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Faculteit Geneeskunde en Levenswetenschappen

master in de revalidatiewetenschappen en de kinesitherapie

Masterthesis

The effects of a physical rehabilitation program on kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in persons with chronic low back pain

Laurien Roebben
Sofie Vanlommel

Eerste deel van het scriptie ingediend tot het behalen van de graad van master in de revalidatiewetenschappen en de kinesitherapie

PROMOTOR :
Prof. dr. Annick TIMMERMANS

COPROMOTOR :
De heer Jonas VERBRUGGHE

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"Physical training (exercise training, cognitive behavioral training or multidisciplinary training containing an active component) seems to be an effective treatment approach for reducing kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in persons with CLBP."

"Further research is needed to determine which rehabilitation program is the most effective in reducing kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in persons with CLBP."

1st Master in science of physiotherapy and rehabilitation science

2017 – 2018

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Supervisor: Prof. Dr. Annick Timmermans

Co-supervisor: Jonas Verbrugghe

OUTLINE

Chronic low back pain (CLBP) is a common musculoskeletal disorder. Research has shown the effect of psychological factors in the transition from acute to CLBP. Kinesiophobia, fear avoidance beliefs, pain catastrophizing thoughts and other psychological factors have a negative influence on the rehabilitation of CLBP. Therefore, a rehabilitation program focused on these factors is necessary.

There are many treatment options for CLBP. Although there is yet no evidence for the best option, an active, conservative rehabilitation program seems to be better than a passive rehabilitation approach. This systematic review focused on the effect of physical training – therapy including an active component - on kinesiophobia and other psychological factors in CLBP.

The most important findings of this literature review (n=26) are the following:

- Kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts was evaluated in respectively seventeen, nine and eight studies.
- Physical training (exercise training, cognitive behavioral training or multidisciplinary training containing an active component) seems to be an effective treatment approach for reducing kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in persons with CLBP.
- Further research is needed to determine which rehabilitation program is the most effective in reducing kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in persons with CLBP

CONTEXT

This systematic review is the first part of our master thesis and discusses the effect of a physical rehabilitation program on kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in persons with chronic low back pain (CLBP). This subject was cited and supervised by Prof. dr. Annick Timmermans and PhD student Jonas Verbrugghe.

This systematic review is a duo-thesis between Sofie Vanlommel and Laurien Roebben, who conducted the literature search together. A central format, conform with the master's thesis guidelines, was used.

This master thesis can be situated in the research domain of musculoskeletal rehabilitation and focuses on chronic low back pain (CLBP). Chronic low back pain is one of the most common musculoskeletal diseases, and has an important socio-economic impact on the society. Research has shown that kinesiophobia, fear avoidance beliefs, pain catastrophizing thoughts and other psychological factors contribute to the transition from acute low back pain (ALBP) to CLBP. Furthermore, these factors have an important role in the maintenance of CLBP. Therefore, it is important to account for these factors in the rehabilitation of CLBP as well. However, little is known about effective treatments to reduce kinesiophobia and other negative psychological factors. Therefore, the aim of this systematic review is to determine the effects of a physical therapy intervention on kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts.

The second part of our master thesis is situated within an ongoing research project by PhD student Jonas Verbrugghe, named 'High intensity training (HIT) in persons with chronic non-specific low back pain' (CNSLBP). We will determine the effects of HIT and cognitive behavioral therapy (CBT) in (NS)CLBP. The study protocol of our research is based on the existing research protocol of the ongoing project of mister Jonas Verbrugghe. Part two of our master's thesis will be complemented in REVAL, which is located on the university campus of Hasselt University.

<u>The dividsion of tasks</u>

- Introduction: Sofie Vanlommel
- Methods: Sofie Vanlommel & Laurien Roebben
- Results: Laurien Roeben
- Discussion: Sofie Vanlommel & Laurien Roebben
- Data extraction: Sofie Vanlommel & Laurien Roebben
- Quality assessment: Sofie Vanlommel & Laurien Roebben
- Tables, figures … : Sofie Vanlommel & Laurien Roebben

PART I: Overview of the literature

PART I: LITERATURE STUDY

1. Abstract

Background

Chronic low back pain (CLBP) is a common musculoskeletal disorder. Psychological factors (e.g. kinesiophobia) seem to have an important factor in the development and maintenance of CLBP. A rehabilitation program regarding those factors is therefore necessary.

Methodes

Studies eligible for inclusion had to be RCTs or cohort studies. Participants had to suffer from CLBP and had to be 18-65 years old. The interventions had to include at least one active, physical component. Quality of the studies (n=26) was assessed by the van Tulder Checklist. Primary outcome measures were the Tampa Scale of Kinesiophobia (TSK), Fear-Avoidance Beliefs Questionnaire (FABQ) and Pain Catastrophizing Scale (PCS). Others outcome measures which are related to kinesiophobia were mentioned as well.

Results

Fourteen studies resulted be of high methodological quality. Average sample size was 87.5, mean age was 44.4 years. Kinesiophobia (KP), fear avoidance beliefs (FAB) and pain catastrophizing thoughts (PCT) improved in respectively twelve, eight and seven studies.

Discussion and conclusion

An active rehabilitation program seems to be effective for reducing KP, FAB and PCT. The results could not determine which rehabilitation program is the most effective, so futher research is needed. Studies which did report improvements in the outcome measures, lacked in methodological quality or intervention length.

Objective

The aim is to determine the effects of high intensity training and cognitive behavioral therapy on KP in persons with CLBP.

Operationalization

What is the effect of high intensity training in comparison to cognitive behavioral therapy on KP in persons with CLBP?

Key words: Chronic low back pain, Kinesiophobia, Fear-avoidance beliefs, Catastrophizing thoughts, Exercise therapy, HIT, CBT

2. Introduction

Low back pain is one of the most frequently reported musculoskeletal disorders (Andersson, 1999 [1]) with a lifetime prevalence up to 84% (Airaksinen et al., 2006 [2]). It is defined as a pain sensation localized below the lower edge of the chest and above the inferior gluteal fold accompanied with or without leg pain (Airaksinen et al., 2006 [2]). While most back pain is acute (i.e. persisting for less than 6 weeks), 23% of all persons will at one time in their life develop chronic low back pain (CLBP) (Balague, Mannion, Pellise and Cedraschi, 2012 [3]). This chronic disorder with a time span of a minimum of 12 weeks is characterized with high levels of disability, work absenteeism and significant costs to the healthcare system (e.g. in Belgium 5.7 million days of work absenteeism per year are paid because of low back pain) (Van Zundert and Van Kleef, 2005; van Tulder, Koes and Bouter, 1995 [4, 5]). Although specific back related pathologies are existent, most persons are categorized as having nonspecific chronic low back pain (NSCLBP), meaning that no underlying pathology can be defined (Balague et al., 2012; Maher, Underwood and Buchbinder, 2017 [3, 6]).

A significant amount of research is currently being done to describe the most effective treatment modality for CLBP. In general, conservative treatments (e.g. exercise therapy) are recommended for CLBP, while invasive and long-term pharmacological treatments are considered as no effective options (Airaksinen et al., 2006 [2]). These interventions mostly affect the physical aspects. Although, conservative treatment modalities, in particular exercise therapy, seem to be the most effective, the results are not always as expected (Aure, Nilsen and Vasseljen, 2003 [7]). This leads to conclude that other factors for maintaining and developing CLBP must exist.

To detect those factors, we must to, first and foremost, understand how acute low back pain can evolve into a chronic state. Already in the early 1980s, Lethem, slade, Troup and Bentley (1983) [8] described the effect of fear avoidance in the development from acute to CLBP. Ever since, a more than considerable amount of research about the psychological factors in the transition from acute to CLBP carried on. Picavet, Vlaeyen and Schouten (2002) found that high levels of pain catastrophizing or kinesiophobia (i.e. fear of pain due to movement) could increase the risk of CLBP and disability [9]. Furthermore Pincus, Burton, Vogel and Field (2002) et al. concludes that psychological factors including distress, depressive mood and somatization, play an important role in the transition from acute to CLBP [10]. These psychological factors do not only affect the risk or the development of CLBP, but they also affect the maintenance. Persons with elevated levels of fear of movement and (re)injury show more fear and avoidance to simple movements and activities (Vlaeyen, Kole-Snijders, Boeren and van Eek, 1955 [11]). This is in line with the study from Grotle, Vøllestad, Veierød and Brox (2004), where fear avoidance beliefs and distress are related to disability and even work loss [12].

Because of the high impact and importance of the psychological factors in the development and maintenance of CLBP, a rehabilitation program regarding those factors is necessary (Thomas et al., 2010; Hoffman, Papas, Chatkoff and Kerns, 2007 [13, 14]). Some studies already described the positive effect of behavioral intervention programs or multidisciplinary programs (Hoffman et al., 2007; van

Tulder et al., 2000 [14, 15]). Further, the addition of a physical component to behavioral therapy is an effective treatment option as well (Turner, Clancy, McQuade and Cardenas, 1990 [16]).

Although vast amounts of research has been done regarding CLBP itself and the treatment of the physical predictors, little is known regarding the effect of different intervention modalities on the psychological factors. Thus, in this systematic review we'll discuss the effects of different physical therapy modalities on kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in persons with CLBP.

3. Methods

Research question

The primary aim of this systematic review is to investigate the following research question: “What is the effect of physical training on kinesiophobia in persons with CLBP?” The primary outcome measures are kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts. Other factors related to these variables are mentioned as well.

The research question can be converted to the following PICO:

P: patients with chronic low back pain

I: therapies with at least one active, physical component

C: other treatment modalities

O: kinesiophobia, fear avoidance beliefs, catastrophizing thoughts or other outcome measures related to these primary outcome measures

Literature search

The literature search was conducted until the 10th of January 2018. The studies included in this systematic review, are derived from the databases Pubmed and Web of Science (WoS). For the literature search, the combination of the following MeSH terms and keywords were used: (Low back pain OR Musculoskeletal diseases OR Chronic pain OR Chronic low back pain) AND (Physical therapy modalities OR Exercise therapy OR Exercise interventions OR Physiotherapy OR Physical therapy OR Rehabilitation) AND (Fear of movement OR Kinesiophobia OR Fear avoidance OR Pain beliefs OR Fear of pain OR Avoidance behavior OR Disability OR Dysfunctional beliefs OR Self-efficacy OR Central sensitisation OR Hyperalgesia OR Hyperalgesia OR Hyperesthesia OR Hyperesthesia OR Catastrophization OR Fear OR Avoidance learning OR Pain related fear OR Movement evoked pain OR Pain behavior OR Pain catastrophizing OR Pain/psychology OR Anxiety). For each database, the search strategy was modified to the structure of the database.

A full search strategy for each database can be found in the appendix.

Selection criteria

Articles were included if they met the following selection criteria: 1) the study design was a randomized controlled trial (RCT) or a cohort study, 2) the included persons were between 18 and 65 years old, 3) the included persons were CLBP patients (> 12 weeks), 4) the applied intervention, had at least one component of an active, physical therapy 5) the outcome measurements were related to fear avoidance beliefs, kinesiophobia, pain catastrophizing thoughts… Articles were excluded if they met one of the following criteria: 1) no full text was available, even after contact with the original author and using different databases 2) an intervention was given as preparation for surgery or after surgery.

Quality assessment

The methodological quality assessment of selected articles was performed independently by two reviewers (S.V. and L.R.). All included articles were assessed by using the van Tulder quality checklist for RCTs. Therefore, not all questions were applicable for the cohort studies (Table 3: ‘Na’). The van

Tulder checklist discusses the internal validity (0-11), descriptive criteria (0-6) and statistical criteria (0-2) of the included study, and has a maximum score of 19. Studies which have a score ≥ 50% on the internal validity (IV), are considered as high quality methodological studies.

Data extraction

Two tables were set up for data extraction. The first table summarizes the general study characteristics: patient population, intervention, outcome measures and results. A second table was set to give a more detailed explanation of the intervention characteristics. This table discusses the intervention location, content, volume, frequency, goals, program length, session duration and the control intervention.

4. Results

Results study selection

The search strategy resulted in 4396 articles (Pubmed: 4040; Web of Science: 356). Each reviewer screened 50% of articles. Titles were excluded when they did not meet the inclusion criteria. The remaining articles (1232) were assessed by abstract by both reviewers. After abstract screening, 153 articles were included for full text screening. Table 2 shows these articles and their reasons of excluding. Practicality reasons compelled us to limit the table to representing excluded, and hence relevant articles after title screening only. Finally, 26 studies were found to be eligible for this review. Figure 1 represents the study selection process in a flowchart diagram.

Results quality assessment

An overview of the van Tulder quality assessment is shown in table 3. After performing the quality assessment on the included studies, 14 studies turned out to be of high methodological quality (internal validity score ≥ 50%). The mean internal validity score was 5.15/11. The mean descriptive score was 4.54/6. All studies scored 2/2 for statistical criteria.

Results data extraction

Table 5 discusses the patient population, intervention, outcome measures and results. Table 6 represents the specific characteristics for each study.

Baseline charactertics

The **patient population** of all the included studies are persons with CLBP for at least 12 weeks and had to be between 18-65 years old. An overview of the patient characteristics is shown in Table 5. In total, the results of 2276 patients with CLBP were included. The number of patients in the studies ranged from 6 to 262. Thus, the sample sizes ranged from small to high, with an average of 87.5. The mean age of included patients was 44.4 years. Schütze et al. (2014) and de Jong et al. (2005) did not describe the mean age of the participants, and were therefore excluded from this calculation [17, 18]. All the studies gave a description of the patient characteristics, although some only gave a minimal amount of information.

Intervention characteristics

The **interventions** applied in the included studies can be divided into three main categories.

Exercise therapy: 12 studies applied an intervention where the main focus lied on exercise therapy interventions. The following types of interventions were applied: strengthening exercises of the spine, lower limbs and upper limbs; endurance exercises of the spine, lower limbs and upper limbs; stretching of the spine, lower limbs and upper limbs; aerobic exercises; trunk stabilisation exercises; coordination exercises; pilates; functional movement therapy; yoga; mobilization of the spine; motor control exercises; walking exercise and stationary cycling.

Cognitive-behavioral interventions: nine studies applied an intervention where the main focus lied on cognitive-behavioral intervention. The following types of interventions were applied: education; relaxation; problem solving therapy; psychological interventions; graded exercise; graded exposure; graded activity; mindfulness meditation and coping strategies exercises.

Multidisciplinary interventions: five studies applied a multidisciplinary intervention. These interventions performed a combination of the previous mentioned therapies with no main focus on one particular modality.

Outcome measure characteristics

The included studies used different **outcome measures**, but they are all related to the main subjects of this review: kinesiophobia, fear-avoidance and pain catastrophizing. Table 7 shows the outcomes measures and their respectives studies. The table focuses on the three most important outcome measures which we wanted to evaluate: the Tampa Scale of Kinesiophobia (TSK), Fear-Avoidance Beliefs Questionnaire (FABQ) and Pain Catastrophizing Scale (PCS). Others outcome measures which are related to kinesiophobia are also mentioned. Sixteen studies evaluated kinesiophobia, nine studies evaluated fear-avoidance beliefs, and eight studies evaluated pain catastrophizing thoughts.

Effectiveness of the included studies

Kinesiophobia (KP)

Twelve studies concluded that KP improved after intervention. Six studies were exercise therapy intervention studies, four studies were multidisciplinary intervention studies and two studies were cognitive-behavioral interventions. Kernan et al. (2007) showed a significant improvement in KP after exercise therapy [19]. The posttreatment mean scores were clinically similar to those at 12 month follow-up. Koumantakis, Watson and Oldham (2005) reported a significant improvement in KP for both the trunk stabilization group as the general exercise group immediately after intervention, and these improvements were maintained three months later. However, no significant time with group interactions were found, thus both groups achieved similar change over time [20]. Helmhout, Harts, Staal, Candel and De Bie (2004) showed a significant difference in KP between the high intensity training (HIT) group and low intensity training group at two and nine months, in favour of the HIT group [21]. Pagé, Marchand, Nougaraou, O'shaughnessy and Descarreaux (2015) reported a significant improvement in KP between baseline and after a four-session biofeedback intervention [22]. Nassif et al. (2011) showed a significant improvement in KP at two and six months in the physical exercise group. The control group showed no significant improvement at either time point [23]. Norris and Matthews (2008) reported a significant improvement in KP in the integrated back stability group. No differences were observed for the control group. Further, significant between group differences were detected for KP [24]. Monticone et al. (2016) showed a significant between group difference in favour of the multidisciplinary group, in comparison to the traditional exercise group, at the end of the intervention [25]. Monticone et al. (2014) reported a significant improvement of KP in the multidisciplinary group only, which was maintained at follow-up. Also, significant between group interactions and time with group interaction effects were found, in favour of the experimental group [26]. Monticone et al. (2013) reported that 98% of the persons in the

multidisciplinary group achieved a clinically significant improvement of KP after five weeks, and 100% after 12 months. The majority of the control group, which only received exercise therapy, experienced no change at any time point [27]. Demoulin et al. (2010) showed a significant improvement of KP from session one to 18, after a multidisciplinary intervention. Kinesiophobia improved further from session 18 to 36. The improvement between session one and 36 was significant. No significant improvements in KP were found between the two evaluations in the control group [28]. de Jong et al. (2005) reported that KP improved in both groups after education. Kinesiophobia decreased even more when the graded exposure intervention was applied, but not when the graded activity intervention was carried out [18]. Vlaeyen, de Jong, Geilen, Heuts and van Breukelen (2002) showed a significant reduction in KP when the experimental intervention was delivered and not during graded activity, independent of the treatment order. Improvements were still present at the one year follow-up [29]. Gema, Enrique, Tomás, Virginia and Daniel (2017) reported significant differences between the 'pain neurophysiology education + physical exercise group' and 'the physical exercise group', in favour of the experimental group [30].

Four studies concluded that KP did not improve after intervention. Two studies were exercise therapy intervention studies and two studies were cognitive-behavioral interventions. Harts, Helmhout, de Bie and Staal (2008) found no significant differences in improvement of KP between the three groups (HIT, LIT and waiting list) [31]. Miyamoto, Costa, Galvanin and Cabral (2013) found no significant improvement in KP after a pilates intervention. Also, no significant differences between the pilates group and the education-only group were found at six month follow-up [32]. Pires, Cruz and Caeiro (2015) reported no significant improvement in KP over time after an aquatic exercise with education intervention. Also, no significant between-group differences were found [33]. George, Wittmer, Fillingim and Robinson (2010) found no significant improvement in KP after a graded exercise or graded exposure intervention [34].

Fear avoidance beliefs (FAB)

Eight studies concluded that FAB improved after intervention. Five studies were exercise therapy intervention studies, three studies were cognitive-behavioral intervention studies. No single multidisciplinary intervention study evaluated FAB. Kernan et al. (2007) showed a significant improvement in FAB after a physical exercise intervention [19]. The posttreatment mean scores were clinically similar to those at 12 month follow-up. Mannion, Muntener, Taimela and Dvorak (1999) reported a significant improvement FAB in all three active therapy groups after treatment [35]. These values remained significant at six and 12 month follow-up. However, no significant group effect regarding the pattern of change was found. Hurley et al. (2015) reported a significant reduction in FAB at all follow-up intervals. However, no significant differences between the walking group, the group exercise class and usual physiotherapy were found [36]. Marshall, Kennedy, Brooks and Lonsdale (2013) showed a significant improvement in FAB for the pilates exercise group only, after eight weeks. After six months, only the stationary cycling group showed a significant reduction FAB. No between group differences were found for FAB at any time point [37]. Shnayderman and Katz-Leurer (2013) reported significant improvements in FAB in both the aerobic exercise group and the muscle strengthening group, with non-significant between group differences [38]. Linden, Scherbe and Cicholas (2014) showed a significant

improvement in FAB in both groups [39]. However, significant between group differences were found, showing a superior improvement in the cognitive behavioral therapy group. O'Sullivan, Dankaerts, O'Sullivan and O'Sullivan (2015) reported a significant improvement FAB after a cognitive functional intervention program [40]. Harris et al. (2017) showed a significant improvement of FAB in all groups (brief intervention, brief intervention + cognitive behavioral therapy, brief intervention + physical exercise) at 12-month follow-up. However, no significant between group differences were found [41]. Only George et al. (2010) showed no significant improvement of FAB in neither the graded exposure group, nor the graded exercise group [34].

Pain catastrophizing thoughts (PCT)

Seven studies concluded that pain catastrophizing thoughts improved after intervention. One study was an exercise therapy intervention, four studies were cognitive-behavioral intervention studies and two studies were multidisciplinary intervention studies. Marshall et al. (2013) showed a significant reduction of PCT in both the pilates group and the stationary cycling group after eight weeks and after six months [37]. O'Sullivan et al. (2015) reported a significant improvement in PCT after a cognitive functional intervention program [40]. Schütze et al. (2014) showed a significant improvement of PCT after immediately after a mindfulness based functional therapy, and after six months [17]. de Jong et al. (2005) reported that PCT improved in both groups after education. Pain catastrophizing thoughts decreased even more when the graded exposure intervention was applied, but not when the graded activity intervention was applied [18]. Vlaeyen et al. (2002) showed a significant reduction in PCT when the experimental intervention was delivered and not during graded activity, independent of the treatment order. Improvements remained at the one year follow-up [29]. Monticone et al. (2014) showed a significant improvement of PCT in both groups [26]. However, the change was clinically meaningful for the multidisciplinary group only. Also, a significant between group difference was found after intervention. Monticone et al. (2014) reported a significant improvement of PCT in the multidisciplinary group. Also, significant between group effects and group with time interaction effects were found, in favour of the multidisciplinary group [26].

Other outcome measures

O'Sullivan et al. (2015) and Schütze et al. (2014) analyzed the effect on depression, anxiety and stress, using the Depression, Anxiety and Stress Scale - 21 items (DASS-21) [17, 40]. O'Sullivan et al. (2015) showed a significant improvement for these emotions at all intervals after a cognitive functional therapy intervention [40]. Schütze et al. (2014) reported a significant improvement in stress immediately after a mindfulness based functional therapy, and after six month follow up. Also, there was a significant improvement in depression at six month follow up, but not immediately after intervention [17]. George et al. (2010) and Smeets, Vlaeyen, Kester and Knottnerus (2006) analyzed the effect on depression using the Beck Depression Inventory (BDI) [34] [42]. George et al. (2010) showed a significant improvement of depressive symptoms in both the graded exercise group and graded exposure group after intervention [34]. Smeets et al. (2002) reported a significant reduction of depressive symptoms in the active physical therapy group only [42]. George et al. (2010) analyzed the effect on fear of pain,

using the Fear of Pain Questionnaire-ll (FPQ-II) [34]. The results showed no significant improvement in fear of pain following treatment. Vlaeyen et al. (2002) and de Jong et al. (2005) analyzed to what extent persons experienced particular movements as 'threatening', using the Photograph Series of Daily Activities (PHODA) [29] [18]. Vlaeyen et al. (2002) reported a significant improvement after an exposure in vivo intervention [29]. No improvements were found after a graded activity intervention. de Jong et al. (2005) showed no significant improvement after education [18]. However, there was a significant improvement for the graded exposure group only after intervention.

Smeets et al. (2006) analyzed the effect on catastrophizing and internal control using the Pain Cognition List (PCL) [42]. Pain catastrophizing showed a significant improvement in all three active interventions in comparison to the control group. Internal control did not change significantly in any active intervention.

5. Discussion

Reflection on the quality of the included studies

Fourteen studies (out of 26) turned out to have a high methodological internal validity. It is possible that more studies would be of high methodological quality if a specific checklist for cohort studies would have been used. None of the included studies blinded the care provider. Patients were blinded in only 1 study (Koumantakis et al., 2005 [20]). However, this is not exceptional. Armigo-olive et al.(2017) found that out of 393 trials, only 2 and 33 studies respectively therapists and patients respectively in a physical therapy setting [43]. Some studies did not applicate blinding of the outcome assessor, which creates the risk for a detection bias. The way outcome measures were analyzed potentially differ between the groups, because the outcome assessor knew which group participated in the experimental intervention and in the control intervention. Further, because some studies used voluntary recruitment of patients, those patients probably were well motivated to participate in an exercise program. Therefore, it is possible that these results are not applicable for patients who are not motivated to participate in a physical intervention, leading to a potential selection bias.

Reflection on the findings in function of the research question

The aim of this systematic review was to determine the effect of physical therapy rehabilitation programs on kinesiophobia, fear avoidance behavior, pain catastrophizing thoughts and other psychological factors in persons with CLBP. The main finding of this systematic review is that physical training (exercise training, cognitive behavioral training or multidisciplinary training containing an active component) seems to be an effective treatment approach for reducing kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in persons with CLBP.

In general, the positive results of the included studies can be linked to the fear-avoidance model by Leeuw et al. (2007) [44], which is based on the original model of Lethem et al. (1983) [8]. This model describes that the way pain is interpreted, can lead to two different pathways. When pain is catastrophized and interpreted as impeding, a vicious circle may be initiated. This catastrophized thinking leads to pain-related fear, avoidance behavior, disability, disuse… A possible explanation for this, is that the brain develops a long-term pain memory system. If one is thinking about movements which may lead to pain, the brain activates the fear-memory centre and produces pain even before the movement is performed, creating fear of movement (Tucker et al. (2017) [45], Mannion et al. (2001) [46]). In an acute stage of pain, this can be seen as relatively normal adaptive behaviour. But in case of long-lasting pain, this behaviour can worsen the problem. However, when pain is interpreted as non-threatening, patients will likely continue to carry out their daily activities. This will promote functional recovery.

After performing the data extraction, interventions were divided into three groups: exercise therapy, cognitive behavioral therapy and multidisciplinary therapy.

Exercise therapy (ET)

When applying ET to the fear-avoidance model, the following hypothesis can be made. Exercise therapy may reduce fear of pain or (re-)injury by altering pain catastrophizing thoughts, which leads to less avoidance behavior. After all, when performing ET, and thus performing physical activity, people are confronted with their fear (e.g. fear for (re-)injury, pain etc.). This confrontation leads to the experience that there is no (re-)injury or worsening of pain/disability when performing physical activity. As a result, people alter their beliefs that physical activity will cause (re-)injury or worsening of pain/disability. A similar explanation is given by Mannion et al. (2001), who suggests that the irrational beliefs (e.g. FAB, PCT) in persons with CLBP may be adjusted by active therapy because they experience something different than they expect [46]. More in particular, persons with irrational beliefs expect a worsening of pain or disability due to performing physical exercise (e.g. spine stabilization exercises, pilates, walking etc.). Further, these findings emphasize the results of Elfving, Andersson and Grooten (2007) who found that low levels of physical activity are associated with high levels of KP and PCT [48]. These findings support our hypothesis that an ET intervention may lead to a reduction in KP, FAB and PCT.

Regarding the exercise therapy modalities, different types of active therapy were used. Positive effects on KP after stabilisation exercises are probably due to increasing the spinal stability of the deep muscles, which results in improvements in general stability (Shakeri et al., 2013 [49]). Hence, this might lead to improvements in KP. Further, high intensity training (HIT) might lead to improvements in KP as well (Helmhout et al., 2004 [21]). However, some studies did not report improvements in these psychological factors after ET. In comparison to other studies (Helmhout et al., 2004 [21]; Kempeneers et al.,), Harts et al. (2008) didn't find a decrease in KP, which might be due to a short intervention length [31]. Regarding pilates intervention, Marshall et al. (2013) is the only study where improvements were found in FAB and PCT [37]. This might be due to a low training frequency. Miyamoto et al. (2016) trained only one time a week, while participants of Marshall et al. (2013) trained three times a week [32] [37]. In a previous study, a training frequency of three times a week seems to be effective in reducing KP in a population with osteoporosis [50]. We might assume the longer the program duration and frequency, the better the effects on kinesiophobia. However, further research is necessary to support this hypothesis. Further, in the study of Miyamoto et al. (2013), education was given by an educational booklet [32]. Because of this, it is impossible to know if patients read this booklet or not.

Cognitive behavioral therapy (CBT)

Cognitive behavioral therapy (CBT) is recommended in rehabilitation of CLBP [2, 51]. Most of the included studies showed a positive effect of CBT on FAB, KF or PCT. Vlaeyen et al. (2002) and de Jong et al. (2005) used a successful graded exposure (GE) intervention [18] [29]. This corresponds with a systematic review by Lohnberg (2007), who recommend GE in persons with chronic pain [52]. Graded exposure is based on the principles of systematic desensitization. Patients are asked to make a hierarchy of fear-eliciting movements. Subsequently, they are challenged to gradually perform these movements they used to avoid. The physiotherapist encourages the patient to engage in these feared movements or activities until they realize that they can perform these movements without anxiety or

pain. In summary, this treatment approach is based on determining which movements activate the fear, challenging and disconfirming catastrophic beliefs, resulting in seeing the fearful movements as less threatening (Vlaeyen et al., 2002; Vlaeyen et al., 2001 [29, 53]). Support for the positive results of exposure in vivo can be found in a study by Crombez et al. (1996) [54]. In this report, patients with CLBP were asked to perform four exercise bouts at maximal force. Before performing the first exercise bout, patients believed that their pain and chance of (re-)injury would increase due to the exercises, and thus these patients overpredicted their pain. The psychological factors were evaluated using a global rating scale for 'expected pain' and 'fear of (re-)injury'. These outcome measures correspond with the primary outcome measures used in this systematic review, namely PCT and KP. They found that the patients corrected this overprediction of pain and chance of (re-)injury after performing the exercises. This shows that exposure to frightening movements, may be an interesting approach for reducing KP and PCT in persons with CLBP. Furthermore, Vlaeyen et al. (2000) concluded that patients have to view their pain as a common result, rather than a dangerous disease [55]. Using education for reducing these catastrophic beliefs about pain, might be helpful to get out of this vicious circle of fear and avoidance. Literature has shown the efficacy of an education program for improving fear, PCT (Louw, Puentedura and Mintken, 2012 [56]) and KP (Lohnberg, 2007; Moseley, 2002 [52, 57]). It makes sense that educating patients about pain can be helpful in reducing pain-related fear, as these fears are learned a response to pain. To come back to the model of Lethem et al. (1983), by reducing these fears, patients might be able to get out of the vicious circle of fear and avoidance [8]. However, some studies did not report improvements in KP, FAB and PCT after CBT. The poor results in the study of George et al. (2010) could be due to the low methodological quality and the absence of an education program [34], which seems to be effective in improving these psychological factors (Lohnberg, 2007; Louw et al., 2012; Moseley, 2002 [52, 56, 57]). In contrast, Pires et al. (2015) did not report improvements after pain neurophysiology education in combination with aquatic exercises [33]. A possible explanation for these results is that the length of the intervention was short in comparison to other CBT inteventions. Also, the education did not seem to be incorporated in the aquatic exercises. This is in contrast with other CBT interventions, where education was incorporated in the physical component of the intervention. These findings support our hypothesis that an education program is necessary in the rehabilitation program for CLBP.

Multidisciplinary therapy (MT)

All included studies which evaluated the effect of a multidisciplinary therapy (MT) intervention on kinesiophobia, reported positive effects related to the intervention (Monticone et al., 2013; Monticone et al., 2014; Monticone et al., 2016; Demoulin et al., 2010 [25-28]). Most of the included studies also reported a positive effect on pain catastrophizing thoughts (Monticone et al. 2013 [27]; Monticone et al. 2016 [25]). These results seem to be in line with a systematic review by Guzman et al. (2001), who already reported that an intensive daily rehabilitation program in a multidisciplinary setting seems to have positive effects on pain and functioning in CLBP [58]. Since MT is a combination of ET and CBT, the positive results can possibly be explained by the hypotheses which were discussed earlier. By using ET and CBT, the patients catastrophizing thoughts about pain or (re-)injury may be altered. This change

in catastrophizing thoughts can help CBLP patients to get out of the vicious circle of fear and avoidance. These findings are in line with the following study. A multidisciplinary intervention is an effective treatment option in increasing physical activity and therefore improving kinesiophobia (Koho et al., 2011 [59]). Even though different studies suggest that a multidisciplinary therapy intervention might be effective in reducing pain catastrophizing thoughts and kinesiophobia in CLBP, the costs and feasibility of those intervention programs can be questioned. It's not clear whether the benefits of these programmes outweigh their cost (Guzman et al., 2001 [58]).

Reflection on the strengths and weakness of the literature study

This is the first systematic review that determined the effect of different physical therapy interventions on KP, FAB and PCT in CLBP. Even though these interventions all included an active physical therapy component, the results of the included studies does not present a clear conclusion as to which is the most effective rehabilitation program for KP, FAB and PCT in CLBP. However, this might be due to the fact that little research is done to compare these three treatment options. This observation partially agrees with Henchoz et al. (2008), who reported that it is still not clear which kind of active therapy induces the greatest improvement in pain and disability in patients with low back pain [60]. These results indicate that more high-quality research is needed to conclude which active therapy induces the greatest improvement in several psychological and functional outcome measures for persons with CLBP. However, based on the findings of this study, an active rehabilitation program (ET, CBT or MT) seems to be effective for improving KP, FAB and PCT in CLBP. This is in line with a study of Franca, Burke, Caffaro, Ramos and Marques (2012), where an active rehabilitation program seems to be better than passive treatment for reducing disability and pain in CLBP [61]. As we described at the beginning of our study, KP, FAB and PCT are important factors in the development and maintenance of CLBP. Thus, this study can be useful for developping an effective rehabilitation program in persons with CLBP. To be sure that all relevant articles would be included, a large search strategy was used. Due to including many articles and different treatment modalities we are able to have a more holistic view on the treatment options for kinesiophobia in CLBP. Also, quality assessment was independently performed by two authors. In case of differences between the authors, these differences were discussed until a consus was reached.

A limitation of this literature study is that all included articles are methodological screened by using the van Tulder checklist. If a specific checklist for assessing the cohort studies was used, maybe more studies would have a high methodological quality. However, this way of methodological rating is used to make an easier comparison of the quality of the included studies. It should be mentioned that this systematic review exclusively focuses on interventions which contain an active physical component. Nonetheless, it is possible that interventions which do not have a physical component (e.g. education only, psychiatric counseling), also lead to an improvement in KF, FAB, PCT or other psychological factors. However, the evaluation of these kinds of therapies was beyond the scope of this review, as it only included interventions with an active therapy component.

Recommendations for further research

First of all, this systematic review shows different effective treatment options for reducing KF and other psychological factors affected in persons with CLBP. However, the results of the included studies failed to determine which treatment option is the most effective approach to reduce KF and other psychological factors in CLBP. The importance of psychological factors is well described. However, these subjective feelings and thoughts are different among people. Including subgroups might be related to different treatment effects and effective rehabilitation approaches (Foster, 2011 [62]). Secondly, similar to previous studies, we could not describe the optimal training duration and frequency (Rose et al., 1997 [63]). Further research is necessary to determine the optimal training duration and frequency. We assume that a patient specific approach is necessary in the rehabilitation of CLBP. As discussed earlier, current research often uses voluntary recruitment. Therefore, we can assume that these patients are well motivated to participate in an intervention.

6. Conclussion

In general, physical training (exercise training, cognitive behavioral training or multidisciplinary training containing an active component) seems to be an effective treatment approach for reducing kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in persons with CLBP. However, further research is necessary to conclude which treatment program is the most effective approach in CLBP.

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8. Appendix

Table 1: Search strategies

Search strategy	# hits PubMed	# hits Web of science
TS=(Chronic low back pain) AND TS=(Physical therapy modalities OR Exercise therapy OR Physiotherapy OR Physical therapy) AND TS=(Fear of movement OR Kinesiophobia OR Fear avoidance OR Pain catastrophizing)		356
TS=(Chronic low back pain)		14167
TS=(Chronic low back pain) AND TS=(Physical therapy modalities)		115
TS=(Chronic low back pain) AND TS=(Physical therapy modalities OR Exercise therapy)		1110
TS=(Chronic low back pain) AND TS=(Physical therapy modalities OR Exercise therapy OR Physiotherapy)		1548
TS=(Chronic low back pain) AND TS=(Physical therapy modalities OR Exercise therapy OR Physiotherapy OR Physical therapy)		2246
TS=(Chronic low back pain) AND TS=(Physical therapy modalities OR Exercise therapy OR Physiotherapy OR Physical therapy) AND TS=(Fear of movement)		90
TS=(Chronic low back pain) AND TS=(Physical therapy modalities OR Exercise therapy OR Physiotherapy OR Physical therapy) AND TS=(Fear of movement OR Kinesiophobia)		147
TS=(Chronic low back pain) AND TS=(Physical therapy modalities OR Exercise therapy OR Physiotherapy OR Physical therapy) AND TS=(Fear of movement OR Kinesiophobia OR Fear avoidance)		319
Low back pain"[MeSH Terms]	18286	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract])	29961	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms])	1020854	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract])	1021411	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]))	1028433	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]))	1049561	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract]))	1049561	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]))	26411	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]))	26448	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]))	26448	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]))	26721	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]))	28685	

(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]))	30697	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp]))	31246	
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(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]))	153	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]))	323	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]) OR ("pain beliefs"[Title/Abstract]))	334	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]) OR ("pain beliefs"[Title/Abstract]) OR ("fear of pain"[Title/Abstract]))	342	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]) OR ("pain beliefs"[Title/Abstract]) OR ("fear of pain"[Title/Abstract]) OR ("avoidance behavior"[Title/Abstract]))	344	

(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]) OR ("pain beliefs"[Title/Abstract]) OR ("fear of pain"[Title/Abstract]) OR ("avoidance behavior"[Title/Abstract]) OR ("disability"[Title/Abstract]))	3179	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]) OR ("pain beliefs"[Title/Abstract]) OR ("fear of pain"[Title/Abstract]) OR ("avoidance behavior"[Title/Abstract]) OR ("disability"[Title/Abstract]) OR ("dysfunctional beliefs"[Title/Abstract]))	3179	
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(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]) OR ("pain beliefs"[Title/Abstract]) OR ("fear of pain"[Title/Abstract]) OR ("avoidance behavior"[Title/Abstract]) OR ("disability"[Title/Abstract]) OR ("dysfunctional beliefs"[Title/Abstract]) OR ("self-efficacy"[Title/Abstract]) OR ("central sensitisation"[Title/Abstract]) OR ("hyperalgesia"[Title/Abstract]) OR ("hyperalgesia"[MeSH Terms]) OR ("hyperesthesia"[Title/Abstract]) OR ("hyperesthesia"[MeSH Terms]) OR ("catastrophization"[Title/Abstract]))	3475	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]) OR ("pain beliefs"[Title/Abstract]) OR ("fear of pain"[Title/Abstract]) OR ("avoidance behavior"[Title/Abstract]) OR ("disability"[Title/Abstract]) OR ("dysfunctional beliefs"[Title/Abstract]) OR ("self-efficacy"[Title/Abstract]) OR ("central sensitisation"[Title/Abstract]) OR ("hyperalgesia"[Title/Abstract]) OR ("hyperalgesia"[MeSH Terms]) OR ("hyperesthesia"[Title/Abstract]) OR ("hyperesthesia"[MeSH Terms]) OR ("catastrophization"[Title/Abstract]) OR ("catastrophization"[MeSH Terms]))	3488	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]) OR ("pain beliefs"[Title/Abstract]) OR ("fear of pain"[Title/Abstract]) OR ("avoidance behavior"[Title/Abstract]) OR ("disability"[Title/Abstract]) OR ("dysfunctional beliefs"[Title/Abstract]) OR ("self-efficacy"[Title/Abstract]) OR ("central sensitisation"[Title/Abstract]) OR ("hyperalgesia"[Title/Abstract]) OR ("hyperalgesia"[MeSH Terms]) OR ("hyperesthesia"[Title/Abstract]) OR ("hyperesthesia"[MeSH Terms]) OR ("catastrophization"[Title/Abstract]) OR ("catastrophization"[MeSH Terms]) OR ("fear"[Title/Abstract]))	3539	

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(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]) OR ("pain beliefs"[Title/Abstract]) OR ("fear of pain"[Title/Abstract]) OR ("avoidance behavior"[Title/Abstract]) OR ("disability"[Title/Abstract]) OR ("dysfunctional beliefs"[Title/Abstract]) OR ("self-efficacy"[Title/Abstract]) OR ("central sensitisation"[Title/Abstract]) OR ("hyperalgesia"[Title/Abstract]) OR ("hyperalgesia"[MeSH Terms]) OR ("hyperesthesia"[Title/Abstract]) OR ("hyperesthesia"[MeSH Terms]) OR ("catastrophization"[Title/Abstract]) OR ("catastrophization"[MeSH Terms]) OR ("fear"[Title/Abstract]) OR ("fear"[MeSH Terms]) OR ("avoidance learning"[Title/Abstract]) OR ("avoidance learning"[MeSH Terms]) OR ("pain related fear"[Title/Abstract]) OR ("movement evoked pain"[Title/Abstract]) OR ("pain behaviour"[Title/Abstract]))	2554	
(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]) OR ("pain beliefs"[Title/Abstract]) OR ("fear of pain"[Title/Abstract]) OR ("avoidance behavior"[Title/Abstract]) OR ("disability"[Title/Abstract]) OR ("dysfunctional beliefs"[Title/Abstract]) OR ("self-efficacy"[Title/Abstract]) OR ("central sensitisation"[Title/Abstract]) OR ("hyperalgesia"[Title/Abstract]) OR ("hyperalgesia"[MeSH Terms]) OR ("hyperesthesia"[Title/Abstract]) OR ("hyperesthesia"[MeSH Terms]) OR ("catastrophization"[Title/Abstract]) OR ("catastrophization"[MeSH Terms]) OR ("fear"[Title/Abstract]) OR ("fear"[MeSH Terms]) OR ("avoidance learning"[Title/Abstract]) OR ("avoidance learning"[MeSH Terms]) OR ("pain related fear"[Title/Abstract]) OR ("movement evoked pain"[Title/Abstract]) OR ("pain behaviour"[Title/Abstract]))	3562	
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(("low back pain"[MeSH Terms]) OR ("low back pain"[Title/Abstract]) OR ("musculoskeletal diseases"[MeSH Terms]) OR ("musculoskeletal diseases"[Title/Abstract]) OR ("chronic pain"[MeSH Terms]) OR ("chronic pain"[Title/Abstract]) OR ("chronic low back pain"[Title/Abstract])) AND (("physical therapy modalities"[MeSH Terms]) OR ("physical therapy modalities"[Title/Abstract]) OR ("exercise therapy"[MeSH Terms]) OR ("exercise therapy"[Title/Abstract]) OR ("exercise interventions"[Title/Abstract]) OR ("physiotherapy"[Title/Abstract]) OR ("physical therapy"[Title/Abstract]) OR ("rehabilitation" [MeSH:NoExp])) AND (("fear of movement"[Title/Abstract]) OR ("kinesiophobia"[Title/Abstract]) OR ("fear avoidance"[Title/Abstract]) OR ("pain beliefs"[Title/Abstract]) OR ("fear of pain"[Title/Abstract]) OR ("avoidance behavior"[Title/Abstract]) OR ("disability"[Title/Abstract]) OR ("dysfunctional beliefs"[Title/Abstract]) OR ("self-efficacy"[Title/Abstract]) OR ("central sensitisation"[Title/Abstract]) OR ("hyperalgesia"[Title/Abstract]) OR ("hyperalgesia"[MeSH Terms]) OR ("hyperesthesia"[Title/Abstract]) OR ("hyperesthesia"[MeSH Terms]) OR ("catastrophization"[Title/Abstract]) OR ("catastrophization"[MeSH Terms]) OR ("fear"[Title/Abstract]) OR ("fear"[MeSH Terms]) OR ("avoidance learning"[Title/Abstract]) OR ("avoidance learning"[MeSH Terms]) OR ("pain related fear"[Title/Abstract]) OR ("movement evoked pain"[Title/Abstract]) OR ("pain behaviour"[Title/Abstract]) OR ("pain catastrophizing"[Title/Abstract]) OR ("pain/psychology"[MeSH Terms]))		

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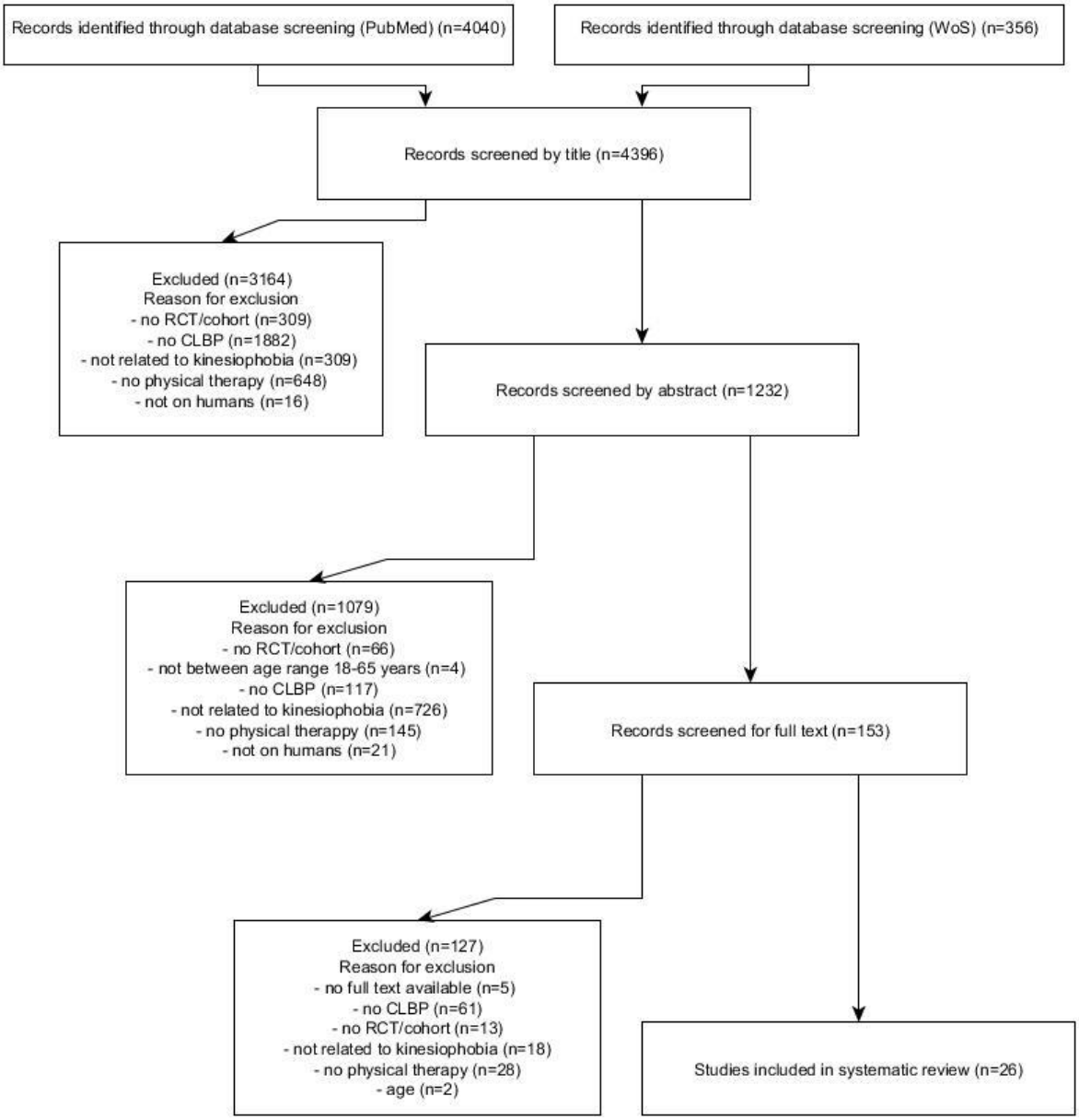

Figure 1: Study flowchart

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Figure 2: Fear – avoidance model by Leeuw et al.

Table 2: Excluded articles (full text screening) and reason of excluding (n=127)

No CLBP (n=61)	No Physical therapy/intervention (n=28)	Study design (n=13)	Outcomes (n=18)	No full text (n=5)	Age (n=2)
Stevenson, Lewis [64]	Mansell, Storheim [65]	Meziat Filho [66]	Helmhout, Harts [67]	Castrillon, Hanney [68]	Leonhardt, Kuss [69]
Meziat-Filho, Lima [70]	Ghadyani, Tavafian [71]	Louw, Puentedura [56]	Friedrich, Gittler [72]	Lee, Kim [73]	Kuss, Leonhardt [74]
Emilson, Demmelmaier [75]	Coppack, Kristensen [76]	Hurley, Tully [77]	Alaranta, Rytokoski [78]	Ogston, Crowell [79]	
Chaleat-Valayer, Denis [80]	Sullivan and Adams [81]	George and Zeppieri [82]	Cohen, Heinrich [83]	Svensson, Wendt [84]	
Kim, Min [85]	Peterson [86]	Slade and Keating [87]	Alfuth and Cornely [88]	Edwards, Zusman [89]	
George, Fritz [90]	Tuzun, Gildir [91]	Miyamoto, Moura [92]	Trapp, Weinberger [93]		
Tran, Guite [94]	Yilmaz Yelvar, Cirak [95]	Gagnon, Stanos [96]	Senlof, Denison [97]		
Palstam, Larsson [98]	da Luz, Costa [99]	McDonough, Tully [100]	Sugano and Nomura [101]		
Monticone, Ambrosini [102]	Atalay, Sahin [103]	Groessl, Schmalzl [104]	Cruz-Diaz, Bergamin [105]		
Xia, Long [106]	Nagrale, Patil [107]	van Erp, Huijnen [108]	Rasmussen-Barr, Ang [109]		
Torres, Martos [110]	Masse-Alarie, Flamand [111]	Thompson, Oldham [112]	Semrau, Hentschke [113]		
Larsson, Palstam [114]	Balthazard, de Goumoens [115]	Ferrari, Vanti [116]	Albaladejo, Kovacs [117]		
Martin, Torre [118]	Froholdt, Reikeraas [119]	Taylor, Carnes [120]	Smeets [121]		
Vincent, Whipple [122]	Al-Obaidi, Al-Sayegh [123]		Tekur, Singphow [124]		
Carbonell-Baeza, Ruiz [125]	Hunter, McDonough [126]	.	Unsgaard-Tondel, Nilsen [127]		
Lopez-Rodriguez, Fernandez-Martinez [128]	Casserley-Feeney, Daly [129]		Unsgaard-Tondel, Fladmark [130]		
Carbonell-Baeza, Aparicio [131]	Jensen, Jensen [132]		Wajswelner, Metcalf [133]		
Lange, Krohn-Grimberghe [134]	Elfving, Andersson [48]		Tilbrook, Cox [135]		
Vincent, Omli [136]	Rod [137]				
Ghadyani, Tavafian [138]	Petrozzi, Leaver [139]				
Bennell, Nelligan [140]	Nijs, Lluch Girbes [141]				
Oksuz and Unal [50]	Iles, Taylor [142]				
Thompson and Woby [143]	Beltran-Alacreu, Lopez-de-Uralde-Villanueva [144]				
Andersen, Juul-Kristensen [145]	Geisser, Wiggert [146]				
Nicholas, Asghari [147]	Murtezani, Hundozi [148]				
Pillastrini, de Lima [149]	Main and George [150]				
Chmielewski, George [151]	Burns, Mintken [152]				
Seneca, Hauge [153]	Sorensen, Bendix [154]				
Celenay, Kaya [155]					
Andersen, Juul-Kristensen [156]					
Granviken and Vasseljen [157]					
Takacs, Krowchuk [158]					
Williams, Williamson [159]					
Sarig Bahat, Takasaki [160]					

Inoue, Inoue [161].
Rolving, Christiansen [162]
Koele, Volker [163]
Brooks, Beaulieu [164]
Tengman, Brax Olofsson [165]
Russell, Jariwala [166]
Manning, Hurley [167]
Toth, Brady [168]
Andersen, Juul-Kristensen [169]
Osteras, Osteras [170]
Levy, Macera [171]
Hunt, Keefe [172]
Thoomes-de Graaf and Schmitt [173]
Hansen, Sogaard [174]
Callahan, Shreffler [175]
Kim, Chung [176]
Breedland, van Scheppingen [177]
Wu, Kao [178]
Booth, Moseley [179]
Wideman and Sullivan [180]
Louw, Puentedura [181]
Williamson, McConkey [182]
Jay, Brandt [183]
Overmeer, Boersma [184]
Staal, Hlobil [185]
Holm, Ljungman [186]
Olthuis, Watt [187]

Table 3: Quality assessment of included studies

Author	A	B1	B2	C	D	E	F	G	H	I	J	K	L	M1	M2	N	O	P	Q	Final score	IV	DC	SC
de Jong et al. [18]	1	1	0	0	1	0	0	0	0	0	1	0	0	1	1	1	1	0	1	9	3	4	2
Demoulin et al. [28]	1	0	0	1	1	0	0	0	0	0	1	1	0	1	0	1	1	0	1	9	2	5	2
Gema et al. et al. [30]	1	1	1	1	1	0	0	1	0	1	1	0	1	1	1	1	1	0	1	14	7	5	2
George et al. [34]	1	0	0	1	1	0	0	0	0	0	1	0	0	1	0	1	1	0	1	8	2	4	2
Harris et al. [41]	1	1	1	0	1	0	0	0	0	1	1	0	1	0	1	0	1	1	1	11	6	3	2
Harts et al. [31]	1	1	1	0	1	0	1	1	0	1	1	0	1	1	1	0	1	0	1	13	7	4	2
Helmhout et al. [67]	1	1	1	0	1	0	1	1	0	0	1	0	1	1	1	0	1	0	1	12	6	4	2
Hurley et al. [36]	1	1	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	1	16	8	6	2
Kernan et al. [19]	1	Na	Na	Na	1	Na	0	1	Na	0	1	0	1	1	1	Na	1	Na	1	9	2	4	2
Koumantakis et al. [20]	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	17	9	6	2
Linden et al. [39]	1	1	0	1	1	0	0	0	0	0	1	0	1	1	0	1	1	0	1	10	4	4	2
Mannion et al. [35]	1	1	0	1	1	0	0	1	0	0	1	0	1	1	1	0	1	1	1	12	5	5	2
Marshall et al. [37]	1	1	1	1	1	0	0	1	0	0	1	0	0	1	1	1	1	1	1	13	6	5	2
Miyamoto et al. [32]	1	1	1	1	1	0	0	1	0	1	1	1	0	1	1	1	1	0	1	14	7	5	2
Monticone et al. [25]	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	17	9	6	2
Monticone et al. [26]	1	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	0	1	16	8	6	2
Monticone et al. [27]	1	1	1	1	1	0	1	0	0	1	1	0	1	1	1	1	1	0	1	14	7	5	2
Nassif et al. [23]	1	1	0	0	1	0	0	0	0	0	1	0	0	1	1	1	1	0	1	9	3	4	2

Norris et al. [24]	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	1	1	0	1	7	2	3	2
O'Sullivan et al. [40]	1	Na	Na	Na	1	Na	0	0	Na	Na	1	0	1	1	1	Na	1	Na	1	8	2	4	2
Pagé et al. [22]	1	Na	Na	Na	1	Na	0	0	Na	Na	1	1	0	1	0	Na	1	Na	1	7	1	4	2
Pires et al. [33]	1	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	15	7	6	2
Schütze et al. [17]	1	Na	Na	Na	0	Na	1	0	Na	Na	1	1	1	1	1	Na	1	Na	1	9	3	4	2
Shnayderman et al. [38]	1	1	1	1	1	0	0	0	0	1	1	0	1	1	0	1	1	1	1	13	7	4	2
Smeets et al. [42]	1	1	0	1	1	0	0	1	0	0	1	0	1	1	1	1	1	1	1	13	6	5	2
Vlaeyen et al. [29]	1	1	1	0	0	0	0	0	0	0	1	0	1	1	1	1	1	0	1	10	5	3	2

Abbreviation: A: Were the eligibility criteria specified?; B1: Was a method of randomization performed?; B2: Was the treatment allocation concealed?; C: Were the groups similar at baseline regarding the most important prognostic indicators?; D: Were the index and control interventions explicitly described?; E: Was the care provider blinded for the intervention?; F: Were co-interventions avoided or comparable?; G: Was the compliance acceptable in all groups?; H: Was the patient blinded to the intervention?; I: Was the outcome assessor blinded to the intervention?; J: Were the outcome measures relevant?; K: Were adverse effects described?; L: Was the withdrawal/drop out rate described and acceptable?; M1: Was a short-term follow-up measurement performed?; M2: Was a long-term follow-up measurement performed?; N: Was the timing of the outcome assessment in both groups comparable?; O: Was the sample size for each group described?; P: Did the analysis include an intention-to-treat analysis?; Q: Were point estimates and measures or variability presented for the primary outcome measures?; 0: no, not satisfied, or unable to determine from text; 1: yes, definitely satisfied/described clearly in the text; Na: Not applicable, a null score is given

Table 4: strengths and weakness of included studies

Harts et al. [31]	Strenghts	• Randomization was applied • Concealed randomization • Outcome assessor was blinded • Co-interventions were avoided • Long follow-up period (≥ 3 months) • Acceptable compliance in all groups (> 70%) • Acceptable drop out rate (< 20% STFU; <30% LTFU) • Index and control interventions explicitly described
	Weaknesses	• No clear description of adverse effects • No intention-to-treat analysis • Lack of statistical power • Voluntary recruitment: participants were well motivated. Further research is needed to confirm these results for more severely disabled patients or patients with confounding psychosocial problems. • Small sample size: n=65 (< 30 per group)
Kernan et al. [19]	Strenghts	• Long follow-up period (≥ 3 months) • Acceptable compliance (> 70%) • Acceptable drop out rate (< 20% STFU; <30% LTFU) • Large sample size: n=82 (> 30 per group) • Index and control interventions explicitly described
	Weaknesses	• No control group: no cause-and-effect relationships, nor differences in effectiveness of the treatment versus other interventions • No clear description of adverse effects • No avoidance of co-interventions

Koumantakis et al. [20]	Strengths	• Randomization was applied • Concealed randomisation • Outcome assessor was blinded • Clear description of adverse effects: low percentage (6.9%) of subjects in the intervention group developed pain, so increase in pain was likely not due to the intervention applied • Long follow-up period (≥ 3 months) • Acceptable compliance in all groups (> 70%) • Acceptable drop-out rate (< 20% STFU; <30% LTFU) • Intention-to-treat analysis was applied • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No avoidance of co-interventions • Small sample size: n=55 (< 30 per group)
Helmhout et al. [21]	Strengths	• Randomization was applied • Concealed randomisation • Long follow-up period (≥ 3 months) • Acceptable compliance in all groups (> 70%) • Large sample size: n=81 (> 30 per group) • Index and control interventions explicitly described
	Weaknesses	• Groups were not similar at baseline for several baseline values: low-compliance group showed considerably worse scores on the baseline RDQ, Oswestry and SF-36 scores than de medium- and good-compliance group • LIT group showed a lower treatment compliance than the HIT group, which may have enlarged the intervention contrast between the groups • Only males included • No avoidance of co-interventions • No clear description of adverse effect • High drop-out rate (> 20% STFU; > 30% LTFU) • No intention-to-treat analysis • No control group (receiving no treatment) • No blinding of the outcome assessor (detection bias) • Voluntary recruitment: participants were well motivated. Further research is needed to confirm these results for more severely disabled patients or patients with confounding psychosocial problems.

Mannion et al. [35]	Strengths	• Randomization was applied • Acceptable drop out rate (< 20% STFU; <30% LTFU) • Long follow-up period (≥ 3 months) • Large sample size: n=148 (> 30 per group) • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No concealment of randomization • No avoidance of co-interventions • No blinding of the outcome assessor (detection bias) • No clear description of adverse effects • No control group (receiving no intervention) • Voluntary recruitment: participants were well motivated. Further research is needed to confirm these results for more severely disabled patients or patients with confounding psychosocial problems.
Pagé et al. [22]	Strengths	• Clear description of adverse effect: no adverse effects occurred • Index and control interventions explicitly described
	Weaknesses	• No control group • No avoidance of co-interventions • No follow-up period • No information about compliance and drop out rate • Small sample size: n=21 (< 30) • Voluntary recruitment: participants were well motivated. Further research is needed to confirm these results for more severely disabled patients or patients with confounding psychosocial problems.

Miyamoto et al. [32]	Strengths	• Randomisation was applied • Concealed randomisation • Outcome assessor was blinded • Clear description of adverse effects: no adverse effect occurred • Intention-to-treat analysis was applied • Acceptable compliance in all groups (> 70%) • Acceptable drop out rate (< 20% STFU; <30% LTFU) • Long follow-up period (≥ 3 months) • Large sample size: n=86 (> 30 per group) • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No avoidance of co-interventions • Adherence to instructions in the educational booklet could not be controlled • Voluntary recruitment: participants were well motivated. Further research is needed to confirm these results for more severely disabled patients or patients with confounding psychosocial problems.
Nassif et al. [23]	Strenghts	• Randomization was applied • Long follow-up period (≥ 3 months) • Large sample size: n=75 (> 30 per group) • Index and control interventions explicitly described
	Weaknesses	• No concealment of randomization • Not clear if groups were similar at baseline • No blinding of the outcome assessor (detection bias) • No clear description of adverse effects • No intention-to-treat analysis • High drop out rate in the control group (> 20% STFU; >30% LTFU) • No clear description of compliance to treatment • Voluntary recruitment: participants were well motivated. Further research is needed to confirm these results for more severely disabled patients or patients with confounding psychosocial problems.

Norris et al. [24]	Strengths	• Index and control interventions explicitly described
	Weaknesses	• No randomisation was applied (selection bias) • Limited information about important prognostic indicators at baseline • No avoidance of co-interventions • No blinding of the outcome assessor (detection bias) • No clear description of adverse effects • No follow-up period • No intention-to-treat analysis • No clear description of compliance to treatment • No clear description of drop out rate • Small sample size (< 30 group)
Monticone et al. [25]	Strenghts	• Randomisation was applied • Concealed randomisation • Patients were blinded to the study hypothesis • Co-interventions were avoided by disallowing patients from taking major pharmacological agents and asking the family doctor to avoid giving referrals for other treatments • Clear description of adverse events: minor worsening of transient pain (7 participants in IT, 5 participants in CT); mood disorders (2 participants in IT, 2 participants in CT) • Acceptable drop-out rate (< 20% STFU; <30% LTFU) • Acceptable compliance in both groups (> 70%) • Intention-to-treat analysis was applied • Outcome assessor was blinded • Long follow-up period (≥ 3 months) • Large sample size: n=150 (> 30 per group) • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• Exclusive use of self-report measures: no investigation for relationships between these measures and physical or behavioral tests • Possible contact time differences between the treatment group due to the psychological intervention • Mood disorders (e.g. anxiety, depression) were not investigated

Hurley et al. [36]	Strengths	• Randomization was performed • Concealed randomization • Outcome assessor was blinded • Clear description of adverse effects: small proportion (n=7) of participants of WP reported worsening of LBP, groin or knee pain • Intention-to-treat analysis was applied • Low drop-out rate in the exercise group and usual physiotherapy (< 30% LTFU) • Acceptable compliance in all groups (> 70%) • Long follow-up period (≥ 3 months) • Large sample size: n=246 (> per group) • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No avoidance of co-interventions • High drop-out rate in the walking group (> 30% LTFU)
Marshall et al. [37]	Strenghts	• Randomization was performed • Concealed randomization • Intention-to-treat analysis was applied • Acceptable drop out rate in the IT (< 20% STFU; <30% LTFU) • Acceptable compliance in both groups (> 70%) • Long follow up period (≥ 3 months) • Large sample size: n=64 (> 30 per group) • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No avoidance of co-interventions • No blinding of the outcome assessor (detection bias) • No clear description of adverse events • High drop-out rate in the CT (> 20% STFU) • Baseline scores score for disability and pain were mild to moderate, thus the results can not be applied to more severely impaired patients. • Voluntary recruitment: the patients were well motivated. Further research is needed to confirm these results for patients with more negative attitudes toward exercise. (selection bias) • Patients were not informed about the comparison between the 2 interventions, but the efficacy of blinding wasn't tested. • Cross contamination was observed at 6 months follow-up

Shnayderman et al. [38]	Strenghts	• Randomization was performed • Concealed randomization • Outcome assessor was blinded • Intention-to-treat analysis was applied • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No avoidance of co-interventions • No clear description of adverse effects • High drop out rate in the IT (> 20% STFU) • No clear description of compliance to treatment • No follow-up period • Mean score for the FABQ was 12.4 (cut-off = 13). Further research is needed to confirm these results for patients with more severe fear of movement. (selection bias) • Short intervention duration • Small sample size: n=52 (< 30 per group)
Pires et al.[33]	Strenghts	• Randomization was performed • Concealed randomization • Outcome assessor was blinded • Clear description of adverse effect: no adverse effects occurred • Intention-to-treat analysis was applied • Acceptable drop out rate (< 20% STFU; <30% LTFU) • Long follow-up period (≥ 3 months) • Large sample size: n=62 (> 30 per group) • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No avoidance of co-interventions • No clear description of compliance to treatment • Baseline scores score for disability and kinesiophobia were low, thus the results can not be applied to more severely impaired patients. • Limited base of recruitment (only 1 outpatient clinic) • Beliefs and attitudes of the physiotherapists concerning CLBP were not controlled. There is evidence for a relationship between the physiotherapists' attitudes and beliefs, the information given to the patients and their maladaptive beliefs. • No assessment of the patients' knowledge about pain neurophysiology

Linden et al. [39]	Strenghts	• Randomization was performed • Acceptable drop out rate (< 20% STFU) • Large sample size: n=103 (> 30 per group) • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No concealment of randomization • No avoidance of co-interventions • No blinding of the outcome assessor (detection bias) • No clear description of adverse effects • No intention-to-treat analysis • No follow-up period • No clear description of compliance to treatment • Short intervention duration
O'Sullivan et al. [40]	Strengths	• Acceptable drop-out rate (< 20% STFU; <30% LTFU) • Long follow-up period • Index and control interventions explicitly described
	Weaknesses	• No control group • No clear description of compliance to treatment • No avoidance of co-interventions • No blinding of the outcome assessor (detection bias) • No description of adverse effects • Small sample size: n=26 (< 30)

George et al. [34]	Strengths	• Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No randomization was performed • No avoidance of co-interventions • No blinding of the outcome assessor (detection bias) • No clear description of adverse effects • High drop-out rate for follow-up data related to pain intensity (>30% LTFU) • No clear description of compliance to treatment • No intention-to-treat analysis • No control group (receiving no treatment) • No clear description of compliance to treatment • Small sample size: n=33 (< 30 per group)
Schütze et al. [17]	Strenghts	• Outcome assessor was blinded • Acceptable drop-out rate (< 20% STFU; <30% LTFU)
	Weaknesses	• No control group • No clear description of compliance to treatment • No clear description to adverse effects • Long follow-up period (≥ 3 months) • Small sample size: n=16 (< 30 per group)

Gema et al. [30]	Strengths	• Randomization was performed • Concealed randomization • Outcome assessor was blinded • Acceptable compliance in both groups (> 70%) • Acceptable drop-out rate (< 20% STFU; <30% LTFU) • Long follow-up period (≥ 3 months) • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No avoidance of co-interventions • No clear description of adverse effects • No intention-to-treat analysis • No control group (receiving no treatment) • Patients contacted the researcher to participate in the study (selection bias) • Small sample size: n=56 (< 30 per group)
Vlaeyen et al. [29]	Strengths	• Randomization was performed • Concealed randomization • Long follow-up period (≥ 3 months)
	Weaknesses	• Not clear if participants were similar at baseline • No avoidance of co-interventions • No blinding of the outcome assessor (detection bias) • No clear description of adverse effects • No intention-to-treat analysis • No clear description of compliance to treatment • No clear description of drop-out rate • Small sample size: n=6 (< 30 per group) • No wash-out period between different treatment components: risk for carry-over effect

de Jong et al. [18]	Strenghts	• Randomization was performed • Long follow-up period (≥ 3 months) • Index and control interventions explicitly described
	Weaknesses	• No concealment of randomization • Not clear if participants were similar at baseline • Small sample size • No avoidance of co-interventions • No blinding of the outcome assessor (detection bias) • No clear description of adverse effects • No intention-to-treat analysis • No clear description of compliance to treatment • No clear description of drop-out rate • Small sample size: n=6 (< 30 per group)
Monticone et al. [26]	Strenghts	• Randomization was performed • Concealed randomization • Co-interventions were avoided by offering no other treatments and allowing no major pharmacological agents • Outcome assessor was blinded • Clear description of adverse events: minor worsening of transient pain (3 participants in IT, 2 participants in CT); mood disorders (1 participants in IT, 2 participants in CT) • Acceptable compliance in both groups (> 70%) • Acceptable drop-out rate (< 20% STFU; <30% LTFU) • Long follow-up period (≥ 3 months) • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No intention-to-treat analysis • Small sample size: n=20 (< 30 per group)

Demoulin et al. [28]	Strenghts	• Clear description of adverse effects: some participants reported worsening of pain • Large sample size: n=262 (> 30 per group) • Groups similar at baseline regarding the most important prognostic indicators
	Weaknesses	• No randomization was performed • No avoidance of co-interventions • No blinding of the outcome assessor (detection bias) • No intention-to-treat analysis • High drop-out rate: 126 (> 20% STFU) • No clear description of compliance to treatment • No follow-up period
Harris et al. [41]	Strengths	• Randomization was performed • Concealed randomization • Outcome assessor was blinded • Intention-to-treat analysis was applied • Large sample size: n= 214 (> 30 per group) • Acceptable drop-out rate for the (<30% LTFU) • Index and control interventions explicitly described
	Weaknesses	• Not clear if groups were similar at baseline • No-avoidance of co-interventions • No clear description of adverse effects • No clear description of compliance to treatment

Smeets et al. [42]	Strengths	• Randomisation was performed • Co-interventions were avoided by requesting the patients to stop other therapies (except for medication) • Intention-to-treat analysis was applied • Large sample size: n=211 (> 30 per group) • Acceptable compliance in all groups (> 70%) • Acceptable drop-out rate (< 20% STFU; <30% LTFU) • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No concealment of randomisation • No blinding of the outcome assessor (detection bias) • No clear description of adverse effects • No follow-up period
Monticone et al. [27]	Strengths	• Randomization was performed • Concealed randomization • Co-interventions were avoided by offering no other treatments, allowing no major pharmacological agents and asking the family doctor to avoid giving referrals for other treatments • Outcome assessor was blinded • Acceptable drop-out rate (< 20% STFU; <30% LTFU) • Long follow-up period (≥ 3 months) • Groups similar at baseline regarding the most important prognostic indicators • Index and control interventions explicitly described
	Weaknesses	• No clear description of adverse events • No intention-to-treat analysis

Abbreviations: IT = intervention therapy; CT = control therapy; WP = walking program; STFU = short term follow up; LTFU = long term follow up

Table 5: data extraction of included studies

Study	Participants	Intervention	Outcome measures	ResuGlts
de Jong et al. [18]	NSCLBP (n=6)	E: education + EXP C: education + OPE	VAS, TSK, PCS, PHODA, PVAQ, RMDQ, activity	Both groups: improvements in PCS, TSK. Improvements in RMDQ. Further improvements in TSK after E.
Demoulin et al. [28]	NSCLBP (n=262)	E: MI C: no intervention	VAS, RMDQ, DPQ, TSK, knowledge questionnaire, MBT, strength, ROM, submax. cycle test	E: improvements over time in VAS, RMDQ, DPQ, TSK, MBT, knowledge questionnaire (P<0.001). Improved strength, ROM, aerobic capacity (P<0.05)
Gema et al. [30]	CLBP (n=56)	E: PNE + PE C: PE	NPRS, RMDQ, PCS, TSK, PGIC, FFDT, PPT	E: improved NPRS (P<0.001) compared to C. Between-group differences: RMDQ, TSK, FFDT, PPT (P<0.001) in favor of E. Differences between groups in PGIC (P<0.05)
George et al. [34]	CLBP (n=33)	E: graded exercise C: graded exposure	VAS, ODQ, FPQ-II, FABQ, TSK, CSQ, BDI	Both groups: reduced VAS (P=0.03), ODQ (P<0.01), CQS (P<0.01) and BDI (P<0.01),
Harris et al. [41]	CLBP (n=214)	E1: BI + CBT (group) (n=55) E2: BI + PE (group) (n=60) C: BI (n=99)	ODI, HADS, SHC, UCL, FABQ	Improved SHC, HADS, FABQ over time in all groups
Harts et al. [31]	NSCLBP (n=65)	E1: HIT E2: LIT C: no treatment	GPE, RMDQ, SF-36, TSK, Isom B-E	E1: improved SF-36 compared to E2 and to C. Decrease in GPE compared to C.
Helmhout et al. [67]	NSCLBP (n=81)	E: HIT C: LIT	RMDQ, ODI, TSK, SF-36, Isom B-E, /p/test, /a/test	Both groups: improved outcomes (except: isom strength and TSK); Between-group difference: improved Isom strength. E: improved isom strength and TSK compared to C.
Hurley et al. [36]	CLBP (n=246)	E1: walking therapy E2: PE C: UC	ODI, NRS, EuroQol-5D-3L, FABQ, BBQ, RCQ, IPAQ, ESEQ, PSQ, cost outcomes	Improvemed ODI, NRS, FABQ, EuroQol-5D-3L (P<0.05). No between-group differences. E1: effective therapy modality
Kernan et al. [19]	CLBP (n=68)	E: education + PE C: /	FABQ, TSK, VAS, ODI, flexibility, lifting, strength	Improved FABQ, TSK, ODI, VAS,flexibility, lifting, strength (P<0.01)
Koumantakis et al. [20]	NSCLBP (n=55)	E: general exercises + trunk stabilization C: general exercises	SF-MPQ, RMDQ, TSK, PSEQ, PLC	Both groups: improved outcomes (P<0.001) (except: PLC); Between-group difference: RMDQ (P=0.027) (in favor of C)

Linden et al. [39]	CLBP (n=103)	E: CBT (n=53)) C: orthopedic treatment + OT (n=50)	FABQ, VAS, PDI, SCL-90-R	Both groups: improvements in all outcomes (except PDI)
Mannion et al. [35]	CLBP (n=148)	E1: PE E2: devices C: aerobics group	VAS, RMDQ, FABQ, ZSDS, MSPQ	All groups: Improvement in VAS, RMDQ, FABQ
Marshall et al. [37]	CLBP (n=64)	E: specific trunk exercise group C: stationary cycling exercise group	VAS, ODI, PCS, FABQ	Greater improvements at 8 weeks in E for VAS, ODI compared to C Both groups: similar reductions in PCS and FABQ
Miyamoto et al. [32]	NSCLBP (n=86)	E: educational booklet + pilates C: educational booklet	NRS, RMDQ, GPE, TSK, PSFS	E: reduced NRS, RMDQ, improved GPE
Monticone et al. [188]	CLBP (n=90)	E: MI → CBT + PE (n=45) C: PE (n=45)	RMDQ, TSK, NRS, SF-36	E: improved RMDQ, TSK, NRS, SF-36
Monticone et al. [26]	CLBP (n=20)	E: MI C: UC	ODI, TSK, PCS, NRS, QoL, 6MWT, gait parameters, GPE	Both groups: improved ODI, gait parameters E: Reduced TSK, PCS, VAS. Improved QoL
Monticone et al. [25]	NSCLBP (n=150)	E: MI (n=75) C: PE in group (n=75)	ODI, TSK, PCS, NRS, SF-36, GPE, QoL	Both groups: improved ODI (P<0.001). E: improved TSK, PS, QoL, PCS
Nassif et al. [23]	CLBP (n=75)	E: PE C: no treatment	NRS, DPQ, TSK, RMDQ, QBPDS, flexibility, Isom E ext + abd m.	E: improved pain parameter, flexibility, back functions (P<0.025). TSK decreased, NRS lowered compared to C. C: improved NRS, flexibility, DPQ
Norris et al. [24]	CLBP (n=59)	E: integrated back stability program (n=27) C: back care advice (n=32)	SF-MPQ, RMDQ, TSK, SDS	E: RMDQ, SF-MPQ, TSK (P<0.0071)
O'Sullivan et al. [40]	NSCLBP (n=27)	E: CFT C: /	ODI, NRS, DASS-21, BBQ, FABQ, PCS, PSEQ,	Reduced ODI (P<0.001), NRS (P<0.001). Improved (P<0.0041) DASS-21, BBQ, PCS, PSEQ, FABQ
Pagé et al. [22]	CLBP (n=21)	E: flexion-extension task with BF C: /	ODI, TSK, NRS	E: TSK reduced
Pires et al. [33]	CLBP (n=62)	E: PNE + aquatic exercises C: aquatic exercises	VAS, QBPDS, TSK	E: improved VAS and QBPDS (P<0.005) No between-group differences in TSK and QBPDS

Schütze et al. [17]	CLBP (n=16)	E: MBFT C: /	OMPQ, ODQ, DASS-21, MAAS, CPAQ, SF-36, C-SQ	Improved ODQ (P<0.022), PCS (P<0.002), CPAQ (P<0.006), DASS-stress(P<0.038), SF-36.
Shnayderman et al. [38]	CLBP (n=52)	E: walking therapy C: PE	6MWT, FABQ, muscle endurance tests, ODQ, LBPFS	Both groups: improvements in all outcomes No differences between groups
Smeets et al. [42]	NSCLBP (n=211)	E: APT, CBT, APT & CBT C: no treatment	RMDQ, VAS, BDI, PCL	All intervention groups: PCL decreased compared to C. Reduction in RMDQ. APT: improvement BDI
Vlaeyen et al. [29]	CLBP (n=6)	E: exposure in vivo + graded activity C: graded activity + exposure in vivo	PHODA, TSK, PVAQ, VAS, RMDQ, PCS, PASS, activity	Improved TSK, PCS, RMDQ, PVAQ after exposure in vivo and not graded activity

Abbreviation: LIT: Low intensity training; C: Control group; PE: Physical exercise; BF: biofeedback; UC: usual care; CFT: cognitive functional therapy; CBT: Cognitive behavioral therapy; CCBT: Contextual cognitive behavioral therapy; APT: Active physical therapy; OT: occupational therapy; MI: multidisciplinary intervention; BI: brief intervention; MR: Muscle reconditioning; PNE: Pain neurophysiology education; EXP: Graded exposure in vivo and behavioral experiments; OPE: Operant graded activity program; CLBP: Chronic low back pain; NSCLBP: Non specific chronic low back pain; GPE: Global Perceived Effect; RMDQ: Roland-Morris Disability Questionnaire; SF-36: Health related quality of life: 36 item Short form health survey; SF-12: Physical and mental health short form health survey; TSK: Tampa scale for kinesiophobia; Isom B-E: Isometric back extension; FABQ: Fear avoidance beliefs questionnaire; VAS: Visual Analogue Scale; ODI: Oswestry back pain disability questionnaire; ODQ: Oswestry disability questionnaire; SF-MPQ: Short-Form McGill pain questionnaire; PSEQ: Pain self-efficacy questionnaire; PLC: Pain locus of control scale; /p/test: passive test; /a/test: active test; ZSDQ: Zung self rating depression questionnaire; MSPQ: Modified somatic perception questionnaire; NRS: Numerical rating scale; PSFS: Pain specific functional scale; DPQ: Dallas Pain questionnaire; QBPDS: Quebec Back Pain Disability Scale; Isom E: isometric endurance; Ext: extensors; Abd: abdominal; SDS: Semantic differential scale; ABPS: Aberdeen back pain scale; PCS: Pain catastrophizing scale; STAI: State-trait-anxiety inventory; FCE: functional capacity evaluation; FESV: Pain management questionnaire; AEQ: Avoidance-endurance questionnaire, FPQ-II: Fear of Pain Questionnaire; CSQ: Coping Strategies Questionnaire, NPRS: Numerical Pain Rating Scale; PGIC: Patients' Global Impression of Change scale; FFDT: finger-to-floor distance test; PPT: pain pressure thresholds, FFbH-R: Hannover Functional Ability Questionnaire; FFkA: Freiburg Questionnaire of physical Activity; PVAQ: Pain vigilance and awareness questionnaire; PCL: Pain cognition list; BDI: Beck depression inventory; MBT: Movement behavior test; DASS-21: 21 item Depression anxiety and Stress Scale; BBQ: Back beliefs Questionnaire; PDI: Pain disability index; SCL-90-R: The Symptom Checklist; LBPFS: Low back pain functional scale; ESEQ: Exercise self-efficacy questionnaire; RCQ: Readiness to change questionnaire; PSQ: Patient satisfaction questionnaire; BNESQ: Borkovec and Nau Expectation and Satisfaction Questionnaire; MBFT: Mindfulness-based functional therapy; OMPQ: Örebro musculoskeletal pain questionnaire; MAAS: Mindful attention awareness scale; CPAQ: Chronic pain acceptance questionnaire; C-SQ: Client Satisfaction questionnaire; PGRS: Pain graphic rating scale; PASS: Pain anxiety symptoms scale

Table 6: Specific intervention characteristics

Study	Intervention location	Intervention content	Intervention volume	Intervention frequency	Program length	Session duration (min)	Control group type
de Jong [18]	unclear	1. E, GE 2. E, GA	1. 24 hours 2. 36 hours	unclear	1. 6w 2. 8w	unclear	/
Demoulin et al. [28]	unclear	E, RE, PSI, OT, AT, ST, SE tr	36 sessions	2-3x/w	12-18w	120	NT
Gema et al. [30]	H (ET) unclear (E)	MC lb, ST, AT (ET) + E	2 sessions (E)	unclear	4m	30-50 (E)	ET
George et al. [34]	unclear	1. GE, CPT, PSI, BF, ST ll + sp, TS, SE ll + ul, AT 2. GEC, CPT, PSI, BF, ST ll + sp, TS, SE ll + ul, AT	unclear	5x/w	variable	420	/
Harris et al. [41]	C	1. E, AT, SE, RE (PE) 2. E, GS, GE	unclear	1. 3x/w 2. unclear	3m	90	/
Harts et al. [31]	C	Lumbar ext. HL SE	15-20 reps	1-2x/w	8w	unclear	Lumbar ext. LL SE
Helmhout et al. [21]	C	Lumbar ext. HL SE	10-15 reps → 15-20 reps	1-2x/w	3m	5-10	Lumbar ext. LL SE
Hurley et al. [36]	1. unclear 2. C C	1. E, D, WA (prescription) 2. E, D, S, AT, SE tr + ll + ul, RE 3. E, ET, MT	unclear	1. 4x/w → 5x/w 2. 1x/w 3. variable	1. 8w 2. 8w 3. unclear	1. 10 → 30 2. 60 3. unclear	/
Kernan et al. [19]	C	ST sp + ll, SE sp, AT, E, GE	5-10 reps	2x/w	6w	60	E, GE
Koumantakis et al. [20]	C	ET, TS	unclear	2x/w	8w	45-60	ET
Linden et al. [39]	C	E, RE, D, FMT, CT, PST	unclear	3x/w	3w	90	GOT, OT

Mannion et al. [35]	C	1. SE, CT, AT (CPT) 2. SE, AT, RE (device PT) 3. AT	unclear	2x/w	3m	1. 30 2. 60 3. 60	/
Marshall et al. [37]	C	1. PI 2. SC	unclear	3x/w	8w	50-60	/
Miyamoto et al. [32]	C	PI, E (booklet)	unclear	1x/w	6w	60	E (booklet)
Monticone et al. [26]	C	TS, ST, /p/ M (ET) + E, MC, GE (CBT)	unclear	2x/w 1x/w	8w (ET) 8w (CBT)	60 (ET) 60 (CBT)	/p/ M sp, ST, SE, MC
Monticone et al. [25]	unclear	M + MC sp, FMT, ST (ET) + E, GS, RE, GE (CBT)	unclear	1x/w	5w	60	/p/ M sp, ST, SE, MC
Monticone et al. [27]	C	/a/ + /p/ M sp, ST + SE sp, E (ET) + E, GE, CS (CBT)	unclear	2-3x/w (ET) 1x/w (CBT)	6w (ET) 5w (CBT)	60 (ET) 60 (CBT)	ET
Nassif et al. [23]	NM	ST, TS, CT, RE maj. musc.	unclear	3x/w	2m	60	NT
Norris et al.[24]	C	ST, SE, EE hi + tr, FMT	unclear	unclear	6w	unclear	E (leaflet)
O'Sullivan et al.[40]	NM	E, RE, D, CT, FMT, LST	unclear	1x/w → 1x/2w	12w	unclear	/
Pagé et al. [22]	unclear	fl/ext task + BF	unclear	unclear	4-6w	180	/
Pires et al. [33]	unclear	AE + E	10 sessions (AE) + 2 sessions (E)	2x/w (AE)	6w	30-50 (AE) 90 (E)	E
Schütze et al. [17]	unclear	MM, CT, FMT, E, GS (CBT)	unclear	1x/w	8w	120	/
Shnayderman et al. [38]	C	WA (treadmill)	unclear	2x/w	6w	40	/a/ M, SE tr + ll + ul
Smeets et al. [42]	unclear	1. AT, SE + EE lb + ll (APT) 2. operant GA, PST (CBT) APT + CBT	2. 10 sessions	1. 3x/w 2. unclear unclear	10w	1. 105 2. 30 unclear	NT
Vlaeyen et al. [29]	unclear	1. E, GE 2. GA	unclear	unclear	8w	unclear	/

Abbreviations: C: therapy in clinical setting; H: therapy at home; NM: therapy in non-medical setting; PI: pilates; TS: trunk stabilisation exercises; HL: high load; LL: low load; w: weeks; m: months; d: days; CPT: conventional physiotherapy; CT: coördination therapy; AT: aerobic therapy; RE: relaxation; E: education; ST: stretching; NT: no treatment; D: diary; WA: walking MT: manual therapy; SC: stationary cycling; SE: strengthening exercises; EE: endurance exercises; /a/: active; M: mobilisation; tr: trunk; ll: lower limb; ul: upper limb; lb: lower back; hi: hip; sp: spine; CBT: cognitive behavioral therapy; GOT: general orthopedic treatment; OT: occupational therapy, FMT: functional movement training; AE: aquatic exercise; ET: exercise therapy; CS: coping strategies; PSI: psychological interventions; MI: multidisciplinary intervention; PST: problem solving therapy; POE: posture exercises; YO: yoga; GE: graded exposure; GEC: graded exercise; MM: mindfulness meditation; GS: group support; MC: motor control exercises

Table 7: Outcome measures per study

Articles	Outcome measures			
	TSK	**FABQ**	**PCS**	**Others**
de Jong et al. [18]	x		x	PHODA
Demoulin et al. [28]	x			
Gema et al. [30]	x		x	
George et al. [34]	x	x		FPQ-II, BDI
Harris et al. [41]		x		
Harts et al.[31]	x			
Helmhout et al. [21]	x			
Hurley et al. [36]		x		BBQ, ESEQ
Kernan et al. [19]	x	x		
Koumantakis et al. [20]	x			
Linden et al.[39]		x		
Mannion et al. [35]		x		
Marshall et al.[37]		x	x	
Miyamoto et al. [32]	x			
Monticone et al. [26]	x		x	
Monticone et al. [25]	x		x	
Monticone et al. [27]	x			
Nassif et al. [23]	x			
Norris et al. [24]	x			
O'Sullivan et al. [40]		x	x	BBQ, DASS-21
Pagé et al. [22]	x			
Pires et al. [33]	x			
Schütze et al. [17]			x	DASS-21
Shnayderman et al. [38]		x		
Smeets et al. [42]				BDI, PCL
Vlaeyen et al. [29]	x		x	PHODA

Search strategies

Pubmed:

((''low back pain''[MeSH Terms]) OR (''low back pain''[Title/Abstract]) OR (''musculoskeletal diseases''[MeSH Terms]) OR (''musculoskeletal diseases''[Title/Abstract]) OR (''chronic pain''[MeSH Terms]) OR (''chronic pain''[Title/Abstract]) OR (''chronic low back pain''[Title/Abstract])) AND ((''physical therapy modalities''[MeSH Terms]) OR (''physical therapy modalities''[Title/Abstract]) OR (''exercise therapy''[MeSH Terms]) OR (''exercise therapy''[Title/Abstract]) OR (''exercise interventions''[Title/Abstract]) OR (''physiotherapy''[Title/Abstract]) OR (''physical therapy''[Title/Abstract]) OR (''rehabilitation'' [MeSH:NoExp])) AND ((''fear of movement''[Title/Abstract]) OR (''kinesiophobia''[Title/Abstract]) OR (''fear avoidance''[Title/Abstract]) OR (''pain beliefs''[Title/Abstract]) OR (''fear of pain''[Title/Abstract]) OR (''avoidance behavior''[Title/Abstract]) OR (''disability''[Title/Abstract]) OR (''dysfunctional beliefs''[Title/Abstract]) OR (''self-efficacy''[Title/Abstract]) OR (''central sensitisation''[Title/Abstract]) OR (''hyperalgesia''[Title/Abstract]) OR (''hyperalgesia''[MeSH Terms]) OR (''hyperesthesia''[Title/Abstract]) OR (''hyperesthesia''[MeSH Terms]) OR (''catastrophization''[Title/Abstract]) OR (''catastrophization''[MeSH Terms]) OR (''fear''[Title/Abstract]) OR (''fear''[MeSH Terms]) OR (''avoidance learning''[Title/Abstract]) OR (''avoidance learning''[MeSH Terms]) OR (''pain related fear''[Title/Abstract]) OR (''movement evoked pain''[Title/Abstract]) OR (''pain behaviour''[Title/Abstract]) OR (''pain catastrophizing''[Title/Abstract]) OR (''pain/psychology''[MeSH Terms]) OR (''anxiety''[MeSH Terms]))

Web of science:

TS=(Chronic low back pain) AND TS=(Physical therapy modalities OR Exercise therapy OR Physiotherapy OR Physical therapy) AND TS=(Fear of movement OR Kinesiophobia OR Fear avoidance)

PART II: Overview of the protocol

PART II: Research protocol

1. Introduction

Low back pain is one of the most frequently reported musculoskeletal disorders (Andersson, 1999 [1]) with a lifetime prevalence up to 84% (Airaksinen et al., 2006 [2]). It is defined as a pain sensation localized below the lower edge of the chest and above the inferior gluteal fold accompanied with or without leg pain (Airaksinen et al., 2006 [2]). While most back pain is acute (i.e. persisting for less than 6 weeks), 23% of all persons will at one time in their life develop chronic low back pain (CLBP) (Balague, Mannion, Pellise and Cedraschi, 2012 [3]). This chronic disorder with a time span of a minimum of 12 weeks is characterized with high levels of disability, work absenteeism and significant costs to the healthcare system (e.g. in Belgium 5.7 million days of work absenteeism per year are paid because of low back pain) (Van Zundert and Van Kleef, 2005; van Tulder, Koes and Bouter, 1995 [4, 5]). Although specific back related pathologies are existent, most persons are categorized as having nonspecific chronic low back pain (NSCLBP), meaning that no underlying pathology can be defined (Balague et al., 2012; Maher, Underwood and Buchbinder, 2017 [3, 6]).

A significant amount of research is currently being done to describe the most effective treatment modality for CLBP. In general, conservative treatments (e.g. exercise therapy) are recommended for CLBP, while invasive and long-term pharmacological treatments are considered as no effective options (Airaksinen et al., 2006 [2]). These interventions mostly affect the physical aspects. Although, conservative treatment modalities, in particular exercise therapy, seem to be the most effective, the results are not always as expected (Aure, Nilsen and Vasseljen, 2003 [7]). This leads to conclude that other factors for maintaining and developing CLBP must exist.

To detect those factors, we must to, first and foremost, understand how acute low back pain can evolve into a chronic state. Already in the early 1980s, Lethem, slade, Troup and Bentley (1983) [8] described the effect of fear avoidance in the development from acute to CLBP. Ever since, a more than considerable amount of research about the psychological factors in the transition from acute to CLBP carried on. Picavet, Vlaeyen and Schouten (2002) found that high levels of pain catastrophizing or kinesiophobia (i.e. fear of pain due to movement) could increase the risk of CLBP and disability [9]. Furthermore Pincus, Burton, Vogel and Field (2002) et al. concludes that psychological factors including distress, depressive mood and somatization, play an important role in the transition from acute to CLBP [10]. These psychological factors do not only affect the risk or the development of CLBP, but they also affect the maintenance. Persons with elevated levels of fear of movement and (re)injury show more fear and avoidance to simple movements and activities (Vlaeyen, Kole-Snijders, Boeren and van Eek, 1955 [11]). This is in line with the study from Grotle, Vøllestad, Veierød and Brox (2004), where fear avoidance beliefs and distress are related to disability and even work loss [12].

A limited amount of research has been done regarding treatment options for influencing these psychological factors, which affect the development and maintenance of CLBP. There is some evidence regarding the success of different types of exercise therapy (ET): general physical exercise (Kernan et al., 2007 [13]; Nassif et al., 2011 [14]; Mannion et al., 1999 [15]; Hurley et al.,2015 [16]; Shnayderman et al., 2013 [17]), spine stabilisation exercises (Koumantakis et al., 2005 [18]; Norris et al., 2008 [19]), biofeedback exercises (Pagé et al., 2015 [20]), walking therapy (Hurley et al., 2015 [16].), pilates (Marshall et al., 2013 [21]) and high intensity training (HIT) (Helmhout et al., 2004 [22]) in reducing irrational beliefs like kinesiophobia, fear avoidance beliefs or pain catastrophizing thoughts. Also, studies using a cognitive behavioral therapy (CBT) intervention seem to report significant reductions in one or more of these psychological factors. These interventions include education (Gema et al., 2017 [23].), graded exposure (Vlaeyen et al., 2002 [24]; de Jong et al., 2005 [25]) and other types of CBT (Linden et al., 2014 [26]; O'Sullivan et al., 2015 [27]; Harris et al.,2017 [28]; Schütze et al., 2014 [29]). Thus, further research is needed to evaluate the effect these treatment options for improving psychological factors, which have an important impact on the course of CLBP. Also, further research should determine if one specific treatment option is more effective than others.

2. Study objective

The aim of this study is to determine the effect of HIT in comparison to CBT on kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in persons with CLBP.

2.1 Research questions

It is not clear which rehabilitation program is the most effective for improving kinesiophobia and other psychological factors in people with CLPB. Therefore, this randomized controlled trial will compare two rehabilitation programs, resulting in the following research question: What is the effect of HIT compared to CBT on kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in persons with CLBP?

2.2 Hypotheses

The results of our master thesis part 1 suggest that a rehabilitation program, containing an active component, seems to be effective in improving kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts. The hypothesis can be made that both the HIT program and the cognitive beharvioral program will lead to improvements in kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts. Due to the lack of research comparing the effect of different active rehabilitation programs on these outcome measures, it is difficult to make a hypothesis about which program will be the most effective. However, CBT may lead to a greater reduction in kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts. This may be due to the fact that cognitive behavioral therapy focusses more on changing these irrational thougths by educating the patient about the origin of pain and the fact that movement or pain not always leads to damage.

3. Methods

3.1 Design

This study is a randomized clinical trial with two intervention groups where the effects of a HIT program in persons with CLBP will be compared to a CBT program. Participants will be randomized in two groups, by using sealed envelopes. Each group will get a specific exercise program composed by the researchers. Group one gets a general HIT program, where the focus is on improving the cardiovascular and general muscular fitness. Group two gets a CBT program, focused on education and graded exposure in vivo. This is a 16 weeks during program where the patient will practice twice a week for two hours in the HIT group and 90 minutes in the CBT group. See Figure 1 for a graphical description of the study design.

3.2 Participants

60 participants (intervention group one: general HIT, intervention group two: CBT) will be recruited for this randomized controlled trial. Patients with low back pain who qualify for the trial and meet the in- and exclusion criteria, will be informed during a intake session. Persons who are interested will receive an information- and permission form. Persons who send back the permission form within one week, will be included as participant of the trial. The following socio demographic data of the patient will be collected when the person is included:

- Gender
- Age
- Education
- Weight and length
- Social and work situation
- Lifestyle habits and lifestyle factors (diet, smoking, …)
- Medical history
- Time passed since onset of low back pain
- History of rehabilitation (global and specific for low back pain)
- Medication use before low back pain (yes/no, dosis, type)
- Work accident, legal procedure with regard to the low back pain
- Average amount of working hour per week
- Time of work performed sitting/standing/moving

3.2.1 Inclusion criteria

Inclusion criteria for the intervention groups:

- Main complaint: chronic low back pain
    - Low back pain is defined as pain and discomfort, localised below the costal margin and above the inferior gluteal folds, with or without referred leg pain by the “European guidelines for the management of nonspecific low back pain”.

    - Chronic: current episode >12 weeks
    - Nonspecific: no underlying pathology can be defined
- Age: 18 - 65 year
- Understand Dutch (written and spoken)

3.2.2 Exclusion criteria

Exclusion criteria for the intervention groups:

- Invasive surgery of the spine in the past 18 months.
- Radiculopathy (uni- or bilateral)
- Comorbidities: pareses and sensory deficits with a neurological cause, diabetes mellitus, rheumatoid arthritis, increase in pain >3/10 and pain >8/10 in the last 48h.
- Incapacity for work > six months
- Rehabilitation or exercise therapy for low back pain in the last 6 months.

3.2.3 Participant recruitment

Participants will be recruited by a free recruitment principle (via social media, flyers …).

3.3 Medical ethics

This study has been approved by the medical ethical committee of Hasselt University and of Jessa Hospital (Hasselt, Belgium) under protocol name 14.87/REVA14.12. Consent to participate will be obtained of each patient prior to the start of any study-related procedures. The clinical trial has been registered at clinicaltrials.gov as NCT02786316.

3.4 Intervention

Participants of the first intervention group (general HIT) will have a physical reconditioning program consisting of cardiovascular training (interval training on a ergometer bike) and maximum strength training (Technogym) at high intensity (HIT) (12 weeks intervention, two sessions/week, two hours/session). Attention to motor control of the lower back during the exercises is necessary. Exercises will be carried out with a rising difficulty so that the participants become continuous challenged during rehabilitation. The progression in the training will be done by a gradual increase in the number of repetitions and/or the duration of the exercise.

Participants of the second intervention group will have a cognitive behavioral program (CBT) consisting of education and exposure in vivo (12 weeks intervention, two sessions/week, 90 minutes/session). Therapists will give education about CLBP, treatment and impact of negative thoughts and psychological factors. Further, therapists will gradually confront patients with activities they feared and avoided due to the belief that this movements might be damaging for their back.

3.5 Outcomes

Primary outcome measures

Pain, kinesiophobia, fear of movement, disability, catastrophizing thoughts

- Tampa scale for kinesiophobia (TSK)
  The TSK is a valid and reliable questionnaire. (17 items) This questionnaire gives information about the pain-related fear of movement of exercises in CLBP. Each of the 17 questions must be scored on a four-point scale. A score of more than 37 is seens as a cutoff score.
  - High internal consistency (α = 0.84) [30]
  - Test retest reliability (ICC = 0.82) [31]
  - Correlation with FABQ work (*r* = 0.35) [30]
  - Correlation with FABQ physical activity (*r* = 0.53) [30]
- Fear avoidance beliefs questionnaire (FABQ)
  This is a questionnaire which focuses on how a patient's fear avoidance beliefs about physical activity and work may affect and contribute to their low back pain and resulting disability
  - High internal consistency (α=0.84 and higher) [32]
  - Subgroup - physical activity: low to moderate (α = 0.57 - 0.79) [32]
  - High test retest reliability FABQ - physical activity (FABQ physical activity ICC = 0.90; FABQ work ICC = 0.96) [33]
  - Validity: low [32]
  - Good correlation with PCS (*r* = 0.64).[33]
- Pain catastrophizing scale (PCS)
  It's one of the most used instruments for measuring catastrophic thinking related to pain. A null score means that the patient doesn't have catastrophizing thoughts or feelings, a score of four means that these thoughts and feelings are present all the time.
  - High internal consistency (α = 0.87) [34]
  - Validity: good
  - Reliable

All primary outcome measures are ordinal variables.

Secondary outcome measures

Pain

- Numeric Pain Rating Score (NPRS)
  This is a tool where the participant can indicate the amount of pain. It's a scale with eleven scores (0-10). A null score means 'no pain', score of 10 means 'worst imaginable pain'. An improvement of pain with two levels is considered clinically relevant and as one significant difference.

Disability

- Roland Morris Disability questionnaire (RMDQ)
  This reliable and valid questionnaire (24 items) evaluates the activity levels from patients with low back pain. A change of five is the minimum clinically important difference, based on the SEM.
- Modified Oswestry Disability Index (ODI)
  This questionnaire is valid and reliable for evaluating persons limitations experienced in their daily activities due to chronic low back pain. It consists of 10 items that can be scored on a five-point scale. A percentage of the disability can be made.

Limitations in participating and quality of life

- The Short form (36) Health Survey (SF-36)
  This questionnaire evaluates the health status, and thus gives an indication about the disabilities of the patient. It consists of eight scores (vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning, mental health). The lower the score, the more major the disability. The SF-36 seems to be responsive to treatment.
- Perceived Stress Scale (PSS)
  This is a questionnaire consisting of 10 items to evaluate the perceived stress of persons in daily living. Each of the 10 questions needs to be scored on a four-point Likert scale. The cutoff score is a score above 14 and represents high stress.

Motivation and compliance

- Motivation
  At the beginning, the motivation will be measured by a visual analog scale (VAS). At the end of the study, there will be an extensive evaluation of the motivation for the program based on the Intrinsic Motivation Inventory (IMI).
- Compliance
  Daily registration of the duration and frequency of the exercises (diary).

3.6 Data analysis

Data analysis will be conducted in SPSS 22.0 (SPSS Inc. Chicago). First, there will be investigated if the data are normally distributed, to determine if parametric or non-parametric analysis need to be conducted. Since we expect a normal distribution, the comparisons between the different groups will be conducted by using a ‘one-way ANOVA’. For the comparison between the two measurement points, a ‘dependent t-test’ will be used. A post-hoc analysis will be conducted where necessary.

4. Time planning

To do	Deadline
Recruitment	January 2019
Testing	April – May 2019
Data analysis	May 2019
Writing	June 2018

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6. Appendix

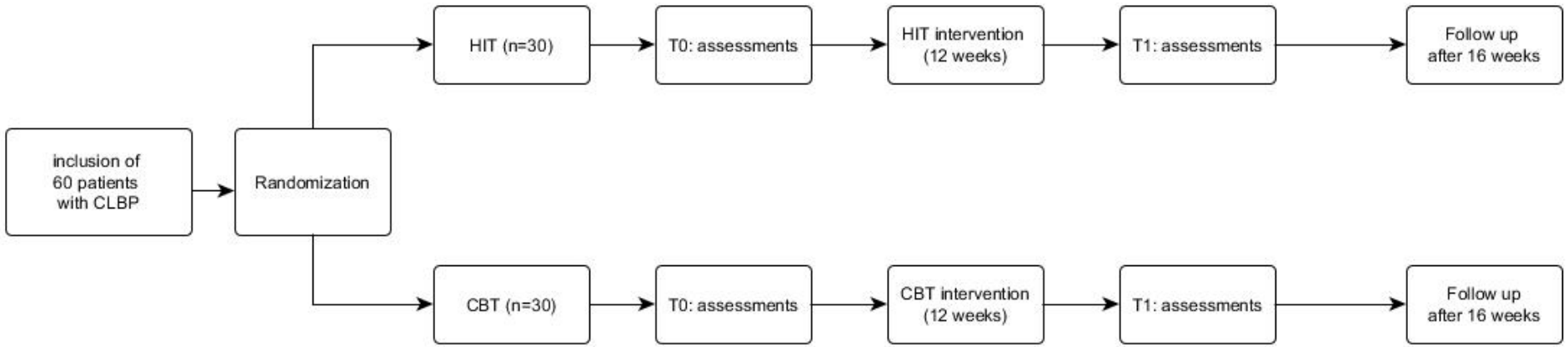

Figure 1: Research design

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BEOORDELING VAN DE WETENSCHAPPELIJKE STAGE-DEEL 1

Wetenschappelijke stage deel 1 (Masterproef deel 1- MP1) van de Master of Science in de revalidatiewetenschappen en de kinesitherapie bestaat uit **twee delen**:

1) De literatuurstudie volgens een welomschreven methodiek.
2) Het opstellen van het onderzoeksprotocol ter voorbereiding van masterproef deel 2.

Omschrijving van de **evaluatie**:

1) 80% van het eindcijfer wordt door de promotor in samenspraak met de copromotor gegeven op grond het product en van het proces dat de student doorliep om de MP1 te realiseren, met name het zelfstandig uitvoeren van de literatuurstudie en het zelfstandig opstellen van het onderzoeksprotocol, alsook de kwaliteit van academisch schrijven.
2) 20% van het eindcijfer wordt door de interne jury gegeven op grond van het ingeleverde product en de mondelinge presentatie waarin de student zijn/haar proces toelicht.

In de beoordeling dient onderscheid gemaakt te worden tussen studenten die, in samenspraak met de promotor, een nieuw onderzoek uitwerkten en studenten die instapten in een lopend onderzoek of zich baseren op voorgaande masterproeven of onderzoeksprojecten. Van deze laatste worden bijkomende inspanningen verwacht zoals bv. het bijsturen van de eerder geformuleerde onderzoeksvraag, de kritische reflectie over het onderzoeksdesign, het uitvoeren van een pilotexperiment.

Beoordelingskader:

Beoordelingskader: criteria op 20	
18-20	Excellente modelmasterproef
16-17	Uitmuntende masterproef
14-15	Zeer goede masterproef die zich onderscheidt van de andere masterproeven
12-13	Goede masterproef
10-11	Voldoende masterproef die op een aantal vlakken zwak scoort
8-9	Onvoldoende masterproef die niet aan de minimumnormen voldoet
6-7	Ernstig onvoldoende masterproef of een masterproef die slechts één van beide bevat
≤ 5	Ernstig onvoldoende en onvolledige masterproef

ZELFEVALUATIERAPPORT

Onderstaand zelfevaluatierapport is een hulpmiddel om je wetenschappelijke stage -deel 1 zelfstandig te organiseren. Bepaal zelf je deadlines, evalueer en reflecteer over je werkwijze en over de diepgang van je werk. Check de deadlines regelmatig. Toets ze eventueel af bij je (co)promotor. Succes!

Prof. M. Vanvuchelen, coördinerende verantwoordelijke wetenschappelijke stages

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ZELFEVALUATIERAPPORT **WETENSCHAPPELIJKE STAGE - DEEL 1** **RWK**

Naam & Voornaam STUDENT: Roebben Laurien

Naam & Voornaam (CO)PROMOTOR & PROMOTOR: Jonas Verbrugghe & Prof. Dr. Annick Timmermans

TITEL masterproef (Nederlandstalig of Engels): The effects of a physical rehabillitation program on kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in chronic low back pain.

LITERATUURSTUDIE	Gestelde deadline	Behaald op	Reflectie
De belangrijkste concepten en conceptuele kaders van het onderzoekdomein uitdiepen en verwerken	November 2017	November 2017	
De belangrijkste informatie opzoeken als inleiding op de onderzoeksvraag van de literatuurstudie	November 2017	November 2017	
De opzoekbare onderzoeksvraag identificeren en helder formuleren in functie van de literatuurstudie	November 2017	November 2017	
De zoekstrategie op systematische wijze uitvoeren in relevante databanken	10/01/2018	10/01/2018	
De kwaliteitsbeoordeling van de artikels diepgaand uitvoeren	8/04/2018	8/04/2018	
De data-extractie grondig uitvoeren	27/02/2018	27/02/2018	
De bevindingen ïntegreren tot een synthese	10/06/2018	10/06/2018	

ONDERZOEKSPROTOCOL	Gestelde deadline	Behaald op	Reflectie
De onderzoeksvraag in functie van het onderzoeksprotocol identificeren	1/06/2018	1/06/2018	
Het onderzoeksdesign bepalen en/of kritisch reflecteren over bestaande onderzoeksdesign	1/06/2018	1/06/2018	
De methodesectie (participanten, interventie, uitkomstmaten, data-analyse) uitwerken	1/06/2018	1/06/2018	

ACADEMISCHE SCHRIJVEN	Gestelde deadline	Behaald op	Reflectie
Het abstract tot he point schrijven	10/062018	10/06/2018	
De inleiding van de literatuurstudie logisch opbouwen	1/05/2018	1/05/2018	
De methodesectie van de literatuurstudie transparant weergegeven	30/04/2018	30/04/2018	
De resultatensectie afstemmen op de onderzoeksvragen	31/05/2018	31/05/2018	
In de discussiesectie de bekomen resultaten in een wetenschappelijke tekst integreren en synthetiseren	10/06/2018	10/06/2018	
Het onderzoeksprotocol deskundig technisch uitschrijven	10/06/2018	10/06/2018	
Referenties correct en volledig weergeven	10/06/2018	10/06/2018	

ZELFSTUREND EN WETENSCHAPPELIJK DENLEN EN HANDELEN	Aanvangsfase	Tussentijdse fase	Eindfase
Een realistische planning opmaken, deadlines stellen en opvolgen	14	14	14
Initiatief en verantwoordelijkheid opnemen ten aanzien van de realisatie van de wetenschappelijke stage	13	13	13
Kritisch wetenschappelijk denken	12	12	12

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De contacten met de promotor voorbereiden en efficiënt benutten	14	14	14
De richtlijnen van de wetenschappelijke stage autonoom opvolgen en toepassen	14	14	14
De communicatie met de medestudent helder en transparant voeren	14	15	15
De communicatie met de promotor/copromotor helder en transparant voeren	14	14	14
Andere verdiensten:			

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ZELFEVALUATIERAPPORT **WETENSCHAPPELIJKE STAGE - DEEL 1** **RWK**

Naam & Voornaam STUDENT: Sofie Vanlommel

Naam & Voornaam (CO)PROMOTOR & PROMOTOR: Jonas Verbrugghe en Annick Timmermans

TITEL masterproef: The effects of a physical rehabillitation program on kinesiophobia, fear avoidance beliefs and pain catastrophizing thoughts in chronic low back pain

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Kritisch wetenschappelijk denken	12	12	13

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VOORTGANGSFORMULIER WETENSCHAPPELIJKE STAGE DEEL 1

DATUM	INHOUD OVERLEG	HANDTEKENINGEN
20 November 2017	Bespreking zoekstrategie + in- en exclusie criteria.	Promotor: Copromotor: Student(e): Student(e): Sofie Vanbiervliet
27 febr. 2018	Bespreking Methode, data extractie en kwaliteitsbeoordeling	Promotor: Copromotor: Student(e): Student(e): Sofie Vanbiervliet
31 Mei 2018	Bespreking Resultaten, inleiding	Promotor: Copromotor: Student(e): Student(e): Sofie Vanbiervliet
4 juni 2018	Bespreking protocol + verbeterpunten literatuurstudie (schrijven)	Promotor: Copromotor: Student(e): Student(e): Sofie Vanbiervliet
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