KU LEUVEN

GROEP BIOMEDISCHE WETENSCHAPPEN

FACULTEIT BEWEGINGS- EN REVALIDATIEWETENSCHAPPEN

Perioperative rehabilitation in patients with lumbar arthrodesis: A systematic review

door Charlotte Amerijckx
en Helena Boonen

masterproef aangeboden, tot het behalen van de graad van Master of Science in de revalidatiewetenschappen en kinesitherapie

o.l.v.
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Woord vooraf

Het schrijven van een masterproef vergt veel discipline, toewijding en ook heel wat tijd. De voorbije twee jaar hebben we nauw samengewerkt aan dit project. Hierbij hebben we de nodige hulp en steun gekregen van verschillende personen.

In de eerste plaats willen we onze oprechte dank betuigen aan onze promotor Prof. dr. Wim Dankaerts en onze twee co-promotoren, Prof. dr. Lotte Janssens en drs. Thijs Swinnen. Zij gaven ons de kans om mee aan de basis te staan van een grootschalig onderzoek omtrent het ontwikkelen van een perioperatief revalidatiepad na lumbale arthrodese. Gezien we beiden dergelijke ingreep ondergaan hebben, waren we bijzonder gemotiveerd om de revalidatie bij deze patiëntenpopulatie te optimaliseren. Bovendien willen we hen bedanken voor het inhoudelijk meedenken en bijsturen van deze masterproef. Ook een welgemeende dankjewel aan Tinne Thys die steeds klaarstond voor onze vragen, ons handige tips en feedback gaf en ons betrok in de Delphi studie wat een erg leerrijke ervaring was. Dankzij de continue feedback en constructieve suggesties van deze vier personen konden we deze masterproef tot een goed einde brengen.

Tot slot willen we familie en vrienden bedanken voor hun steun tijdens deze toch wel stresserende periode van onze studiecarrière.

Putte, 21 mei 2018 C.A

Geel, 21 mei 2018 H.B.

Situering

Deze masterproef situeert zich binnen de masteropleiding Revalidatiewetenschappen en Kinesitherapie aan de Faculteit Bewegings- en Revalidatiewetenschappen (FaBeR) van de Katholieke Universiteit Leuven. De masterproef vormt een onderdeel van een groter samenwerkingsproject tussen FaBeR en de UZ Leuven gericht op het optimaliseren van een zorgpad met betrekking tot de revalidatie van patiënten met een lumbale arthrodese. Dit project loopt binnen het dienstoverschrijdend zorgprogramma 'Niet Traumatische Aandoeningen van het Axiaal Skelet' (NTAAS) dat de zorg voor alle pathologieën gerelateerd aan het axiale skelet integreert. Vanhaecht en Sermeus definieerden acht belangrijke stappen voor de ontwikkeling, implementatie en evaluatie van een klinisch pad [1]. Op basis hiervan werden vier grote stappen (zie A-D, Figuur 1) bepaald voor het optimaliseren van het zorgpad 'lumbale arthrodese'.

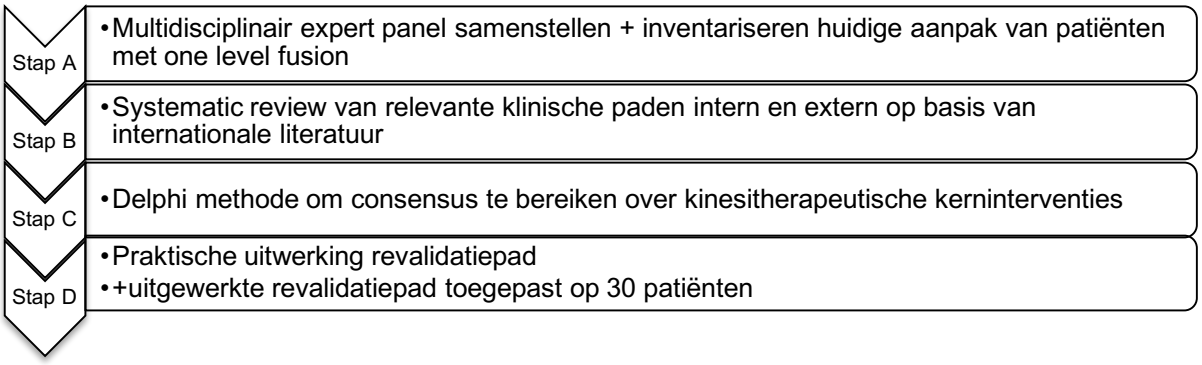

Fig. 1 Vier belangrijke stappen bij het optimaliseren van het zorgpad 'lumbale arthrodese'

Een belangrijk onderdeel hiervan is het bundelen van de bestaande literatuur omtrent de perioperatieve interventies bij deze doelgroep (Stap B, Figuur 1). Hierdoor vormde deze systematic review onze voornaamste bijdrage aan dit project. Naast de studie die onderwerp vormt van onze masterproef wordt er in dit project ook gekeken naar de huidige strategie in de UZ Leuven (Stap A, Figuur 1). Hierbij worden o.a. zorgverleners uit verschillende disciplines bevraagd over de huidige perioperatieve behandelstrategieën en hun visie op het optimale zorgtraject. Bijkomstig identificeert een expertpanel de kerninterventies en uitkomstmaten met als doel de huidige werking te optimaliseren. Vervolgens wordt een actieplan opgesteld omtrent een nieuwe kinesitherapeutische aanpak op maat van de patiënt die uiteindelijk in een pilootstudie wordt getest.

Ongeveer 80% van de bevolking wordt ooit in het leven geconfronteerd met lage rugpijn. Wereldwijd is dit één van de voornaamste redenen van beperking in onze maatschappij met degeneratieve aandoeningen als meest voorkomende oorzaak [2]. Het percentage mannen

en vrouwen die lijden aan lage rugpijn neemt toe tot op de leeftijd van 80 jaar en stagneert nadien [3]. De impact op het welzijn en de functionaliteit van de patiënt weerspiegelt zich ook op maatschappelijk vlak door de verminderde werkbijdrage en hoge medische kosten. Kinesitherapie geniet de voorkeur als initiële behandeling bij niet-gecompliceerde mechanische lage rugpijn [4] maar ook chirurgie toont positieve resultaten bij degeneratieve aandoeningen zoals spinale stenose met of zonder spondylolisthese [5]. Echter, in de huidige literatuur heerst er nog controverse over de meest geschikte behandelmethode door verschillen in indicatiestelling en heterogeniteit in zowel interventies als uitkomstmaten. Een veelvoorkomende ingreep bij lage rugpijn ten gevolge van degeneratieve aandoeningen is een lumbale arthrodese, welke de laatste twee decennia steeds meer wordt toegepast [6]. Hoewel studies positieve effecten van lumbale arthrodese aanhalen, blijft 15 tot 40% van de patiënten postoperatief met blijvende pijn en beperking kampen [7,8,9]. Predictoren voor negatieve postoperatieve uitkomsten zijn reeds extensief beschreven in de literatuur [9]. Verschillende biopsychosociale factoren zoals onder andere roken, depressie, kinesiofobie, coping en ziektewinst kunnen een rol spelen in het postoperatief verloop na lumbale arthrodese. Hierdoor is het relevant te onderzoeken hoe deze factoren in rekening worden gebracht bij het ontwikkelen en evalueren van perioperatieve interventies. Zo moet het effect van de interventie op de gewenste uitkomstmaten zoals onder andere pijn, beperking, kinesiofobie en kwaliteit van leven geëvalueerd worden. Het doel van deze systematic review is om de inhoud van perioperatieve revalidatie bij patiënten met een lumbale arthrodese te beschrijven in biopsychosociale categorieën en om de efficiëntie ervan te evalueren binnen de verschillende componenten van het ICF. Tot slot wordt ook de kwaliteit van de geïncludeerde studies onderzocht en gerapporteerd.

Referenties

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Perioperative rehabilitation in patients with lumbar arthrodesis: A systematic review

Abstract

Purpose: The purpose of this systematic review was to describe rehabilitation interventions in patients following lumbar arthrodesis into biopsychosocial categories and to evaluate their efficacy on the different components of the International Classification of functioning, disability and health (ICF).

Methods: Two independent reviewers searched six electronic databases for relevant articles describing perioperative rehabilitation in a population with single or double level lumbar arthrodesis. To retrieve information on the intervention characteristics, a predefined extraction form was applied. Interventions were subdivided based on their specific focus into biological, psychological, social or combined. Outcomes were described according to the ICF framework. A modified Cochrane Collaboration tool was used for assessing risk of bias (ROB) and quality of reporting studies was reported by STROBE and CONSORT.

Results: Twenty-one studies were implemented. Compared to no psychological intervention, patients after psychological interventions had less disability and there was an overall trend of reduction in fear avoidance beliefs and catastrophizing. Therapies combining exercise and psychological interventions showed less disability, more return to work, improvements on kinesiophobia, self-efficacy, back beliefs, coping and an increase in health-related quality of life compared to usual care. Due to a small amount of studies describing biological and social interventions valuable conclusions regarding their effectiveness could not be made. Many criteria of the ROB assessment were generally unclear.

Conclusions: While a wide range of intervention types and outcome measures is used through all studies, we found that interventions combining cognitive-behavioural and exercise therapy retrieved significant better results on most components of the ICF framework.

Key words: spinal fusion, arthrodesis, lumbar region, rehabilitation, exercise therapy, cognitive-behavioural therapy

Trial registration number: CRD42018083422

Introduction

Worldwide, chronic low back pain is one of the most common and costly problems to our health care system [1]. With a lifetime prevalence ranging from 11-84% it is one of the main causes of disability [2]. Although previous studies have shown that rehabilitation is effective as a primary intervention [3], the rate of spine surgery has largely increased in the past two decades [4]. A wide range of spinal surgical methods exist whereby lumbar arthrodesis is a possible approach for degenerative disorders of the lumbar spine [4]. To reduce the negative impact of surgery these techniques could be performed minimally invasive in contrast to "open" methods [5]. The aims of lumbar arthrodesis are formulated as restoring function and providing segmental stability to diminish back pain, segmental instability and sometimes deformity [6]. Around 63% of operated patients indicate a significant and clinical important improvement of their pain and disability [7,8] up to two years post arthrodesis [9]. However, 15 to 40% still has a poor outcome on those measures [8,10]. This could be a result of the ongoing discussion about the appropriate indications for lumbar spinal surgery [11]. For degenerative disc disease, there has been found no advantage of lumbar arthrodesis in comparison with comprehensive rehabilitation [12]. Therefore, guidelines advise to consider lumbar arthrodesis only if conservative treatment failed [13]. When radiculopathy is also present, microdiscectomy has favourable effects on pain and disability in the short term [12]. In this case, fusion is only recommended in patients with serious degenerative changes or instability [14]. Lastly, when stenosis with degenerative spondylolisthesis is diagnosed, surgical decompression with fusion is recommended [15] and yields better results than conservative treatment [16].

Literature describes several predictors of outcome of spinal surgery. Especially psychological factors were frequently interacting with outcomes on disability following lumbar arthrodesis as measured by the Oswestry Disability Index (ODI) [9,17,18]. For example, preoperative fear-avoidance beliefs have shown to be a predictor for disability six months postoperative [19]. Another predictor was preoperative depressive symptoms, which not only affected disability, but also predicted increased pain and decreased physical health six [18,25] and twelve months after surgery [20]. Also fear of movement measured six weeks postoperatively was a predictor of several worse outcomes [18,21,22]. On the other hand, other studies reported enhanced health-related quality of life (HRQoL) measures [23,24] and decreases in depression due to lumbar arthrodesis [7,18,25].

Spinal surgery also has several documented biophysical implications. Studies have noticed a decrease in paraspinal muscle volume [26] and cross-sectional area [27] with an increase in fatty infiltrations 12 months after lumbar arthrodesis [26]. This paraspinal atrophy was correlated with a significant increase in pathological spontaneous activity (indicating denervation) of the multifidus and erector spinae muscles on the electromyogram six months postoperatively [28]. Various studies described that paraspinal fatty infiltrations measured by Medical Resonance Imaging were related to a higher intensity and a longer duration of low back pain (LBP) [29,30]. At last, about 11% of the patients develop adjacent segment disease five years after arthrodesis [31,32].

On top of these psychological and biophysical factors, social factors are also known for their influence on outcomes after spinal arthrodesis [33,34]. For example, preoperative work status has an influence on postoperative disability. Patients without work or on sick leave compared to patients working had an increased risk of higher levels of disability at one year follow up. [33] A systematic review reported the influence of spinal surgery on work status. After spinal surgery, the rate of return to the same job was more than 80% within the first year. After minimally invasive surgery more patients returned to work compared to patients after open surgery techniques. Lumbar arthrodesis patients who returned to work had substantial recurrent sick leave or rehabilitation episodes. Moreover, the time to return to work was determined by the type of surgery, with a variation of return within three to six months. Lastly, patients with workers compensation and 'heavy labour' jobs showed to have a longer time to return to work. [34]

A way to describe potential predictors and/or outcome measures in a biopsychosocial context is by integrating the International Classification of Functioning, Disability and Health (ICF) framework. This biopsychosocial framework not only considers body functions, activity and participation of patients, but also takes environmental and personal components into account. [35] Categorisation of content and outcomes into ICF might be interesting not only because of the holistic view on a patient, but it is also useful for transparent communication about patients between different health care professionals in an international context.

An overview of predictors within ICF could give guidance to the development of a biopsychosocial orientated rehabilitation program following lumbar arthrodesis. Such a comprehensive perioperative rehabilitation program was recently suggested by a systematic review of Madera *et al* [36]. Although, this review did not classify outcomes according to ICF, findings of the literature were divided into several groups referring to the interventional variables like timing, duration and terminology. Madera *et al* [36] explored the need for

rehabilitation of morbidities related to lumbar spinal arthrodesis and how this influenced postoperative outcomes. Furthermore, the impact of psychosocial co-morbidities or psychosocial stressors (e.g. loss of income) on post-operative outcomes was reported. Their findings suggest that rehabilitation post lumbar arthrodesis is recommended, but a clear statement on how intervention should be integrated into a biopsychosocial approach was lacking and should be considered. [36]

Altogether, the aim of this study was to perform a systematic review to 1) describe the content of existing rehabilitation interventions in patients following (single or double level) lumbar arthrodesis into biopsychosocial categories, to 2) evaluate the efficacy of those rehabilitation interventions on function, activity, participation, extrinsic and intrinsic components (ICF) and to 3) report the quality of reporting in Randomized Controlled Trials (RCTs) and observational studies with respectively Consolidated Standards of Reporting Trials (CONSORT) and STrengthening the Reporting of Observational studies in Epidemiology (STROBE). We hypothesized that perioperative rehabilitation with a biopsychosocial approach has better postoperative outcomes in terms of ICF than standard physiotherapeutic care after lumbar arthrodesis.

Methods

This systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [37]. The review protocol was registered at PROSPERO (CRD42018083422).

The search strategy was in line with the Cochrane Back and Neck group guidelines [38]. For full search string, see Appendix 1. According to our research question(s) we defined following search terms: “lumbosacral region”, “lumbar vertebrae”, “spinal fusion”, “arthrodesis”, “rehabilitation”, “physical therapy modalities”, “exercise therapy”, “cognitive therapy”, “patient education as topic”, “health education” and “behavior therapy”.

The following electronic databases were used for retrieval of relevant articles: PubMed, Embase, Web of Science, Pedro and Cochrane. To identify ongoing research Clinicaltrials.gov was searched. This search was restricted for articles written in English or Dutch. There was no restriction for the year of publication.

RCTs, observational studies and case-control studies describing rehabilitation in a lumbar arthrodesis population aged above 16 years were included. The exclusion criteria were thoracic/cervical arthrodesis, > 2 lumbar levels fused in the majority of the sample, dynamic arthrodesis, preceding arthrodesis, arthrodesis after trauma and articles not reporting outcomes of interest.

Two independent reviewers (C.A. & H.B.) selected potentially eligible articles by title and abstract. Disagreement between reviewers was resolved by a third and fourth reviewer (L.J. & T.T). After obtaining full texts, inclusion was completed. To ensure a complete coverage of the literature, reference lists of the included articles and other articles of authors with several publications in this domain were manually searched. When full text was not available or not yet published, principal authors were contacted. Articles were excluded if we received no response or the obtained full text did not match the inclusion criteria. The last date of retrieving updated articles was April 3rd, 2018.

Using a predefined extraction form [Appendix 2] the same two reviewers extracted data from the included articles. This form was tested in advance on three articles to control for conformity of extraction and included details about participant characteristics, methodology, content of intervention and control, outcome measurement (biopsychosocial subdivision) and

results according to ICF. A third reviewer checked the accuracy of data extraction on selected articles. The primary outcomes of interest were on the one hand rehabilitation characteristics: timing, duration, content of intervention and individual versus group therapy. A subdivision of interventions was made into biological, psychological, social or combined interventions including biosocial, biopsychological, psychosocial and biopsychosocial interventions (Figure 1). Biological meant purely physio-anatomical interventions, psychological as given by any caregiver with cognitive-behavioural aspects and social ones with therapies focusing on the interaction between the patient and his environment [39]. Lastly, combined interventions were a mixture of those mentioned above. On the other hand, we made a distinction in advance between the diverse components of the ICF and divided outcome measures into this framework (Figure 2). Outcome measures about the effect of rehabilitation on function, activity, participation, extrinsic and intrinsic components based on the ICF framework were retrieved.

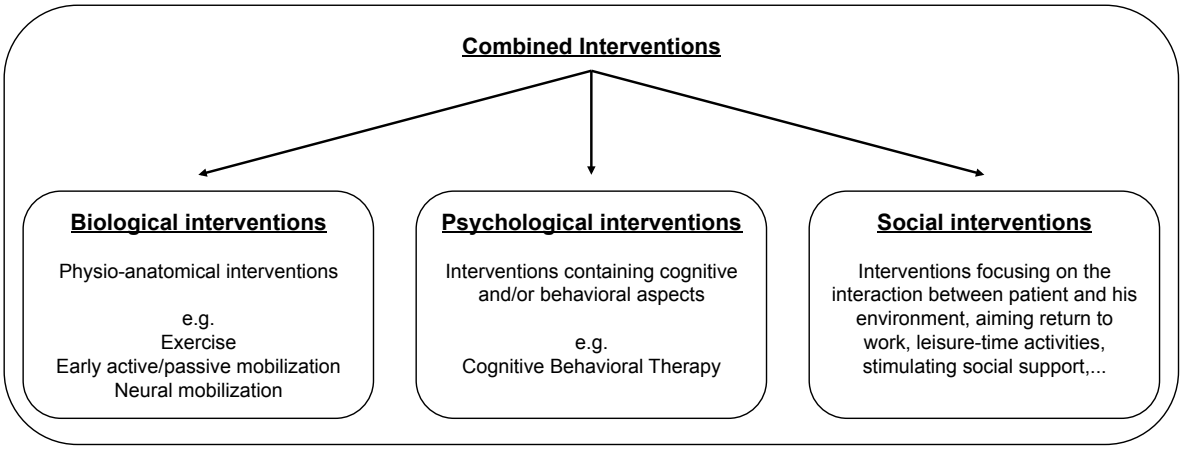
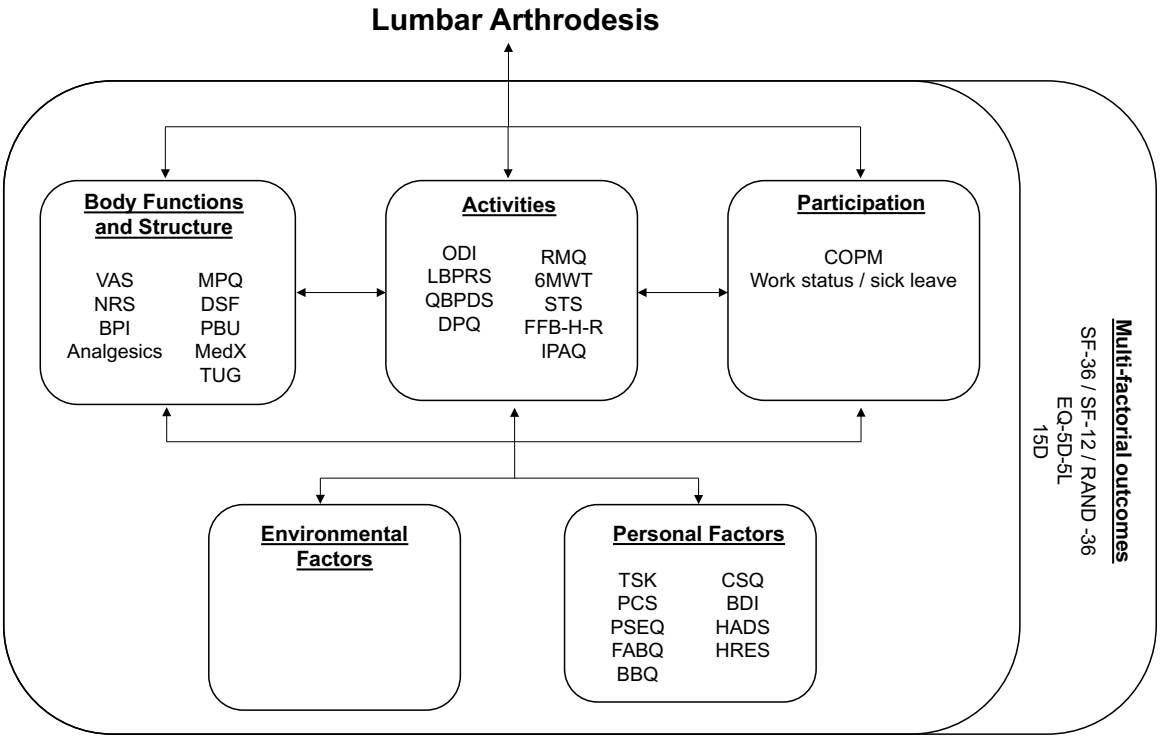


Fig. 1 Overview of interventions in a biopsychosocial context



VAS: Visual Analog Scale. NRS: Numeric Rating Scale. BPI: Brief Pain Inventory. MPQ: McGill Pain Questionnaire. DSF: German Pain Questionnaire. PBU: Pressure Biofeedback Unit. TUG: Timed Up and Go. ODI: Oswestry Disability Index. LBPRS: Low Back Pain Rating Scale. QBPDS: Quebec Back Pain Disability Scale. DPQ: Dallas Pain Questionnaire. RMQ: Roland Morris Questionnaire. 6MWT: 6 Minute Walking Test. STS: Sit To Stand. FFB-H-R: Funktionsfrageboden Hannover-Rücken. IPAQ: International Physical Activity Questionnaire. COPM: Canadian Occupational Performance Measure. TSK: Tampa Scale of Kinesiophobia. PCS: Pain Catastrophizing Scale. PSEQ: Pain Self-Efficacy Questionnaire. FABQ: Fear Avoidance Beliefs Questionnaire. BBQ: Back Beliefs Questionnaire. CSQ: Coping Strategies Questionnaire. BDI: Beck Depression Inventory. HADS: Hospital Anxiety and Depression Scale. HRES: Hopkins Rehabilitation Engagement rating Scale. SF-36/12: 36/12-item Short Form Health Survey. RAND-36: Research And Development – 36 Health Survey. EQ-5D-5L: EuroQoL 5 dimensions health related quality of life. 15D: 15 dimensions health related quality of life.

Fig. 2 Outcome measures based on the ICF framework

Lastly, the quality of reporting in RCTs and observational studies was evaluated with respectively CONSORT and STROBE [40,41]. Internal validity of individual studies was evaluated by the use of the Cochrane Collaboration tool for risk of bias (ROB) assessment supplemented with the criteria proposed by the Cochrane Back and Neck group [38,42]. Since results were subdivided in several categories, the assessment was done at the study level instead of outcome level to have a general overview on how bias might influence the results. The evaluation of selective reporting was used to determine ROB across studies. Non-randomized studies were not evaluated by the tool, since inherently coupled to the design the risk is already high.

Results

Study selection

The search of identified databases retrieved 1915 results. Additional data sources yielded inclusion of three other articles, which contains one unpublished article [Art 21]. After removing duplicates and irrelevant articles, 109 papers were screened based on title and abstract. This resulted in 79 articles potentially eligible for inclusion, which were reviewed based on full text. Lastly, 21 articles met the inclusion criteria and were implemented in the review (Figure 3). References of all the included studies are listed in Appendix 3.

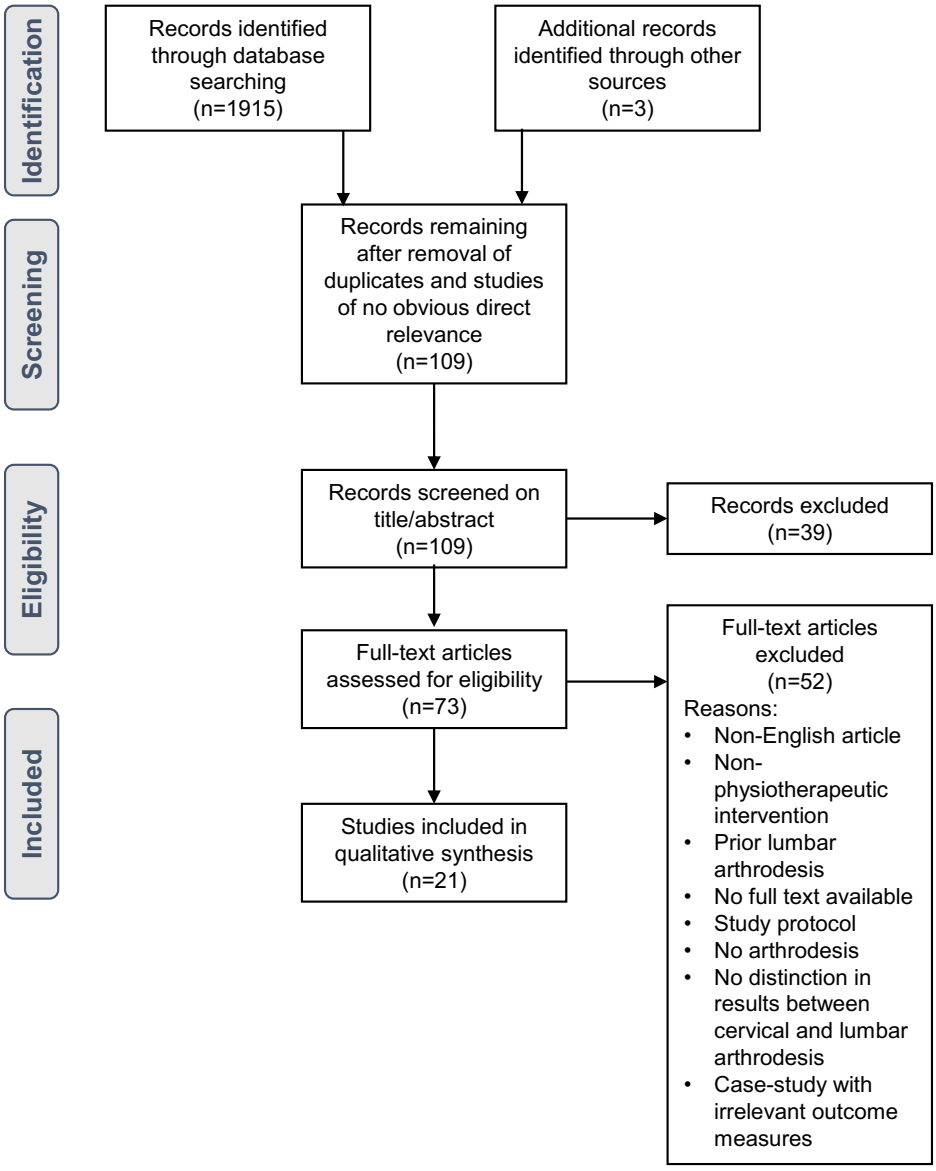


Fig. 3 Flow diagram of included studies (based on Moher et al [37])

Study characteristics

A total of 1743 participants were included in this review. There was variability in age range with a mean of 55. Most studies had a majority of female participants and the reported period of preoperative complaints was frequently more than six months. Pathologies, such as degenerative or isthmic spondylolisthesis and degenerative disc disease, were the common underlying indications for surgery. The most frequent performed surgical technique in terms of arthrodesis was posterolateral fusion. Notice that merely half of the studies described the used surgical techniques, which and how many lumbar levels were fused and the period of complaints before surgery (Tables 1-3). Details about the various interventions are found in Tables 4-10. These tables also present an overview of the content of usual care, which often involved early mobilisation, instructions for home exercise and/or an educational component. In studies containing cognitive behavioural therapy (CBT), a psychologist was responsible for this part of the intervention. However, in some combined interventions a physiotherapist trained in these techniques took care of the CBT aspect. An overview of outcome measures per study is represented in Appendix 4.

Quality of reporting studies

In general, the quality of reporting studies was low to moderate with a range of 7 to 26 items reported out of 37 (Tables 4,5). The most common missing information was allocation ratio, methods of randomisation and concealment, reasons for losses and exclusions after randomisation, subdivisions in primary and secondary outcomes and reporting of confidence intervals. Frequently, changes in trial methods or outcomes could not be retrieved because links to trial registry or full trial protocol were lacking.

Risk of bias

Linked to the abovementioned findings on the quality of reporting in the included studies, a certain proportion of unclear ROB was found in most of the criteria (Figure 4). Regarding selection bias, 11 studies reported a well randomized sequence generation but only six had sufficient methods of concealment. Often it was only stated that the selection was done in a randomized manner and the method of concealment was not explicitly mentioned which could lead to non-similar groupings. However, only three studies had a high ROB due to non-equal baseline variables possibly linked to one of the outcomes. Due to the specific nature of interventions, blinding of participants and personnel was impossible in the majority of studies.

Consequently, blinding of outcome assessment yielded a high ROB since most of the outcomes were patient-assessed. The timing of outcome assessment was similar in all studies. Concerning the similarities in therapies between the intervention and control groups, most studies reported that the experimental therapy was supplementary to usual care. Nevertheless, not all studies mentioned if patients did receive other treatments than those in the study and not every study controlled for the possible confounding effect of additional attention in the experimental group. Whether patients were compliant to the therapy was often unclear. In contrast to the compliance to therapy, the description of attrition rates and reasons was generally well done and balanced between groups. This criterion was rated unclear when no reasons or numbers were given. In relation to attrition, it was often unclear or insufficiently described which statistical analysis was performed to control for the biasing impact of missing values. Finally, a clear decision on selective reporting could not be made since no protocol or trial registration was retrievable for the majority of studies. Although the outcomes mentioned in methods were in accordance with those discussed in the results, this was not enough to make a strong conclusion. Moreover, some studies reported outcomes in such ways that they could not be used for meta-analysis. A ROB summary is presented in Table 6.

Outcomes of perioperative interventions on function and anatomy

Overall, in four studies there were no significant results in favour of the experimental group, but a reduction in pain after surgery was found in both control and experimental groups [Art 6, Art 14, Art 18, Art 19]. In addition, there was an association between change in LBP and change in kinesiophobia (r= 0.37) across the whole sample [Art 19].

Biological interventions

Interventions based on an exercise component resulted in greater reductions in pain [Art 6] and lower pain intensities [Art 10] compared to usual care. However, other studies containing exercises showed no significant differences in back and leg pain [Art 4, Art 18]. Back muscle stretching and lumbar stabilization led to higher extensor muscle strength [Art 6], whereas acupuncture compared to six weeks of bed rest showed a larger functional recovery rate up to twelve months [Art 1].

Psychological interventions

Analgesic consumption was lower on the second postoperative day after pre-operative CBT compared to without [Art 11]. On the contrary, no significant differences in analgesic use [Art

11] and pain [Art 2, Art 11] were found in other studies studying CBT. Finally, two perioperative CBT sessions compared to usual care led to significantly lower maximal pain intensities at six weeks [Art 14].

Combined interventions

Pain diminished more in a combined exercise and CBT program compared to exercise training alone up to six [Art 3] and twelve months [Art 8], in contrast to other studies which did not retrieve any differences at these time points [Art 12, Art 19]. Starting the intervention at twelve weeks showed greater reductions in back pain compared to starting at six weeks [Art 16]. Another significant finding in an observational study about a performance-based work conditioning program targeting physical condition and return to work was an increase in predicted one Repetition Maximum (1RM) for all subjects [Art 9].

Outcomes of perioperative interventions on activities

Disability [Art 8, Art 12], endurance of walking speed [Art 18] and subjective physical activity [Art 19] improved after surgery in control and experimental groups, both after psychological and biopsychological interventions [Art 8, Art 12, Art 18]. However, experimental interventions were not significantly more favourable.

Biological interventions

Compared to usual care there were no significant differences in disability following neural mobilisation and exercises for strength and flexibility of core and lower limb muscles [Art 13, Art 18].

Psychological interventions

Perioperative CBT led to a reduction in disability [Art 2, Art 14], which was significantly larger at six weeks compared to usual care [Art 14]. Also, after a Health Behavior Change Counselling (HBCC) program, ODI scores were more favourable [Art 20]. Preoperative CBT sessions made possible that more patients achieved independent walking, getting in and out of bed and rising from a chair on the second and third postoperative day [Art 11].

Combined interventions

A combination of exercise and CBT compared to six sessions of physiotherapy and exercise-based self-management advice had a greater reduction in disability from three to six months [Art 21]. Other similar interventions showed greater improvements in ODI scores even up to

one [Art 8] and three [Art 3] years postoperatively compared to an exercise group only. Starting rehabilitation at twelve weeks compared to starting at six weeks led to greater reductions in ODI and Dallas Pain Questionnaire (DPQ) for anxiety and depression at six months and for daily activities even up to twelve months [Art 16]. Other subscales of the DPQ were not significantly different between groups [Art 16]. Moreover, performance measured by six-minute walking test (6MWT) significantly improved in both timing groups [Art 17]. The 6MWT was inversely correlated with disability, back and leg pain [Art 17], but the same intervention did not retrieve significant group differences on back and leg pain [Art 16].

Outcomes of perioperative interventions on participation

Social interventions

The use of the Canadian Occupational Performance Measure's (COPM) semi structured interview retrieved more information about problems with Activities of Daily Living (ADL) related to work, education, self-care and household work at three months [Art 15].

Combined interventions

Christensen *et al* described a biopsychological intervention containing exercises and psychological support in a back café concept [Art 7]. After comparison with an exercise and a video group, the back café group showed less sick leave, resignations due to LBP and better daily function up to two years postoperative [Art 7]. Besides, a combined exercise and CBT program led to more employment and fewer sickness duration of longer than six months compared to an exercise group [Art 3]. Finally, patients after a work conditioning program targeting physical condition and return to work managed to reach higher levels of workload capacities [Art 9].

Outcomes of perioperative interventions on intrinsic components

Significant time effects on catastrophizing [Art 8] and kinesiophobia were found but a combination of exercises and CBT did not lead to more favourable outcomes [Art 8, Art 19]. Moreover, a high preoperative level of kinesiophobia was associated with a larger decrease in kinesiophobia three months postoperative (r= -0.62) [Art 19].

Biological interventions

An intervention containing preoperative home exercises with education and postoperative early mobilisation led to more satisfaction with overall treatment and outcome compared to a control group [Art 10]. On the other hand, general perceived effect was not significantly larger twelve months after active and passive neural tissue mobilisation [Art 13].

Psychological interventions

The trend towards decrease in fear avoidance beliefs found in a CBT group [Art 14] was confirmed with better results on fear avoidance beliefs at six months in the study of Rolving *et al* [Art 2]. At the same time point, they also reported larger effects of CBT on coping strategies [Art 2]. Regarding results on fear avoidance and coping at three and twelve months there were no significant group differences [Art 2]. Lastly, patient activation mediated the effect of HBCC on rehabilitation [Art 5].

Combined interventions

Postoperative exercise with CBT compared to without CBT led to larger improvements in kinesiophobia, self-efficacy and back beliefs up to three years. Besides, coping and the ability to decrease pain also improved up to one year [Art 3]. Another study confirmed the effects of a similar intervention on catastrophizing and kinesiophobia. Patients in this combined intervention group achieved a better general perceived effect. [Art 8] Moreover, there was a greater improvement in pain self-efficacy from three to six months [Art 21]. In the study about the back café concept, the back café and training groups as described above reported less influence of back and leg pain on status of emotional relationship [Art 7].

Outcomes of perioperative interventions on extrinsic components

The search strategy did not retrieve any results relating this subdivision.

Outcomes of perioperative interventions on multi-factorial outcomes

Biological interventions

A twelve-week during intervention based on back stretching and lumbar stabilization revealed higher scores on physical role functioning, bodily pain, general health perception, vitality and social functioning compared to usual care**.** In addition, this intervention led to an improvement of mental health at one year postoperative. Overall, physical health significantly improved in both groups but without differences between groups. [Art 6] Patients in the study of Nielsen *et al* reached milestones and discharge earlier [Art 10].

Psychological interventions

Rehabilitation engagement and participation over six months was higher after a HBCC intervention. Apparently, this was a significant mediator in the effect of HBCC on disability and pain catastrophizing at three and six months. Moreover, at these time points more patients in the intervention group experienced a Minimal Clinical Important Difference (MCID) in physical health. [Art 20]

Social interventions

COPM semi-structured interview retrieved a significant higher median number of treatment/rehabilitation goals and plans of action [Art 15].

Combined interventions

In two papers with a postoperative CBT and exercise intervention the effect on HRQoL at one year was significantly larger in favour of the intervention group [Art 3, Art 8]. However, Abbott *et al* retrieved no significant results on HRQoL in favour of the early rehabilitation group at 3, 6, 24 and 36 months [Art 3]. Positive time effects were found on physical functioning, role physical dimensions (RAND-36) [Art 12] and 36-item Short Form Health Survey (SF-36) [Art 8] over the whole sample. A twelve-month during intervention (starting at three months postoperative) showed a higher compliance to back specific exercises the first two months compared to the last two months [Art 10]. Lastly, need for external health care was lower after a combined intervention (42,9%) compared to an exercise intervention (64,4%) [Art 3].

Table 1 Demographic variables, part 1

Article	Sample size	Mean age experimental group (years)	Age range experimental group (years or SD)	Gender experimental group (male + female)	Surgical technique(s) & (number of patients)	N° of levels	Level of arthrodesis	Exclusively arthrodesis patients
Zhao *et al.* 2008 (Art 1)	69	52.3	25-69	19 (54%) + 16 (46%)	Intervertebral fusion	1 level	L3-4, L4-5, L5-S1	Y
Rolving *et al.* 2015 (Art 2)	96	51.4	SD = 9.2	23 (39%) + 36 (61%)	PLF, TLIF, uninstrumented fusion	1,2 & 3 levels	N/A	Y
Abbott *et al.* 2010 (Art 3)	107	50.3	SD = 10	18 (34%) + 35 (66%)	Transforaminal intervertebral fusion, posterolateral fusion	N/A	N/A	Y
Kang *et al.* 2012 (Art 4)	60	**ER**: 60.5 **EER**: 61.2 **SER**: 60.2	**ER**: SD = 9.7 **EER**: SD = 9.9 **SER**: SD = 11.4	**ER**: 11 (55%) + 9 (45%) **EER**: 11 (52%) + 10 (48%) **SER**: 9 (47%) + 10 (53%)	PLIF	N/A	N/A	Y
Skolasky *et al.* 2015 (Art 5)	122	N/A	N/A	N/A	Lumbar spine surgery	N/A	N/A	Y
Lee *et al.* 2017 (Art 6)	65	55	SD = 4.8	0 (0%) + 65 (100%)	PLIF	1 level (n=43), 2 levels (n=16)	Between L3-S1	Y
Christensen *et al.* 2003 (Art 7)	90	45	24-60	30 (33.3%) + 60 (66.7%)	Posterolateral spinal fusion (n=57) + 360 degrees fusion (n=33)	N/A	N/A	Y
Monticone *et al.* 2013 (Art 8)	130	58.75	SD = 11.81	21 (32%) + 44 (68%)	Lumbar fusion with or without decompression	N/A	N/A	Y

SD: standard deviation. Y: Yes, included patients all had an arthrodesis. N: No, some of the included patients had other surgical techniques. ER: exercise rehabilitation. EER: extension exercise rehabilitation. SER: lumbar stability exercise rehabilitation. PLIF: posterior lumbar interbody fusion. ALIF: anterior lumbar interbody fusion. TLIF: transforaminal lumbar interbody fusion. PLF: posterior lumbar fusion. n: number of patients. Max.: maximal.

Table 2 Demographic variables, part 2

Article	Sample size	Mean age experimental group (years)	Age range experimental group (years or SD)	Gender experimental group (male + female)	Surgical technique(s) & (number of patients)	N° of levels	Level of arthrodesis	Exclusively arthrodesis patients
Cole *et al.* 2009 (Art 9)	54	N/A	20-58	N/A	Lumbar fusion	Single & multiple levels	N/A	Y
Nielsen *et al.* 2010 (Art 10)	73	48	31-80	14 (39%) + 21 (61%)	Non-instrumented spondylodesis with or without decompression (n=80%) & small number instrumented fusion	Max. 2 levels	N/A	N
Rolving *et al.* 2016 (Art 11)	90	51.4	SD = 9.2	23 (39%) + 36 (61%)	PLF, TLIF, uninstrumented fusion	Max. 3 levels	N/A	Y
Ilves *et al.* 2016 (Art 12)	98	59	SD = 12	14 (29%) + 34 (71%)	PLIF + posterior or transforaminal interbody fusion (n=21%)	N/A	N/A	Y
Scrimshaw *et al.* 2001 (Art 13)	81	55	SD = 17	20 (57%) + 15 (43%)	Discectomy, laminectomy, fusion (PLIF, ALIF, posterior fusion)	N/A	N/A	N
Reichart *et al.* 2012 (Art 14)	40	59.36	32-81	8 (42%) + 11 (58%)	PLIF	1,2 & 3 levels	L2 - S1	Y

SD: standard deviation. Y: Yes, included patients all had an arthrodesis. N: No, some of the included patients had other surgical techniques. ER: exercise rehabilitation. EER: extension exercise rehabilitation. SER: lumbar stability exercise rehabilitation. PLIF: posterior lumbar interbody fusion. ALIF: anterior lumbar interbody fusion. TLIF: transforaminal lumbar interbody fusion. PLF: posterior lumbar fusion. n: number of patients. Max.: maximal.

Table 3 Demographic variables, part 3

Article	Sample size	Mean age experimental group (years)	Age range experimental group (years or SD)	Gender experimental group (male + female)	Surgical technique(s) & (number of patients)	N° of levels	Level of arthrodesis	Exclusively arthrodesis patients
Oestergaard *et al.* 2012 (Art 15)	87	54.5	N/A	14 (35%) + 26 (65%)	ALIF, PLF without instrumentation, PLF with instrumentation, TLIF, fusion and decompression	N/A	N/A	Y
Oestergaard *et al.* 2012 (Art 16)	92	52	SD = 8.5	21 (53%) + 20 (47%)	PLF, TLIF	1 & 2 levels	N/A	Y
Oestergaard *et al.* 2013 (Art 17)	92	52	SD = 8.5	21 (53%) + 20 (47%)	PLF, TLIF	1 & 2 levels	N/A	Y
Aalto *et al.* 2010 (Art 18)	102	62.8	N/A	21 (42%) + 29 (58%)	Open or microscopic decompression: additional disc excision (n=17), additional fusion (n=19)	N/A	L2 - L5	N
Ilves *et al.* 2017 (Art 19)	104	59	SD = 12	14 (29%) + 34 (71%)	PLIF + posterior interbody fusion (n=21%)	N/A	N/A	Y
Skolasky *et al.* 2015 (Art 20)	122	59.9	SD = 13.2	25 (39.7%) + 38 (60.3%)	Lumbar decompression and fusion procedures	N/A	N/A	N
Greenwood *et al.* 2018 (Art 21)	43	55.9	SD= 13.5	6 (24%) + 19 (76%)	Lumbar fusion surgery	1 level (n=17), 2 levels (n=6), 3 levels (n=1)	N/A	Y

SD: standard deviation. Y: Yes, included patients all had an arthrodesis. N: No, some of the included patients had other surgical techniques. ER: exercise rehabilitation. EER: extension exercise rehabilitation. SER: lumbar stability exercise rehabilitation. PLIF: posterior lumbar interbody fusion. ALIF: anterior lumbar interbody fusion. TLIF: transforaminal lumbar interbody fusion. PLF: posterior lumbar fusion. n: number of patients. Max.: maximal.

Table 4 CONSORT reporting of RCTs [40]

N° criterium	Zhao *et al.* 2008 (Art 1)	Rolving *et al.* 2015 (Art 2)	Abbott *et al.* 2010 (Art 3)	Kang *et al.* 2012 (Art 4)	Skolasky *et al.* 2015 (Art 5)	Lee *et al.* 2017 (Art 6)	Christensen *et al.* 2003 (Art 7)	Monticone *et al.* 2013 (Art 8)	Nielsen *et al.* 2010 (Art 10)	Rolving *et al.* 2016 (Art 11)	Ilves *et al.* 2016 (Art 12)	Scrimshaw *et al.* 2001 (Art 13)	Reichart *et al.* 2012 (Art 14)	Oestergaard *et al.* 2012 (Art 15)	Oestergaard *et al.* 2012 (Art 16)	Oestergaard *et al.* 2013 (Art 17)	Aalto *et al.* 2010 (Art 18)	Ilves *et al.* 2017 (Art 19)	Skolasky *et al.* 2015 (Art 20)	Greenwood *et al.* 2018 (Art 21)
1a	0	0	1	1	0	0	1	1	1	0	1	1	0	1	1	1	0	1	0	1
1b	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	NA
2a	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3a	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0
3b	0	0	0	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA
4a	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4b	0	0	1	0	0	1	0	1	0	1	1	1	1	1	1	1	1	1	0	1
5	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1
6a	0	1	1	0	0	1	0	1	0	1	0	1	0	1	1	0	1	0	1	0
6b	0	0	0	0	0	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7a	0	1	1	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0
7b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8a	0	1	1	1	0	0	0	1	1	1	1	1	1	0	0	0	0	1	0	1
8b	0	1	1	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	0	1
9	0	0	1	0	0	0	0	1	1	0	1	0	0	1	1	1	0	1	0	1
10	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0
11a	0	1	1	1	0	0	0	0	1	1	1	1	0	1	1	1	0	1	0	1
11b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA	NA	NA
12a	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12b	NA	1	NA	NA	0	NA	NA	NA	1	1	NA	NA	1	NA	1	1	1	1	1	NA
13a	0	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1
13b	0	1	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	1	0	1
14a	1	1	1	0	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
14b	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
15	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0	1	1	1
16	0	1	1	0	1	0	0	1	1	1	0	0	0	1	0	1	1	1	1	1
17a	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
17b	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	NA	0	NA	NA	NA	NA	NA	NA	NA	NA
18	NA	1	NA	NA	0	NA	0	NA	1	1	NA	NA	1	NA	1	1	1	1	1	NA
19	1	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	1	0	0
20	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21	0	1	0	0	0	0	0	1	0	1	1	1	0	1	1	0	0	1	0	1
22	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NA
24	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	NA
25	0	0	0	0	0	1	1	0	1	1	1	0	1	1	1	1	1	1	0	NA
Score on 37	7	23	20	9	11	13	14	23	22	25	24	23	15	18	23	22	19	26	14	19

1	criterium ok
0	critrium not ok
NA	Not applicable

Table 5 STROBE reporting of observational studies [41]

N° criterium	Cole *et al.* 2009 (Art 9)
1a	1
1b	1
2	1
3	1
4	1
5	1
6a	1
6b	0
7	NA
8	1
9	1
10	0
11	1
12a	1
12b	1
12c	0
12d	NA
12e	0
13a	0
13b	0
13c	0
14a	0
14b	0
14c	1
15	1
16a	0
16b	1
16c	0
17	1
18	1
19	1
20	1
21	1
22	1

1	criterium ok
0	critrium not ok
NA	Not applicable

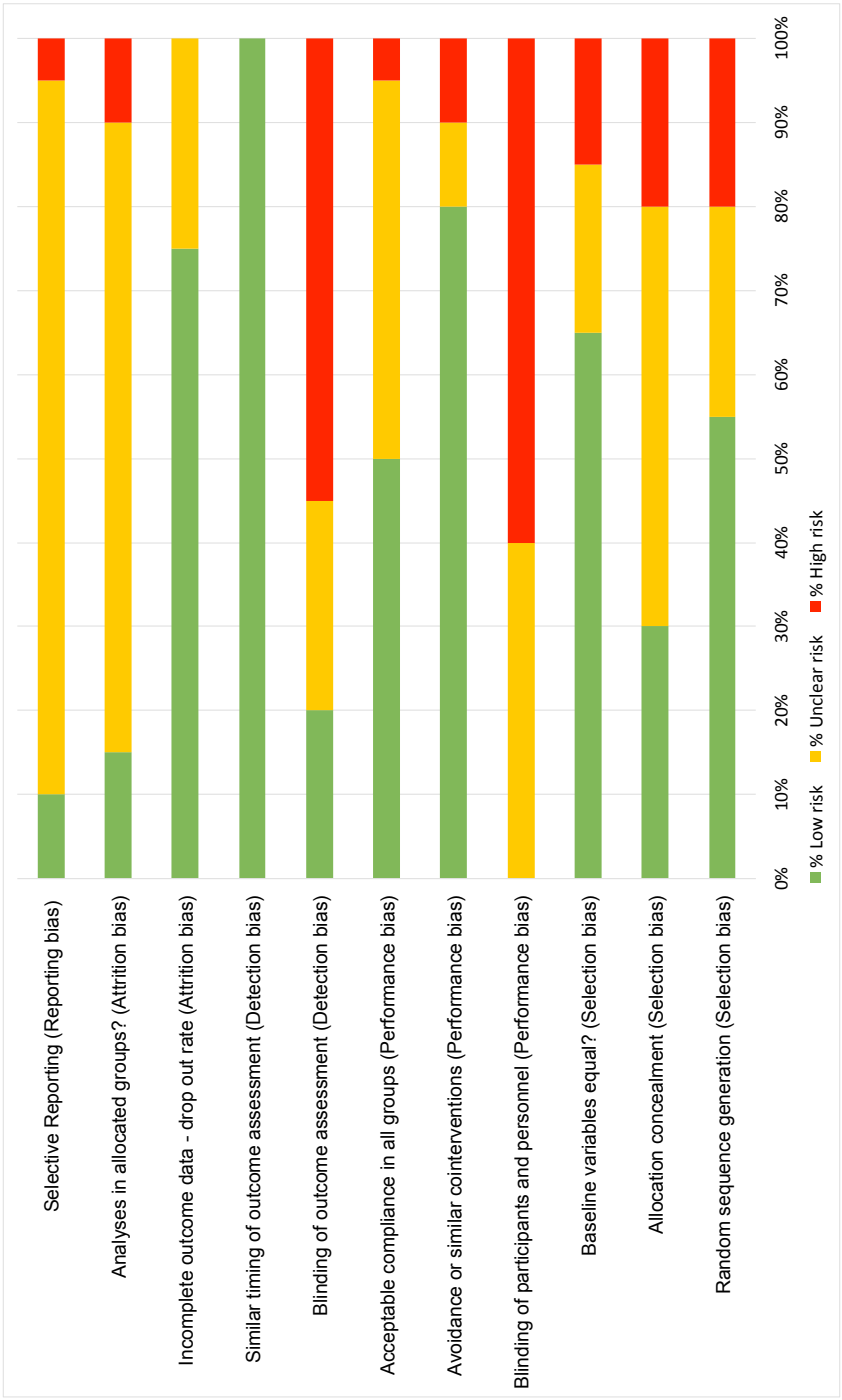


Fig. 4 Risk of bias

Table 6 Risk of bias summary

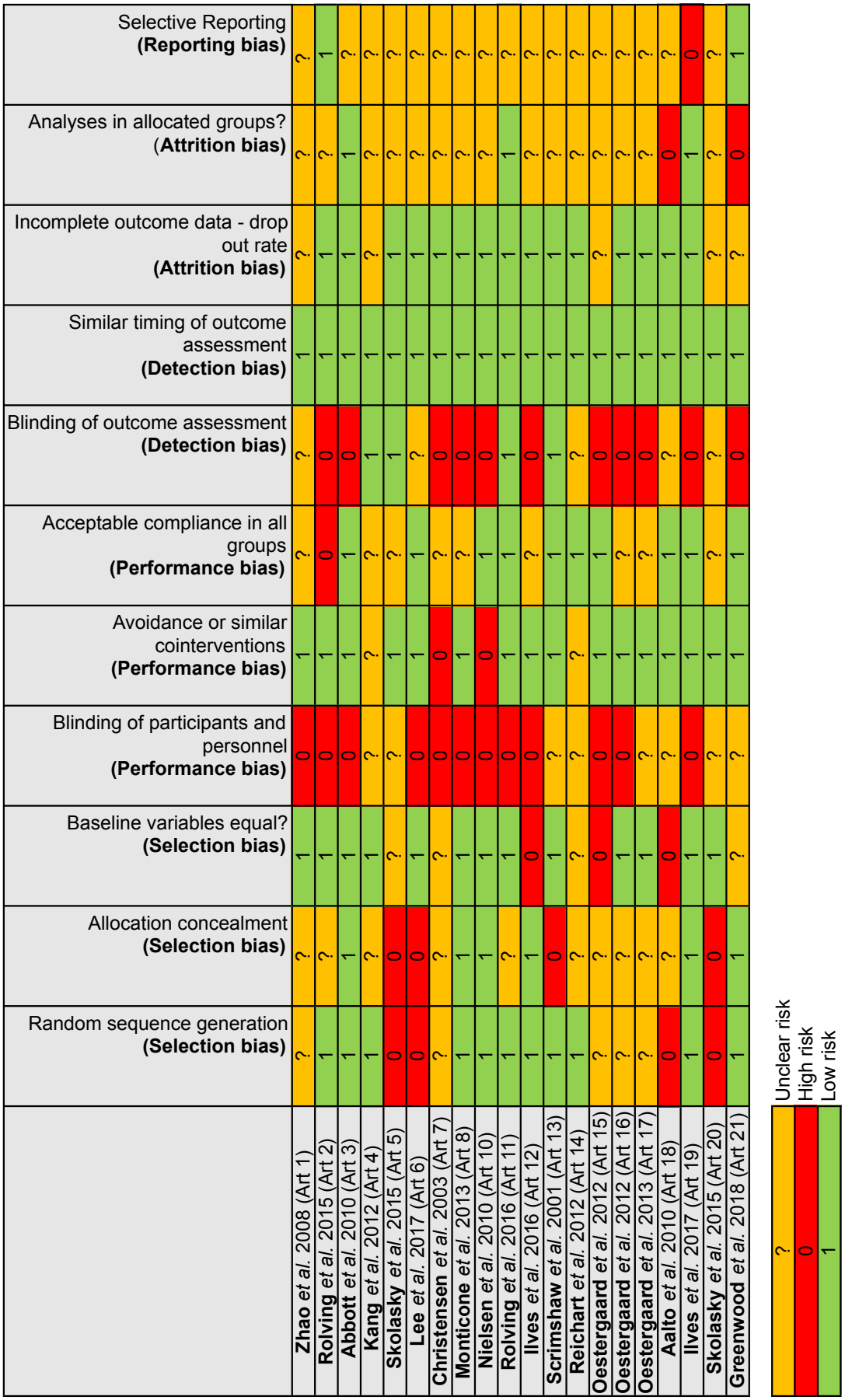


Table 7 Content of interventions

Type of intervention	Article	Content of intervention	Individual/ group therapy	Intervention setting	Starting time of intervention in relation to surgery	Frequency of intervention	Duration of 1 intervention	Total duration intervention	Follow-up	Therapists involved	Training therapist	Content usual care/control group
Biological	Zhao *et al.* 2008 (Art 1)	Electroacupuncture and cuppong	Individual	N/A	N/A	Min. 6 sessions	Electroacupuncture: 30 min/day. Cuppong: N/A	N/A	At 3, 6, 12 months	N/A	N/A	6 weeks of staying in bed.
	Kang *et al.* 2012 (Art 4)	Warming up / cooling down & **Exercise group**: William and McKenzie exercise program OR **Extension exercise group**: exercises using MedX device, McKenzie extension exercises OR **Lumbar stability exercise group**: transverse abdominis and multifidus co-contraction method	N/A	N/A	Min. 3 months postoperative	3 times/week	30 minutes	8 weeks	Pretest, at 8 weeks	3 physical therapists	N/A	N/A
	Lee *et al.* 2017 (Art 6)	Cardiovascular warming-up, stretching and lumbar stabilisation exercises.	N/A	At sports center of clinic	3 months postoperative	36 times/12weeks	60 minutes	36 hours	Before surgery & at 3, 6, 12 months	Physical therapist	N/A	No exercise prescription (continue usual exercise and physical activity without any restrictions).
	Nielsen *et al.* 2010 (Art 10)	**Preoperative**: home program focussing on back and abdomen muscle strengthening, cardiovascular conditioning. **Postoperative**: early mobilisation and similar exercises as preoperative.	N/A	Preoperative: at home. Postoperative: inpatient.	6 - 8 weeks preoperative	Preoperative: daily. Postopterative: 1st day once, following days 2 times/day.	30 minutes	Preoperative: 6-8 weeks. Postoperative: untill discharge (4-9 days)	At 1 day preoperative, 1st, 3th, 5th postoperative day, discharge, 1, 3, 6 months	Physiotherapist, anesthesiologist, nurse	N/A	Preoperative information e.g. about the postoperative rehabilitation (to all subjects*). Post-operative: mobilisation on day of surgery and once daily in the next 8 days.

N/A = not appliccable. *To all subjects: received by both intervention & control group. Min.: minimal. SLR: straight leg raise.

Table 8 Content of interventions

Type of intervention	Article	Content of intervention	Individual/ group therapy	Intervention setting	Starting time of intervention in relation to surgery	Frequency of intervention	Duration of 1 intervention	Total duration intervention	Follow-up	Therapists involved	Training therapist	Content usual care/control group
Biological	Scrimshaw *et al*. 2001 (Art 13)	Active and passive exercises to mobilize the neural tissues (e.g. SLR, passive/active neck flexion).	Individual	Inpatient & after discharge: at home.	1 day postoperative	Bed rest: 2 times/day. Once out of bed: 2 or 3 times/day. Neural mobilisations: 2 times/day. Therapist supervised 2 times/day.	N/A	During hospitalisation & after discharge ≥6 weeks	**Pain** (baseline, discharge, 6 weeks, 6 months, 12 months), **disability** (baseline, 6 weeks, 6 months, 12 months), **SLR** (before surgery, day 1 post-op, discharge, 6 weeks), **return to work** (6 weeks, 6 months, 12 months), **return to normal activities** (12 months)	Physiotherapist	N/A	Isometric and dynamic exercises for the lower limb and trunk (starting at day 1).
	Aalto *et al*. 2010 (Art 18)	Strengthening and stretching exercises for hip, thigh, abdominal and back muscles to maintain and improve muscle strength and endurance.	Group	Outpatient & at home	3 months postoperative	Supervised exercise training: 1x/week. Home exercises: strength training: 3-5x/week recommendation. Stretching: daily recommandation.	90 minutes	2 x 12 sessions/weeks until 24 months follow-up	At 3 months, 6, 12 and 24 months	Physiotherapist	Trained & experience in postoperative back patients	Preoperative information e.g. about the postoperative rehabilitation (to all subjects*), immediate postoperative mobilisation.

N/A = not appliccable. *To all subjects: received by both intervention & control group. Min.: minimal. SLR: straight leg raise.

Table 9 Content of interventions

Type of intervention	Article	Content of intervention	Individual/ group therapy	Intervention setting	Starting time of intervention in relation to surgery	Frequency of intervention	Duration of 1 intervention	Total duration intervention	Follow-up	Therapists involved	Training therapist	Content usual care/control group
Psychological	Rolving *et al.* 2015 (Art 2)	**CBT** covering following topics: interaction of cognition and pain perception, coping strategies, pacing principles. Sessions on ergonomic directions, return to work and details about the surgical procedure.	Group	N/A	Preoperative	Preoperative: 4 sessions. Postoperative: 2 sessions.	3 hours	18 hours	At baseline (ca. 42 days preoperative), 3, 6 months, 1 year	Physiotherapist, psychologist, occupational therapist, social worker, spine surgeon, previously operated patient	Trained (all health staff)	Preoperative information e.g. about the postoperative rehabilitation (to all subjects*), supervised exercise in groups or individually
	Skolasky *et al.* 2015 (Art 5)	**HBCC**: motivational interviewing to increase perception of importance of physical therapy or home exercise program and confidence to follow through on rehabilitation. Discussing progress, identifying barriers and facilitate commitment to engage in adaptive behavior.	Individual	At home	N/A	N/A	N/A	N/A	Before and after intervention	Trained interventionist (research staff)	Trained & experienced	30-minute telephone calls at 3 and 6 months about progress after surgery
	Rolving *et al.* 2016 (Art 11)	**CBT** covering following topics: interaction of cognition and pain perception, coping strategies, pacing principles. Sessions on ergonomic directions, return to work and details about the surgical procedure.	Group	Outpatient	Preoperative	4 sessions	3 hours	N/A	At day 1-4 postoperative	Physical therapist, nurse, psychologist, occupational therapist, spine surgeon, social worker, previously operated patient	Staff manual & meetings with primary investigator	Preoperative information e.g. about the postoperative rehabilitation (to all subjects*)

N/A = not applicable. *To all subjects: received by both intervention & control group. HBCC: Health Behaviour Change Counseling. CBT: cognitive-behavioural therapy

Table 10 Content of interventions

Type of intervention	Article	Content of intervention	Individual/ group therapy	Intervention setting	Starting time of intervention in relation to surgery	Frequency of intervention	Duration of 1 intervention	Total duration intervention	Follow-up	Therapists involved	Training therapist	Content usual care/control group
Psychological	Reichart *et al.* 2012 (Art 14)	Reducing fear avoidance and fear avoidance beliefs by fostering motivation based on the concept of **mental contrasting**, problem-solving and setting of resolutions. Setting of specific **implementation intentions** to closely define goals and ways of achieving them.	Individual	N/A	1 day preoperative	1st session after preoperative assessment, 2nd session whithin 2-4 days after neurosurgiscal procedure	± 30 minutes	1 hour	1 day preoperative & before intervention, 6 weeks after discharge	Psychologist	Trained in behavioral therapy	N/A
	Skolasky *et al.* 2015 (Art 20)	**HBCC**: motivational interviewing to increase perception of importance of physical therapy or home exercise program and confidence to follow through on rehabilitation. Discussing progress, identifying barriers and facilitate commitment to engage in adaptive behavior.	Individual	At home	Preoperative	1st session preoperative, 2nd: 3 months postoperative, 3th: 6 months postoperative	1st: 60 minutes, 2nd and 3th: 30 minutes	2 hours	Preoperative & at 3 months, 6 months	Trained interventionist (research staff)	N/A	30-minute telephone calls at 3 and 6 months about progress after surgery
Social	Oestergaard *et al.* 2012 (Art 15)	**Semi-structured interview** (COPM) as starting point for occupational therapy: rating importance of **ADL problems**, current performance and satisfaction. Rehabilitation strategies based on the identified problems. Multidisciplinary determination of joint course of action and include the goals in each domain.	Individual	Inpatient	1 day postoperative (as soon as possible)	N/A	N/A	N/A	At 1 week, 1 months, 3 months, 3 years post-discharge	Occupational therapist	N/A	Instruction in using aids and appliances for bath and dressing activities, guidance in connection with kitchen activities.

N/A = not appliccable. *To all subjects: received by both intervention & control group. HBCC: Health Behaviour Change Counseling. CBT: cognitive-behavioural therapy. ADL: Activities of Daily Living.

Table 11 Content of interventions

Type of intervention	Article	Content of intervention	Individual/ group therapy	Intervention setting	Starting time of intervention in relation to surgery	Frequency of intervention	Duration of 1 intervention	Total duration intervention	Follow-up	Therapists involved	Training therapist	Content usual care/control group
Biosocial	Cole *et al.* 2009 (Art 9)	Sports related work conditioning/hardening programme: resistance training, aerobic conditioning, flexibility, core stabilisation, intense functional strength training and **work specific type tasks.**	N/A	Outpatient	After completion of traditional physical therapy and physician referral	4-5 days/week	≥4 hours a day	≥ 4 weeks	At 1st week, last week	N/A	N/A	N/A
Biopsychosocial	Oestergaard *et al.* 2012 (Art 16)	**Home exercises** focussing on active stability training of the truncus and large muscle groups. Instructions on proper ergonomics and working posture in relation to experienced **ADL problems and return to work**. **Exchange of experiences** of pain and physical incapacity, problems and solutions in performing ADL, expressions of doubts, straight tips and psychological support	Group	Outpatient	6 weeks postoperative	N/A	2 hours	4 sessions	At baseline, 6 weeks, 3 months, 6 months, 12 months	Physiotherapist, occupational therapist	N/A	Starting intervention at 12 weeks (content: same as intervention group).
	Oestergaard *et al.* 2013 (Art 17)	**Home exercises** focussing on active stability training of the truncus and large muscle groups. Instructions on proper ergonomics and working posture in relation to experienced **ADL problems and return to work**. **Exchange of experiences** of pain and physical incapacity, problems and solutions in performing ADL, expressions of doubts, straight tips and psychological support	Group	Outpatient	6 weeks postoperative	Advise: 1 time/day; 2 x 10 repetitions per exercise	2 hours	4 sessions	At baseline, 3 months, 6 months, 12 months	Physiotherapist, occupational therapist, kindred spirits	Trained (to conduct the tests in conformity with the protocols)	Starting intervention at 12 weeks (content: same as intervention group).

NA = not appliccable. * to all subjects: intervention + control group. COPM: Canadian Occupational Performance Measure. ADL: Activities of Daily Living.

Table 12 Content of interventions

Type of intervention	Article	Content of intervention	Individual/ group therapy	Intervention setting	Starting time of intervention in relation to surgery	Frequency of intervention	Duration of 1 intervention	Total duration intervention	Follow-up	Therapists involved	Training therapist	Content usual care/control group
Biopsychological	Abbott *et al.* 2010 (Art 3)	Early mobilisation, cognitive behavioral therapy based upon Linton's early intervention program and lumbopelvic stabilization according to Richardson et al.	Individual & group	At home & outpatient	Exercise component: 1 day postoperative , CBT component: 3 weeks postoperative	3 sessions (at 3, 6, 9 weeks postoperative)	90 minutes	4 hours 30 minutes	Preoperative, at 3 months, 6 months, 12 months, 2 years, 3 years	3 physiotherapists	Trained & experienced	Respiratory and circulatory exercises, training of transfers, walking, and other activities of daily living, dynamic exercises (back, abdominal & leg muscles), stretches.
	Christensen *et al.* 2003 (Art 7)	**Video group**: video-recorded demonstration of exercises (dynamic muscular training to enhance endurance capabilities of the back/abdominal/leg muscle groups). **Café group**: same program as the video group combined with meetings with a physical therapist and other spinal fusion patients. **Training group**: supervised conditioning training, dynamic muscular endurance training (back/abdominal/leg muscles) and stretching.	**Video:** individual. **Café:** combined. **Training:** group.	**Video:** home. **Café:** home & outpatient. **Training:** outpatient.	3 months postoperative (within+ 1 week)	**Video:** N/A. **Café:** 3 times/8 weeks. **Training:** 2 times/8weeks	**Video**: N/A. **Café:**1.5 hours. **Training**: 1.5 hours.	8 weeks	At 3 months, 6 months, 12 months, 2 years	Physical therapist	N/A	N/A
	Monticone *et al.* 2013 (Art 8)	**Exercises** identic as control group. **CBT**: education on the fear-avoidance model and pain management, developping awareness of the problem and seeking a means of reacting to frightening thoughts, graded exposure to previously identified dangerous situations for transferring attention from a fear of movement to increasing their level of activity, motivation and goalsetting.	In- & outpatient	At a hospital	Postoperative (inpatient)	**CBT:** 2times/week. **Exercises**: 5times/week	**CBT**: 60 minutes. **Exercises:** 90 minutes	4 weeks	Before treatment, at 4 weeks post treatment, 12 months after discharge	4 physiotherapists, 2 physiatrists, 1 psychologist	Clinical experience & scienfitic knowledge	Active spinal mobilisation, strengthening exercises (deep spinal muscles), exercises for postural control, stretching (lower limb and back muscles), walking exercises, training in changing of positions.

NA = not appliccable. * to all subjects: intervention + control group. CBT: cognitive-behavioural therapy. Video: experimental group with video intervention. Café: experimental group with gathering at 'back café'. Training: experimental group with training sessions intervention.

Table 13 Content of interventions

Type of intervention	Article	Content of intervention	Individual/ group therapy	Intervention setting	Starting time of intervention in relation to surgery	Frequency of intervention	Duration of 1 intervention	Total duration intervention	Follow-up	Therapists involved	Training therapist	Content usual care/control group
Biopsychological	Ilves *et al.* 2016 (Art 12)	**Back specific and aerobic exercises** (improving coordination, muscle strength and physical activity). **Fear-avoidance counselling** (identifying barriers to physical activity, correction of harmful, irrational beliefs and fears towards activity, goalsetting).	Individual	Inpatient + home	3 months postoperative	**Home exercise:** not determined. **Booster sessions**: every second month.	N/A	12 months	At 3 months, 15 months, 27 months	Physiotherapist	N/A	1 session (3 months postoperative): instructions for home exercises endurance (abdominal, back & hip muscles) stretching & balance; 3 times/week.
	Ilves *et al.* 2017 (Art 19)	**Progressive back-specific exercises** (control, coordination, strength and endurance of back, abdominal, gluteal and thigh muscles) and **aerobic training** (walking sessions). **Fear-avoidance counselling** (identifying barriers to physical activity, correction of harmful, irrational beliefs and fears towards activity, goalsetting).	Individual	Outpatient + home	3 months postoperative	Booster physiotherapy sessions: 6 sessions every second month + advised to exercise at least 2-3 times a week. Walking training: ≥3 times/week	Physiotherapy session: N/A. Walking training: ≥25-30 minutes	12 months	Preoperative, at 3 months, 15 months	Physiotherapist	Skilled & experienced (scientific research & clinical practice)	1 session (3 months postoperative): instructions for home exercises endurance (abdominal, back & hip muscles) stretching & balance; 3 times/week.
	Greenwood *et al.* 2018 (Art 21)	**Home exercises** focussing on active stability training of the truncus and large muscle groups. Instructions on proper ergonomics and working posture in relation to experienced **ADL problems and return to work**. **Exchange of experiences** of pain and physical incapacity, problems and solutions in performing ADL, expressions of doubts, straight tips and psychological support	Group	Outpatient + home	3 months postoperative	1 time/week	Max. 90 minutes	10 weeks	Preoperative, at 3 months, 6 months, 12 months	Physiotherapists	Trained (logistical set up, overarching theoretical framework & common participant concern)	Physiotherapy and exercise-based self-management advice (6 sessions).

NA = not appliccable. * to all subjects: intervention + control group. CBT: cognitive-behavioural therapy. Video: experimental group with video intervention. Café: experimental group with gathering at 'back café'. Training: experimental group with training sessions intervention.

Discussion

This systematic review demonstrates that perioperative rehabilitation in patients following lumbar arthrodesis describes outcomes on most of the categories of the ICF with the exception of extrinsic components. In terms of 'function and anatomy' conflicting results were noticed regarding the effect on pain after biological, psychological and combined interventions. On the 'activity' component less disability was seen in both psychological and combined therapies. Effects on 'participation' included generally more return to work after combined interventions. Regarding the 'intrinsic' component, an overall trend of reductions in fear avoidance beliefs and catastrophizing was seen after psychological interventions. Otherwise, combined studies consistently reported significant improvements on kinesiophobia, self-efficacy, back beliefs and coping. Finally, an increase in HRQoL, seen as a multi-factorial finding, was mostly found in combined studies.

Several studies confirmed that after lumbar arthrodesis both the interventional and usual care groups had an overall trend of improvement in pain, kinesiophobia, disability and physical health in relation to quality of life. A part of this was in line with research stating that the majority of patients receiving lumbar arthrodesis experience improvement of pain, disability and HRQoL [7,8,23,24,28]. Although psychological and combined therapies decreased disability more than usual care they could not resolve it completely either. On top of enhancement in disability, these types of interventions led to better psychological outcomes like fear avoidance beliefs, catastrophizing, self-efficacy and coping. There could be a relation between intrinsic and activity components of the ICF since psychological factors were also found to be frequently interacting with arthrodesis outcomes like disability [9,17,18,20,25]. It is therefore possible that the CBT components in combination with exercise give the patients cognitive and physical tools, which improve their thoughts and (mental and physical) behaviour and consequently their disability.

Although preoperative depressive symptoms were linked to inferior results in disability, pain and physical health [18,20,25] none of the studies included in this systematic review reported on this outcome. Given that depression decreases after arthrodesis [7,18,25], it would be interesting to know if comprehensive therapies have an additional effect on depression and its linked worse outcomes. In other words, depression could be a non-studied confounder in the effects of current research. A recent systematic review found five factors related to depression and anxiety in spinal fusion, namely pain, disability, employment, psychological well-being and information [43]. These findings support our hypothesis that depression could

interact with outcomes of perioperative rehabilitation on all ICF domains. Moreover, education could play a central role in prevention of anxiety and depression [43]. Regarding the bodily function of pain, this review found conflicting results over all types of interventions which could be explained by differences in starting point. The only study that compared two different starting points showed significant larger improvements of pain when rehabilitation was initiated three months postoperative [17].

We cannot make conclusions about the most optimal starting point of rehabilitation or total duration of interventions because a lack of evidence comparing these aspects. Only one study investigated the effect of a mixed intervention containing CBT and exercise therapy starting at six weeks compared to twelve weeks following lumbar arthrodesis [17,18]. It revealed positive outcomes for the twelve-week group on pain and disability. Whereas, an RCT regarding early rehabilitation (starting at two weeks) in patients after microdiscectomy indicated better results on functionality compared to no rehabilitation [44]. Due to the difference in population, indications for surgery and surgical techniques we cannot compare these studies. However, such a study might indicate the influence of timing on postoperative outcomes.

Although some studies report preoperative interventions, these are always in combination with postoperative treatment. This made it difficult for this review to distinguish the possible effects of preoperative treatment alone. We found no evidence on preoperative sessions in biological interventions, whereas perioperative therapies had dominantly combined behavioural and exercise components. Moreover, most studies described multimodal interventions, which could be linked to the psychological predictors of surgery outcome [45]. Remarkably, these outcomes were measured with a variety of measuring instruments. According to the guideline for the assessment of functional outcome it is recommended to assess outcomes with reliable, valid and responsive outcome measures specific to the population of interest with consideration of the minimal clinically important difference (MCID) [46]. Unfortunately, merely half of the included studies [Art 2,3,8,11,13,15,16,18,20,21] took these guidelines into account and there was a discrepancy in mentioned MCID for similar outcome measures. Finally, other unreported characteristics were details about the levels of arthrodesis, i.e. how many and which levels, which might have an effect on multiple outcomes.

One of the strengths of our review is that it is the first to report results based on a classification of outcomes within the ICF framework. This is advantageous for transparent communication about treatment goals and corresponding effects across multiple health

disciplines. It also gives an overview of the complex interplay of different components, which leads to the overall outcome. Furthermore, this framework reveals in which ICF domains evidence is scarce. Another strength is the non-exclusion based upon quality of evidence, whereby we wanted to include the whole spectrum of physiotherapy interventions. It explains why our systematic review included over twenty articles, which is in contrast with the fewer articles retrieved by previous reviews [36,47,48].
A limitation is that the abundance of incorporated articles led to heterogeneity in interventions and outcome measures. A qualitative meta-analysis and grading of evidence was therefore impossible to perform.

From an economic point of view [49], clinical guidelines only recommend lumbar arthrodesis for the treatment of patients with chronic LBP, provided that patients are well selected [14,15,50]. As stated in the introduction, for LBP without neurological symptoms arthrodesis does not yield better results than an intensive rehabilitation incorporating CBT aspects. On the other hand, decompressive surgery for spinal stenosis with or without spondylolistheses leads to favourable results on the short term. [12] Arthrodesis in this population has no clear added value although some studies show positive effects [51]. In short, only severe progressive neurological deficits caused by stenosis with spondylolisthesis are clear indications for spinal surgery [52]. However, included studies did not compare the effects of perioperative rehabilitation in separate groups based on their indication for surgery. There's currently no evidence of economic advantages of perioperative rehabilitation after such lumbar arthrodesis. Nevertheless, research showed a trend towards faster return to work in patients after a daily home-training program compared to standard care [53]. Moreover, a trend towards lower costs and less primary health care use was seen at two year follow up in patients after behavioural and exercise therapies compared to patients who received instructions and a videotape for home-training [54]. In our opinion, cost-effectiveness expressed as Quality Adjusted Life Years (QALY's) should be researched to evaluate the (acceptable) societal expense for improvement of health after lumbar arthrodesis since this has not been reported so far. Furthermore, we hypothesize that perioperative rehabilitation is economically beneficial over no rehabilitation since there is a risk for failed back surgery syndrome and revision surgery [55,56]. These possible consequences were associated with a lower success rate [57] and therefore possibly coupled to a higher economic burden.

Future research should improve the methodological quality in order to limit ROB and consequently report their study according to guidelines, such as CONSORT and STROBE. Besides, the reported outcome measuring instruments should be valid and reliable with reference to MCID. Due to a lack of outcomes in the participation and extrinsic component of the ICF, we advise researchers to implement those outcomes, such as social support, in rehabilitation programs. Additionally, preoperative depressive symptoms should not only be investigated but also taken into account in the development of biopsychosocial rehabilitation. Within this comprehensive approach, it would be necessary to consider the timing and modalities of postoperative rehabilitation. It is recommended to explore the relevance of preoperative therapies by contrasting perioperative with postoperative interventions. Moreover, perioperative rehabilitation should be investigated among the different groups based on indication for surgery. Lastly, regarding common interest, cost-effectiveness expressed as QALY's should be researched to evaluate the (acceptable) societal expense for improvement of health after lumbar arthrodesis.

In general, based on this systematic review health care professionals are advised to use a multimodal rehabilitation approach, including both cognitive behavioural elements and exercise therapy. A well-trained physiotherapist with knowledge of CBT techniques can take care of the largest part of biopsychosocial rehabilitation. However, more specific or complex demands from the patient regarding return to work or psychosocial problems should be covered by a multidisciplinary team containing an occupational therapist, social worker and psychologist. Within this approach preoperative education and screening for psychological predictors is important to take into account.

Conclusion

While a wide range of intervention types and outcome measures is used through all studies, this systematic review found that interventions combining cognitive-behavioural and exercise therapy retrieved significant better results on most components of the ICF framework. These combined therapies showed less disability, more return to work, improvements on kinesiophobia, self-efficacy, back beliefs, coping and an increase in HRQoL compared to usual care. Quality of reporting was low to moderate, which resulted in a large proportion of unclear ROB. Future research should explore even more the timing and modalities of perioperative rehabilitation among the different groups based on indication for lumbar arthrodesis.

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Appendices

1. Full search strategy PubMed

#1 MeSH descriptor Rehabilitation explode all trees
#2 (rehabilitation* OR revalidation*):ti,ab
#3 MeSH descriptor Physical Therapy Modalities explode all trees
#4 (physical therapy modalit* OR physical therap* OR physical therapy technique* OR physiotherapy* OR kinesiotherapy* OR kinesitherap*):ti,ab
#5 MeSH descriptor Exercise Therapy explode all trees
#6 (exercise therap* OR rehabilitation exercise* OR remedial exercise* PR exercise treatment*):ti,ab
#7 MeSH descriptor Cognitive Therapy explode all trees
#8 (cognitive Therap* OR cognitive behaviour therap* OR cognitive psychotherapy* OR cognitive behavioural therap*):ti,ab
#9 MeSH descriptor Patient Education As Topic explode all trees
#10 (patient educat*):ti,ab
#11 MeSH descriptor Physical Education And Training explode all trees
#12 (physical educat*):ti,ab
#13 MeSH descriptor Health Education explode all trees
#14 (health educat* OR psychosocial rehabilitat* OR psychosocial therap*):ti,ab
#15 MeSH descriptor Behavior Therapy explode all trees
#16 (behaviour modificat* OR behaviour therap* OR behaviour treatment OR conditioning therap*):ti,ab
#17 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR 10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16)
#18 MeSH descriptor Lumbosacral Region explode all trees
#19 (lumbosacral region* OR lumbar region* OR lumbar OR lumbosacr*):ti,ab
#20 MeSH descriptor Lumbar Vertebrae explode all trees
#21 (lumbar vertebr* OR lumbar spine):ti,ab
#22 (#18 OR #19 OR #20 OR #21)
#23 MeSH descriptor Spinal Fusion explode all trees
#24 (spinal fusion* OR spondylodes* OR spondylosyndes* OR spine fusion* OR vertebral fusion*):ti,ab
#25 MeSH descriptor Athrodesis explode all trees

#26 (arthrodes* OR anterior lumbar interbody fusion* OR lateral lumbar interbody fusion* OR posterior lumbar interbody fusion* OR transforaminal lumbar interbody fusion* OR posterolateral lumbar interbody fusion* OR direct lateral lumbar interbody fusion* OR extreme lateral lumbar interbody fusion OR ALIF OR LLIF OR PLIF OR TLIF OR DLIF OR XLIF):ti,ab

#27 (#23 OR #24 OR #25 OR #26)

#28 (#22 AND #27)

#29 (#17 AND #28)

2. Extraction form

Data-extraction

Key to symbols / colours	
Not applicable	N/A
Yes, criterium fulfilled	Y
No, criterium not fulfilled	N
Intervention group	IG
Control group	CG

Population	Article n°
Description	
Inclusion criteria	
Exclusion criteria	
Participant flow / flowchart of patients included? Reasons for exclusion / non participating?	
Sample size + how determined (power?)	
N° of participants experimental/case group	
N° of participants control group	
Mean age experimental/case group	
Age range experimental/case group	
Surgical technique(s)	
Lumbar level(s)	
N° of levels	
Gender experimental/case group *[N° of male (%) + N° of female (%)]*	
Pathologies as reason for surgery	
Leg pain?	
Period of complaints before surgery	
Recruitment setting + period (dates of recruiting) + method of participant/case selection (non-RCT) + informed consent	
Exclusively arthrodesis patients?	
Randomisation? + type of + restrictions (ex. Blocking) + allocation concealment method mentioned? + Implementation of randomisation mentioned?	
Blinding? + who	

Intervention	**Article n°**
Description	
Hypothesis	
Aims	
Total duration of interventions + *[write down duration]*	
Frequency of interventions *(ex. X times/week)* *(describe per intervention type)*	
Duration of one intervention session (*describe per intervention type)*	
Start time of intervention in relation to surgery	
Follow-up *[duration + all follow-up moments]*	
Therapists involved	
IG/ Intervention described?	
Type of intervention *[bio / psycho / social / combined]*	
IG/ Content of intervention	
IG/ Individual / group- / combined therapy + mode of delivery (including materials)	
IG/ Intervention setting (inpatient / outpatient / home / healthcare provider / other)	
IG/ Other therapies allowed during intervention? (ex. Medication changes, other treatments,...) *+ describe*	
IG/ Training of therapist(s) prior to and/or during delivery of intervention? *+ describe training*	
CG/ Intervention described?	
Type of intervention *[bio / psycho / social / combined]*	
CG/ Content of intervention	
CG/ Individual / group- / combined therapy + mode of delivery (including materials)	
CG/ Intervention setting (inpatient / outpatient / home / healthcare provider / other)	
CG/ Other therapies allowed during intervention? (ex. Medication changes, other treatments,…)	
CG/ Training of therapist(s) prior to and/or during delivery of intervention? + describe training	

Methodology	**Article n°**
Description	
Trail design *[RCT / case-control / cohort / …]*	
Important changes after starting het trail?	
Demografic data?	
Baseline demographics equal?	
[Primary outcome measure(s) + measuring instrument + MCID] Are those explicit mentioned? + if y, describe / if n, note down	
[Secondary outcome measure(s) + measuring instrument + MCID] Are those explicit mentioned? + if y, describe	
Data handling (ex. Categories in continuous variables) + describe briefly	
Statistics used *[outcome measure + statistic + numbers exp./numbers control] If not per outcome measure described = unclear + note down list*	
Additional statistics described?	
Missing data / loss to follow up described? + statistics (ex. ITT)	
Sensitivity analysis?	

Results study	**Article n°**
Description	
Baseline values equal between groups?	
Changes to trail outcomes after commencement?	
N° of drop-outs experimental/case group + reasons why	
N° of drop-outs control group + reasons why	
Results on functioning level *[outcome measure + per timing of measurement: significant results with confidence interval + p-value + effect size]* *make a new [box] for each outcome measure*	
Results on activity level *[outcome measure + per timing of measurement: significant results with confidence interval + p-value + effect size]* *make a new [box] for each outcome measure*	
Results on participation level *[outcome measure + per timing of measurement: significant results with confidence interval + p-value + effect size]* *make a new [box] for each outcome measure*	
Results on environmental level [outcome measure + per timing of measurement: significant results with confidence interval + p-value + effect size] *make a new [box] for each outcome measure*	
Results on personal level [outcome measure + per timing of measurement: significant results with confidence interval + p-value + effect size] *make a new [box] for each outcome measure*	
Estimates of relative risk translated into absolute risk?	
Adverse events experimental/case group + *describe*	
Adverse events control group + *describe*	
Interim analysis or stopping guidelines?	
Potential bias?	
Conflict of interest?	
External validity described in discussion? + *few words*	

Additional notes	**Article n°**

3. References included studies

	Authors + Year of Publication + Title + Journal
Art 1	Zhao BX, Wang KZ, Zhao JX, et al (2008) Clinical effects of acupuncture after surgical operation in patients with prolapse of the lumbar intervertebral disc. (2008) J Trad Chin Med 28(4): 250-54.
Art 2	Rolving N, Nielsen CV, Christensen FB, et al (2015) Does a preoperative cognitive-behavioral intervention affect disability, pain behavior, pain and return to work the first year after lumbar spinal fusion surgery? Spine 40(9): 593-600.
Art 3	Abbott AD, Tyni-Lenné R, Hedlund R, et al (2010) Early rehabilitation targeting cognition, behavior and motor function after lumbar fusion: a randomized controlled trial. Spine 35(8):848-57.
Art 4	Kang H, Cho K, Shim S, et al (2012) Effects of exercise rehabilitation on pain, disability, and muscle strength after posterior lumbarinterbody fusion surgery - a randomized controlled trial. J Phys Ther Sci 24:1037-40.
Art 5	Skolasky RL, Maggard AM, Li D, et al (2015) Health Behavior Change Counseling in Surgery for Degenerative Lumbar Spinal Stenosis. Part II- Patient Activation Mediates the Effects of Health Behavior Change Counseling. Arch Phys Med Rehabil 96:1208-14.
Art 6	Lee CS, Kang KC, Chung SS, et al (2017) How does back muscle strength change after posterior lumbar interbody fusion? J Neurosurg Spine 26(2):163-70.
Art 7	Christensen FB, Laurberg I, Bünger CE, et al (2003) Importance of the back-café concept to rehabilitation after lumbar spinal fusion - a randomized clinical study with a 2-year follow-up. Spine 28 (23): 2561-69.
Art 8	Monticone M, Ferrante S, Teli M, et al (2014) Management of catastrophising and kinesiophobia improves rehabilitation after fusion for lumbar spondylolisthesis and stenosis. A randomised controlled trial. Eur Spine J 23(1):87-95.
Art 9	Cole K, Kruger M, Bates D, et al (2009) Physical demand levels in individuals completing a sports performance-based work conditioning/hardening program after lumbar fusion. The Spine Journal 9(1):39-46.
Art 10	Nielsen PE, Jørgensen DL, Dahl B, et al (2010) Prehabilitation and early rehabilitation after spinal surgery: randomized clinical trial. Clinical Rehabil 24(2): 137-48.
Art 11	Rolving N, Nielsen CV, Christensen FB, et al (2016) Preoperative cognitive-behavioural intervention improves in-hospital mobilisation and analgesic use for lumbar spinal fusion patients. BMC Musculoskelet Disord 17:217.
Art 12	Ilves O, Häkkinen A, Dekker J, et al (2017) Quality of life and disability: can they be improved by active postoperative rehabilitation after spinal fusion surgery in patients with spondylolisthesis? A randomised controlled trial with 12-month follow-up. Eur Spine J 26 (3):777-84.
Art 13	Scrimshaw SV, Maher CG (2001) Randomized controlled trial of neural mobilization after spinal surgery. Spine 26(24);2647-52.
Art 14	Reichart R, Vogel I, Weiss T, et al (2012) Short Psychological Intervention as a Perioperative Pain Reduction Treatment in Spinal Neurosurgery. J Neurol Surg A Cent Eur Neurosurg 73(6):387–96.
Art 15	Oestergaard LG, Maribo T, Bünger CE, et al (2012) The Canadian Occupational Performance Measure's semi-structured interview: its applicability to lumbar spinal fusion patients. A prospective randomized clinical study. Eur Spine J 21(1):115–21.
Art 16	Oestergaard LG, Nielsen CV, Bünger CE, et al (2012) The effect of early initiation of rehabilitation after lumbar spinal fusion: a randomized clinical study. Spine 37(21):1803–9.
Art 17	Oestergaard LG, Nielsen CV, Bünger CE, et al (2013) The effect of timing of rehabilitation on physical performance after lumbar spinal fusion: a randomized clinical study. Eur Spine J 22(8):1884–90.
Art 18	Aalto TJ, Leinonen V, Herno A, et al (2011) Postoperative rehabilitation does not improve functional outcome in lumbar spinal stenosis: a prospective study with 2-year postoperative follow-up. Eur Spine J 20(8):1331–40.
Art 19	Ilves O, Häkkinen Ä, Dekker J, et al (2017) Effectiveness of postoperative home-exercise compared with usual care on kinesiophobia and physical activity in spondylolisthesis: A Randomized Controlled Trial. J Rehabil Med 49(9):751-57.
Art 20	Skolasky RL, Maggard AM, Li D, et al (2015) Health behavior change counseling in surgery for degenerative lumbar spinal stenosis. part I: improvement in rehabilitation engagement and functional outcomes. Arch Phys Med Rehabil 96(7):1200-7.
Art 21	Greenwood J (2018) Rehabilitation following lumbar fusion surgery (REFS): a randomised controlled feasibility study. (Preliminary data).

4. Overview of outcome measures per study

Type of intervention	Article n°	Outcome measures	MCID mentioned
Biological	Art 1	Japanese orthopaedic association, formula for functional recovery rate	
	Art 4	ODI, VAS, PBU, MedX	
	Art 6	SF-36, VAS, MedX	
	Art 10	BPI, STS, TUG, EQ-5D, RMQ	
	Art 13	QBPDS, VAS, MPQ (pain rating)	QBPDS: 20 units, VAS: 20mm, MPQ: 10 units
	Art 18	ODI, VAS, NRS, BDI	ODI: 12 points
Biopsychological	Art 3	TSK, PSEQ, ODI, EQ-5D, SF-36, VAS, BBQ, CSQ	ODI: 10 units
	Art 7	LBPRS	
	Art 8	TSK, PCS, ODI, SF-36, NRS	ODI: 10 units, NRS: 2 points
	Art 12	ODI, RAND-36, VAS	
	Art 19	TSK, VAS, IPAQ	
	Art 21	PSEQ, ODI, STS, 6MWT, EQ-5D, HADS	ODI: 10%
Biopsychosocial	Art 16	ODI, DPQ, LBPRS	ODI: 15 points
	Art 17	ODI, DPQ, LBPRS, NRS, 6MWT, Astrand Fitness Test	
Biosocial	Art 9	"occasional" lifting descriptors	
Psychological	Art 2	ODI, LBPRS, FABQ, CSQ-CAT	ODI: 15 points
	Art 5	Patient activation measure, HRES	
	Art 11	NRS, Cumulated ambulation score	NRS: 2 points
	Art 14	DSF, FFB-H-R, FABQ	
	Art 20	ODI, SF-12-v2, HRES	ODI: 10 units, PCS* & MCS 5 points
Social	Art 15	DPQ, COPM	DPQ: 15

ODI: Oswestry Disability Inventory. VAS: Visual Analogue Scale. PBU: Pressure Biofeedback Unit. SF-36: 36-item Short Form Health Survey. BPI: Brief Pain Inventory. STS: Sit To Stand. TUG: Timed Up and Go. EQ-5D: EuroQol 5 dimensions health related quality of life. RMQ: Roland Morris Questionnaire. QBPDS: Quebec Back Pain Disability Scale. MPQ: McGill Pain Questionnaire. NRS: Numeric Rating Scale. BDI: Beck Depression Inventory. TSK: Tampa Scale for Kinesiophobia. PSEQ: Pain Self Efficacy Questionnaire. BBQ: Back Beliefs Questionnaire. CSQ: Coping Strategies Questionnaire. LBPRS: Low Back Pain Rating Scale. RAND-36: Research And Development - 36 Health Survey. IPAQ: International Physical Activity Questionnaire. PCS: Pain Catastrophizing Scale. 6MWT: 6 Minutes Walking Test. HADS: Hospital Anxiety and Depression Scale. DPQ: Dallas Pain Questionnaire. DSF: German Pain Questionnaire. FFB-H-R: Funktionsfrageboden Hannover-Rücken. FABQ: Fear Avoidance Beliefs Questionnaire. CSQ-CAT: Coping Strategies Questionnaire Catastrophizing subscale. HRES: Hopkins Rehabilitation Engagement Rating Scale. SF-12: 12 item Short Form Health Survey. COPM: Canadian Occupational Performance Measure.

Scales or questionnaires
Patient satisfaction, general perceived effect, pedometer, inclinometer, return to work, sick leave, analgesic use, nature of social status and psychological capacity, milestones in physical performance, exercise compliance, length of hospitalization, attendance

5. Populaire samenvatting

Ongeveer 80% van de bevolking wordt ooit in het leven geconfronteerd met lage rugpijn, wat één van de voornaamste redenen van beperking in onze maatschappij is. De impact op het welzijn en de functionaliteit van de patiënt weerspiegelt zich ook op maatschappelijk vlak door de verminderde werkbijdrage en hoge medische kosten. Zowel kinesitherapie als chirurgie tonen positieve resultaten, maar in de huidige literatuur is er nog discussie over de meest geschikte behandeling. Een ingreep die de laatste 20 jaar steeds meer werd toegepast, is lumbale arthrodese. Dit houdt in dat men wervels in de onderrug gaat verbinden met behulp van chirurgisch materiaal zoals titanium schroeven en plaatjes. Dergelijke ingreep is permanent, enkel in geval van ernstige complicaties wordt het materiaal weer verwijderd.

Gezien zo'n ingreep behoorlijk ingrijpend is, is het vanzelfsprekend dat deze een effect heeft op het lichaam met onder andere spierschade, verminderde spierkracht en stijfheid als gevolg. Bovendien heeft het ook een impact op het welzijn van de patiënt. Meerdere onderzoeken tonen aan dat er na operatie een verbetering is in pijn, beperking en kwaliteit van leven, maar deze blijven toch bij 15 tot 40% van de patiënten postoperatief aanwezig. Om de resultaten na chirurgie te optimaliseren, kan gekeken worden naar predictoren, factoren die de uitkomsten voorspellen. Enkele voorbeelden hiervan zijn roken, depressie, bewegingsangst, omgang met de situatie en ziekteverzuim. Deze zouden in rekening gebracht kunnen worden bij het ontwikkelen van een revalidatieprogramma. Om die reden hebben we gekeken op welke manier dit reeds gebeurd is in bestaand onderzoek en wat het effect op uitkomstmaten is.

Het doel van deze systematische literatuurstudie is het beschrijven van de inhoud van revalidatie volgens biopsychosociale categorieën bij patiënten met een lumbale arthrodese en het evalueren van hun efficiëntie binnen de verschillende componenten van het ICF-classificatiesysteem. Twee onafhankelijke reviewers zochten via zes verschillende elektronische databanken naar relevante artikels. Twijfelgevallen werden besproken met een derde en vierde reviewer. Met behulp van een vooraf bepaalde tabel werd relevante informatie in verband met de patiënten-kenmerken, inhoud van revalidatie, uitkomstmaten en resultaten geëxtraheerd. Kinesitherapeutische behandelingen werden onderverdeeld volgens biologische, psychologische, sociale of gecombineerde interventies en het ICF-classificatiesysteem werd gebruikt om de uitkomstmaten te beschrijven. We maakten ook een inschatting of de resultaten vertekend konden zijn door methodologie van onvoldoende kwaliteit (risk of bias).

We merkten op dat er verschillende types van kinesitherapeutische interventies en meetschalen beschreven werden en bovendien vonden we dat een combinatie van cognitief gedragsmatige- en oefentherapie een positief resultaat toonde in de meeste componenten van het ICF. Deze gecombineerde therapieën leidden tot minder beperking, meer werkhervatting, verbetering van bewegingsangst, self-efficacy, omgaan met de situatie en een toename in kwaliteit van leven in vergelijking met patiënten die de normale zorg ontvingen.

Verder onderzoek naar het startmoment, de totale duur en frequentie van de therapie alsnog het betrekken van predictoren zoals depressie en het nut van preoperatieve interventies is aangeraden.

6. Akkoord ethische commissie

Betreft uw aanvraag Ethische begeleiding masterproeven met titel "Ontwikkeling van een perioperatief revalidatiepad bij lumbaal single level fusion" (mp17041)

English version below

Geachte Heer/Mevrouw

De Opleidingspecifieke Ethische Begeleidingscommissie van de opleiding "Master in de revalidatiewetenschappen en de kinesitherapie (Leuven e.a.)" heeft uw voorstel tot Masterproef "Ontwikkeling van een perioperatief revalidatiepad bij lumbaal single level fusion" onderzocht en gunstig geadviseerd. Dit betekent dat de commissie van oordeel is dat de studie, zoals beschreven in het protocol, wetenschappelijk relevant en ethisch verantwoord is. Dit gunstig advies van de commissie houdt niet in dat zij de verantwoordelijkheid voor de geplande studie op zich neemt. U blijft hiervoor zelf verantwoordelijk. Indien u van plan bent uw masterproef te publiceren kan deze e-mail dienen als bewijs van goedkeuring.

Dear Mr/Ms

The Supervisory Committee on Medical ethics of the "Master in de revalidatiewetenschappen en de kinesitherapie (Leuven e.a.)" programme has reviewed your master's thesis project proposal "Ontwikkeling van een perioperatief revalidatiepad bij lumbaal single level fusion" and advises in its favour. This means that the committee has acknowledged that your project, as described in the protocol, is scientifically relevant and in line with prevailing ethical standards. This favourable advice does not entail the committee's responsibility for the planned project, however. You remain solely responsible. If you intend to publish your master's thesis, this e-mail may be used as proof of the committee's consent.

Met vriendelijke groeten

Opleidingsspecifieke begeleidingscommissie van de opleiding Master in de revalidatiewetenschappen en de kinesitherapie (Leuven e.a.)

	Reg. nr.	Titel van de studie	Status	Beheer
	mp17041	Ontwikkeling van een perioperatief revalidatiepad bij lumbaal single level fusion **Student(en):** Charlotte Amerijckx, Helena Boonen **Promotor:** Wim Dankaerts	Gunstig advies van OBC	

7. Guidelines for authors

Hyperlink to the Guidelines for authors – European Spine Journal

https://www.springer.com/medicine/orthopedics/journal/586?print_view=true&detailsPage=pltci_2257232