst the staff and students of the Zurich University of Applied Sciences, Winterthur, Switzerland (ZHAV). The trial was registered (ISRCTN80064281) and ethical approval obtained from the Swiss Ethics Committee KEK-ZH-NR: 2010-0034/5. The protocol has been previously published (Saner et al., 2011).

2.2. Participants

Patients presenting with sub-acute or chronic low back pain (persisting for longer than six weeks and no radiating symptoms below the knee) were recruited. Age had to be 18–75 years. Eligible patients also had to present with: predefined MCI complaints (pain provocation in static positions) (Dankaerts and O’Sullivan, 2011), together with a score of two or more positive results out of the six MCI tests (Luomajoki et al., 2007). Disability levels had to be at least five points on the Roland Morris Disability Questionnaire (RMDQ) (Roland and Morris, 1983; Wiesinger et al., 1999; Pengel et al., 2004).

Excluded were patients (1) with LBP due to known or suspected specific causes with recent surgery on the spine (<6 weeks); (2) with spondylodiscitis; (3) with comorbid health conditions, which limited exercise training. (4) To focus on patients with pain responding to movement, we also excluded patients complaining of constant pain and/or pain below the knee. (5) To avoid confounding by psychosocial factors, patients with a score of more than 130 on the Orebro Musculoskeletal Pain Screening Questionnaire (OMPSQ) (Linton and Boersma, 2003) and/or (6) more than 3 months of sick leave due to LBP were also excluded. German language had to be sufficient to understand study information, instructions and questionnaires. For further details see flow chart Fig. 1.

2.3. Randomisation and blinding

Following signing informed consent, patients attended baseline assessment, which was conducted by an independent, experienced and specially-trained physiotherapist. Eligible patients were randomly allocated to one of two groups. The computer-generated randomisation schedule was produced before trial start, using block-randomisation with a block size of four. Group allocation was communicated to the therapist by means of telephone contact from an independent research assistant at the ZHAV. Outcome assessors and data analysts were blinded to the allocation and were not involved in treatment throughout the trial. Blinding of patients and physiotherapists to the allocation was not possible, but patients were kept naïve to the specific research goal. Physiotherapists of the MC group received all baseline information concerning the MCI sub-classification and instruction on the six physical tests, in order to plan and apply a specific treatment. All other physiotherapists involved remained masked for initial assessments and trial results.
2.4. Interventions

Patients in both groups received individual treatment sessions of 30 min, preferably twice per week, over a period of nine to 12 weeks. Progression of the treatment, in accordance with the treatment protocol, was determined by the physiotherapist. Ten minutes of each session was allowed for other physiotherapy applications, where necessary. The length and type of additional interventions were recorded and monitored. All patients received instructions for a minimum of three home exercises and were encouraged to practise them at least twice a week for up to one year after treatment. Patients were contacted by telephone after six months and encouraged to maintain the training.

Movement control (MC) treatment consisted of active exercises addressing the pain-provoking postures and control of the impaired movement(s). These were assessed and classified at baseline, as proposed by O’Sullivan and Luomajoki (O’Sullivan, 2005; Dankaerts, O’Sullivan, 2006) (Luomajoki et al., 2010). As initial exercises, patients learnt to perform controlled movements in supported positions. Later they progressed to open chain positions, to exercises involving controlled movements with increased load and to specific functional tasks. Strength and endurance training was allowed once movement control was achieved. Following the rationale that the MC test battery is representative of functional MCI, the focus of the treatment was on functional restoration of the impaired movement(s). Exercises aimed specifically at local lumbar stabilising muscles (Hides et al., 2001), or treatment according to behavioural classification as recently proposed by O’Sullivan (O’Sullivan, 2012), were not included in the MCI treatment protocol. For example, patient A, when asked to bend forward without moving the lower part of the spine, was not able to stabilise the lumbar spine: this MCI was classified as flexion impairment, and the corresponding test is called “waiter’s bow”. In treatment, the patient learns to control the lumbar spine stepwise: initially performing exercises with hip movements only in well-supported body positions (such as lying and sitting) and gradually progressing to exercises in standing. Load, frequency and velocity can gradually be increased once the movement is retrained. The ultimate goal is that patient A should be able to move freely and automatically in complex functional situations according to his personal needs in daily life.

General exercise (GE) treatment aimed to improve the muscular strength of the lumbar and pelvic region and legs. In a standardised programme, as described in a study manual, all relevant muscle groups (abdominals, erector spinae, gluteals, quadriceps and hamstrings) were addressed in each treatment (Koumantakis et al., 2005). Start load and progression were assessed individually and followed a submaximal training protocol, according to the guidelines of the American College of Sports Medicine (Whaley, 2006).

The main contrast between the two programmes was the tailored-exercise training targeting functional improvement of MCI in the experimental group, as opposed to the non-specific general strength training performed by the control group.

All therapists showed a positive attitude towards their treatment group and had used the treatments in their daily practice. Therapists in the MC group were either trained to OMT (Orthopaedic Manual Therapy) standard or were novice physiotherapists working under the supervision of a highly-qualified OMT clinician of the ZHAW. All physiotherapists attended at least 4 h of specific
training on the protocol of their respective treatment. Additionally, they received a manual of conduct and exercise procedures. The therapists reported the trained exercises, number and description of home exercises and other interventions for each patient in a written log.

2.5. Baseline descriptives

Demographic and psychosocial characteristics of age, sex, height, weight, sports activities, workload, work status, sickness absence, medication, duration of LBP-related symptoms and Örebro musculoskeletal pain questionnaire (OMPQ) were recorded at baseline.

2.6. Outcome measures

Measurements of outcome were taken at baseline, post-treatment, after six months and 12 months. Outcome measures pre- and post-treatment were obtained by a research assistant onsite. Research assistants at the study centre collected primary outcome measures at six months and 12 months by telephone. On this occasion, they communicated the questionnaire on secondary outcomes, which were delivered and returned by postal mail.

Primary outcome was patient-specific LBP-related activity limitation measured with the Patient Specific Functional Scale (PSFS), the latter having shown excellent reliability for mechanical and chronic LBP (Stratford P, 1995; Hall et al., 2011; Horn et al., 2012) and concurrent validity with Roland–Morris Disability Questionnaire (RMDQ). PSFS was selected because it showed good responsiveness in patients with moderate LBP complaints and reflected patients’ individual relevant limitations (Pengel et al., 2004; Hall et al., 2010).

Secondary outcome variables were pain over the last three months (measured with the subscales “Characteristic Pain Intensity” of the Graded Chronic Pain Scale (GCPS) (Turk and Melzack, 2011) (v. 2.0)) and disability (measured with the subscales “Disability Score” of the GCPS and the Roland–Morris Disability Questionnaire (RMDQ) (Roland and Morris, 1983)). Total GCPS scores for pain ranged from 0 to 30 and for disability from 0 to 40. Reliability and validity of GCPS and RMDQ were high for the English and the German versions (Wiesinger et al., 1999; Roland and Fairbank, 2000; Klases et al., 2004). More details about outcome measurements are described in the study protocol (Saner et al., 2011).

2.7. Adherence and satisfaction

Adherence to treatment by patients and therapists was monitored using log books and a comprehensive questionnaire, both during and after treatment. Patient satisfaction was assessed with a numeric rating scale from 0 (extremely dissatisfied) to 10 (completely satisfied) after six months and one year.

2.8. Data analysis

Descriptive statistics of demographic and clinical measures were performed. Analyses followed the intention-to-treat principle. For the primary outcome, only the first activity mentioned in the PSFS was used for analysis, i.e. the first open-ended response item, since correlation between the averages of the three activities versus the first activity was very high at 0.9. Univariate analysis of variance (ANOVA) for the primary outcome and subsequent analysis of covariance (ANCOVA) analysed the potential influence of the identified covariates of baseline differences and pain duration. Missing data for this analysis were replaced by the group mean value (Holli and Campbell, 1999).

For primary and secondary outcome, we fitted a linear mixed model (LMM) to the data with time, treatment group and the interaction time: treatment group as fixed effects, subject was included as random intercept (Son et al., 2012). Random intercept models are equivalent to repeated measures ANOVA and take into account the correlation between repeated measurements. In contrast to classical repeated measures ANOVA, they can deal naturally with missing observations. All missing values were handled in the model as missing at random. In a first step, the parameters of the model were estimated; in a second step, specific contrasts were estimated.

For the intervention, we described differences of adherence between both groups regarding frequency of home exercises and patient satisfaction. For work status descriptive data over one year were provided.

Analyses were conducted using IBM SPSS Statistics 20. Two-sided significance was set at p ≤ 0.05.

3. Results

3.1. Participants

Between August 2010 and February 2012 a total of 201 patients were evaluated for eligibility. As described in the flow chart (Fig. 1), 48 patients did not meet the primary inclusion criteria. A further 47 patients were excluded from randomisation after baseline assessment. The main reasons for exclusion were minimal disability (<5 RMDQ) or no movement control impairment (<2 MCI tests positive). After signing informed consent, 106 patients were randomised (MC = 52, GE = 54). The final number of participants equates to the sample size calculation (power 0.9; 2-sided α 0.05; 10% drop out) (Saner et al., 2011). Follow-up data collection ended in March 2013.

Table 2 shows that most baseline characteristics were similar in both groups. There were more men than women, participants were relatively active in sports, only 11% were absent from work or on restricted work because of their LBP. Participants with LBP for longer than one year comprised 80%. Patients in the MC group had experienced a longer mean duration of pain than those in the GE group.

For unknown reasons, three patients in the MC and two in the GE group withdrew from the study during treatment. One patient withdrew for other unrelated medical reasons. Baseline characteristics did not differ between assessed and non-assessed patients during follow-up, except for the duration of pain (MC/GE; 9.0/15.7 years). The attrition rate of six % was within the anticipated 10%.

3.2. Primary outcome

Table 2 and Fig. 2 show outcomes for LMM of treatment effects of PSFS at all follow-ups. Both groups improved significantly over time (p < 0.001). The time and group interaction effect for the PSFS was not significant (p > 0.05). A slight post-treatment trend in favour of the MC group (mean – 0.4; –1.4 to 0.6, 95%CI) levelled off at 6 months. Baseline differences and information from the literature identified pain duration as potentially having an influence on outcomes (Dunn and Croft, 2006; Hill et al., 2008; Von Korff and Dunn, 2008). However, the results were not changed to a level of significance and these variables were not taken into account for further analysis (LMM) (Ryoo, 2011).

The minimal clinical important change was reported >0.9 on PSFS for mechanical pain (Stratford et al., 1995) and >1.9 for chronic pain (Maughan and Lewis, 2010). 95 patients (89.9%) reached the
Table 1
Baseline demographic data and baseline results of questionnaires.

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>Movement control n = 52</th>
<th>General exercise n = 54</th>
<th>Total group n = 106</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (SD)</td>
<td>42.8 (13.8)</td>
<td>40.5 (14.7)</td>
<td>41.6 (1.4)</td>
</tr>
<tr>
<td>Gender</td>
<td>female, n = 16</td>
<td>male, n = 24</td>
<td>n = 40</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>mean (SD)</td>
<td>173.0 (8.5)</td>
<td>73.9 (8.0)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>mean (SD)</td>
<td>75.5 (11.7)</td>
<td>74.7 (11.9)</td>
</tr>
<tr>
<td>Physical workload</td>
<td>low, n = 23</td>
<td>44.2%</td>
<td>21 (38.9%)</td>
</tr>
<tr>
<td>medium, n = 22</td>
<td>42.3%</td>
<td>26 (48.1%)</td>
<td>48 (43.5%)</td>
</tr>
<tr>
<td>heavy, n = 5</td>
<td>9.6%</td>
<td>6 (11.1%)</td>
<td>11 (10.4%)</td>
</tr>
<tr>
<td>missing, n = 2</td>
<td>3.8%</td>
<td>1 (1.9%)</td>
<td>3 (2.8%)</td>
</tr>
<tr>
<td>Sport participation</td>
<td>no</td>
<td>19 (36.5%)</td>
<td>30 (58.3%)</td>
</tr>
<tr>
<td>1–2x week</td>
<td>21 (42.0%)</td>
<td>23 (43.1%)</td>
<td>44 (41.5%)</td>
</tr>
<tr>
<td>&gt;2x week</td>
<td>10 (20.0%)</td>
<td>13 (25.0%)</td>
<td>23 (21.7%)</td>
</tr>
<tr>
<td>missing</td>
<td>2 (3.8%)</td>
<td>2 (3.8%)</td>
<td>4 (3.8%)</td>
</tr>
<tr>
<td>Work status</td>
<td>part-time</td>
<td>3 (5.8%)</td>
<td>3 (5.6%)</td>
</tr>
<tr>
<td>full-time</td>
<td>39 (75.0%)</td>
<td>38 (70.4%)</td>
<td>77 (72.6%)</td>
</tr>
<tr>
<td>no paid job</td>
<td>5 (9.6%)</td>
<td>8 (14.8%)</td>
<td>13 (12.3%)</td>
</tr>
<tr>
<td>missing</td>
<td>4 (7.7%)</td>
<td>0</td>
<td>4 (3.8%)</td>
</tr>
<tr>
<td>Pain Duration&lt; (y)</td>
<td>mean (SD)</td>
<td>11.6 (12.8)</td>
<td>8.4 (8.9)</td>
</tr>
<tr>
<td>&lt;1 year, n = 4</td>
<td>8</td>
<td>12 (11.3%)</td>
<td></td>
</tr>
<tr>
<td>1–5 years, n = 17</td>
<td>15</td>
<td>32 (30.2%)</td>
<td></td>
</tr>
<tr>
<td>&gt;5 years, n = 26</td>
<td>27</td>
<td>53 (50.0%)</td>
<td></td>
</tr>
<tr>
<td>OMPQ</td>
<td>mean (SD)</td>
<td>78.3 (24.3)</td>
<td>81.5 (20.4)</td>
</tr>
</tbody>
</table>

Abbreviations: y = year; SD = standard deviation; OMPQ: Oerebro musculoskeletal pain questionnaire.

first (MC/GE: 90.4%/88.9%) and 81 (76.4%) the second value (MC/GE: 75.0%/77.8%).

3.3. Secondary outcomes

Table 2 and Fig. 2 show the results of GCPS and RMDQ. Pain differences were non-significant at all follow-ups. The between-group difference for the RMDQ in favour of the MCI group, which was significant post-treatment, was no longer significant after six and 12 months.

As in the primary outcome, all secondary outcomes improved significantly over time in both groups. Again, the main effect over time was shown between pre- and post-treatment and improvements were maintained for up to one year.

All but one patient, who were initially on full or partial sick leave because of their back pain, improved their work status. One patient in the GE group remained on partial sick leave.

3.4. Treatment descriptives

Patients received a mean of 8–9 treatment sessions (range MC 4–18; GE 5–25) in both groups. Patients completing treatment reported a mean number of recommended exercises of MC/GE 3.9/5.0, respectively. One year after randomisation, approximately 46% of the patients in both groups (MC/GE; n = 20/22) reported that they still did their exercises in accordance with the recommended twice per week or daily. Patient satisfaction with treatment was comparable between groups. At the six months and twelve months follow-ups 70% and 80% of the patients in both groups rated satisfaction with treatment as high to very high (8 or more on a 0–10 scale) (Kool et al., 2007).

Patients in both groups started with a mean number of impaired movement control tests of 3.9, the MC group improved to a mean of 1.8 and the GE patients to 2.8 positive tests after treatment. The 10 min allocated to other physiotherapy applications was monitored in the log book and did not exceed the allowance for any patient.

A total of 28 physiotherapists performed the treatments. Therapists in both groups had mixed levels of experience. Due to the different recruitment processes, therapists in private practice reported mean years of experience MC/GE: 12.9/9.8. Physiotherapists from the ZHAW (four therapists in each group) were novices and were treating 15 patients in each group.

4. Discussion

The findings of this study indicate no additional benefit on disability and pain to patients with NSLBP and MCI of movement control exercise versus general exercise. Both groups improved significantly on all outcomes over time.
4.1. Strengths of this study

This trial was prospectively registered, the protocol was published and every attempt was made in the design to minimise bias. In general, patients were representative of people with mild to moderate pain and disability as a result of their long-lasting low back disorders. Patients with a high risk of psychosocial burden were excluded, in order to principally address the physical aspects of NSLBP.

For the interventions, we chose two exercise programmes, which had previously shown positive effects, with the aim of clarifying the choice of treatment for the physiotherapist. The pragmatic approach, with 28 physiotherapists in different clinical settings and therapists with different length of work experience, shows that the treatments are widely applicable.

The adherence to the intervention protocol was high for therapists and patients in both groups. A blinded research assistant, who obtained the third and fourth PSFS results by telephone, also encouraged participants to stay compliant with their home exercise programme. This might have supported the high adherence and follow-up rates (Evers et al., 2012).

4.2. Limitations of this study

The unexpected improvements in both groups may be influenced by the inclusion criteria of the study. Previous observational studies, analysing the natural history of LBP, have stated repeatedly that patients with previous episodes of back pain are likely to remain in a stable situation over years with no improvement over time (Von Korff, 1994; Tamcan et al., 2010). In our RCT, a selection bias towards a NSLBP population with low psychosocial influence and high self-management competence may be present and must be considered when selecting either exercise programme for future treatment. Additionally, the inclusion criteria of MCI - 2 positive tests out of 6 was designed to select patients who would have the best chance of improvement with specific exercises. Likewise, it was not possible to blind physiotherapists or patients due to the nature of the treatment; patients would have noticed during treatment whether they were performing a general exercise program or tailored, focused exercises that matched the tests they underwent at baseline. The therapists treating patients in the MCI group had an OMT degree, which is a two-year postgraduate specialisation in musculoskeletal physiotherapy. It was assumed that they were sufficiently specialised in treating MCI. However, O’Sullivan claims that it needs a further 100-h programme to learn to treat patients in this subgroup. Therefore, the equal results might be due to insufficient training. However, in our opinion, treatment of MCI is achievable by every physiotherapist, should be not too complex and form part of every physiotherapists toolbox.

4.3. Comparison with other studies

We are not aware of any results from other RCTs with the same inclusion criteria and this type of MC treatment. In a study of moderate methodological quality, a similar patient group, identified with the same classification system, found a significant benefit from behaviourally-orientated exercises when compared with spinal manipulation plus exercise (Vibe Fersum et al., 2013). Other than in our study, patients were additionally classified according to their behavioural pattern. The intervention of the experimental group followed a mixed approach of exercise and cognitive behavioural treatment. We are aware of changes to the assessment...
and treatment approaches in more recent years (O'Sullivan, 2012). Nowadays, non-specific low back pain disorders should be considered within the multidimensional bio-psycho-social framework. Implementation of this approach is of major concern regarding the ‘beliefs’ of the therapists in terms of how they understand and deal with NSLBP.

### 4.4. The importance of exercise in NSLBP

The results of our study support previous findings that exercise in general, regardless of the type, is beneficial for patients with NSLBP. Alongside disability, pain, a major concern for patients, improved significantly and continuously. Clearly both treatments share general effective aspects of exercise. All patients receive attention to their complaints, they are introduced to exercise at their level of fitness, and the exercises are controlled regularly. As a result, they improve their physical activity levels, fitness and gain confidence in movement and adjustment of lifestyle.

Furthermore, the importance of general influences of the therapeutic relationship and the effects on pain beliefs, as explained in the common factors model, may be underestimated (Hall et al., 2010; Miciak et al., 2012). This assumption is supported by the high level of satisfaction with treatment in both groups. Although all these factors are likely to explain a substantial part of the improvement in both groups, the previously mentioned effect of some degree of selection bias towards a sample with an existing good prognosis, cannot be ruled out.

### 5. Conclusion

Contrary to our expectation, MC exercise and GE exercise appear equally effective in the patient subgroup included in this study. We can conclude that the contrast between both types of intervention did not bring additional value to the shared effects. Decisions for the application of either active treatment approach can currently not be taken on the basis of the results of this study. It is possible that the type of exercise treatment is less important than previously presumed; that the patient is guided to a consistent long-term exercise lifestyle is of most importance.

Based on the results of this study, we can recommend exercise therapy for patients with NSLBP and MCI, either using movement control or general exercise. Future research on treatment for NSLBP may reconsider the concept of testing exercises for specific subgroups. If the theoretical model, clinical findings, patients likely to respond to the treatment (but with a prognosis that can be improved) and adequate treatment goals are found, the means to treat need to have sufficient contrast. The concept behind exercise may not be based so much on specific movements, but on activity per se, the dosage of exercise, the kind of information and general aspects of a physiotherapy treatment.

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