Work capacity of patients with chronic musculoskeletal pain

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of patients with chronic musculoskeletal pain

Sandra Lakke

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Contents

General Introduction

Background

Musculoskeletal Pain

Non-specific musculoskeletal pain, such as low back pain and neck pain, is defined as musculoskeletal system pain not attributed to recognizable, known specific pathology (e.g., infection, tumor, osteoporosis, ankylosing spondylitis, fracture, inflammatory process, radicular syndrome, and cauda equina syndrome) and named musculoskeletal pain in this thesis.[1]

The one year prevalence of musculoskeletal pain in a Dutch population above 25 years of age is 31.4 % for neck pain, 43.9 % for low back pain, 23.2 % for elbow-hand pain, and 28.0 % for hip-knee pain.[2] The lifetime prevalence of low back pain is 84 %.[3] Due to this high prevalence, musculoskeletal pain can be regarded as a common health problem.[4] Most people experiencing musculoskeletal pain are able to be gainfully employed, while others with musculoskeletal pain are limited in executing work activities.[5] In the Netherlands, 10% of the working population between 15 and 64 years old experience limitations in performing or finding work due to musculoskeletal pain, resulting in musculoskeletal pain being the number one causal reason for restricted participation at work, which places a significant financial burden on society.[2,6]

In order to reduce the individual and societal burden, we must be aware of the risk and prognostic factors. There are two types of causal factors for musculoskeletal pain. The transition from healthy to acute musculoskeletal pain can be explained by risk factors, and prognostic factors are responsible for the transition from acute to chronic pain that exists for more than 3 months. Risk and prognostic factors were studied in cohorts of healthy persons and patients with musculoskeletal pain. Psychosocial factors are believed to be important risk and prognostic factors, however, an overview of results from previous literature is nonexistent, making it difficult for health care providers to give evidence based recommendations.[7]

Work Capacity

Work capacity is defined as the highest probable level of functioning that a person may reach at a given moment in a standardized environment. In patients with musculoskeletal pain who experience limitations in executing work activities, work capacity can be measured by means of functional capacity tests.[8] Functional capacity tests are standardized performance based functional measurements that are employed to evaluate the work capacity in patients with musculoskeletal pain.[8] The theoretical basis of functional capacity measures is that physical capacity components fit the physical components of a job.[9]

Reduction of work capacity can be attributed to several models. The traditional medical model of sickness, impairment and disability postulates a direct causal pathway from musculoskeletal pain to impairment, limitations in activity, and to restriction in participation.[10] According to this medical model the medical diagnosis labels the underlying causal impairment.[4] Treatment was aimed at applying therapy in order to recover the body function.[4] Previous literature indicated that, in patients with chronic musculoskeletal pain, the substantiation of causal relationships between the severity of musculoskeletal pain, impairment and activity limitations is not evident.[11] The alternative social model of disability stated that social factors including adjustments at work, societal attitudes, and expectations are causal factors for work capacity.[4] Each of the two latter models struggled with their individual paradigms and were followed by the bio-psychosocial model of George Engel.[12] Engel hypothesized that physical, mental, and social factors play a role in human functioning.[12,13] Functioning is currently regarded as a multidimensional concept. However, knowledge of the amount of influence of the specific multidimensional factors is not evident.

Conceptual framework of this thesis

The conceptual framework of this thesis is the International Classification of Functioning, Disability and Health (ICF).[14] The ICF classifies several facets of functioning based on the bio-psychosocial model and offers a conceptual framework and common language to describe human functioning (*Fig. 1*).[14] Functioning is subdivided into body functions and body structures as well as activities and participation. Functional capacity can be classified in the ICF activity and participation domain. Functioning can be limited or facilitated by both environmental factors and personal factors; however, personal factors are not yet classified in the ICF. In this thesis, personal factors are divided into psychological factors, such as beliefs or expectations, and physical factors, such as age and gender.

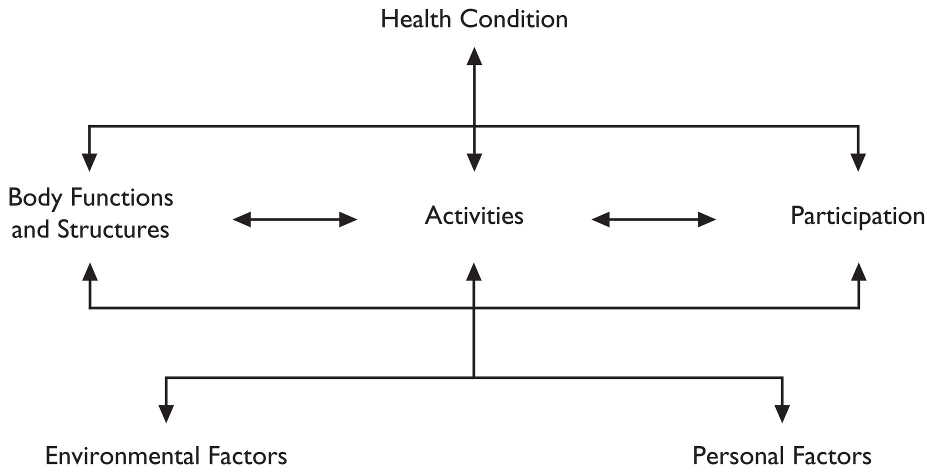

Fig. 1 *International Classification of Functioning, Disability and Health [14]*

Measuring work capacity

Measuring the capacity to work of patients with musculoskeletal pain is challenging. It is not clear which factors are related to work capacity. Insurance physicians considered it of major significance to take the 'body functions and structures' ICF components into account when assessing work capacity and the personal and environmental factors as less important.[15] In patients with musculoskeletal pain, information regarding the perceived amount of pain, musculoskeletal pain specific functional status, and presenteeism or absenteeism is currently aggregated through the employment of questionnaires.[16,17] In patients with chronic musculoskeletal pain, one of the aims of treatment is to remain working or return to work. Objective functional capacity measures may be useful for the assessment of physical work ability, advice on returning to work, and disability claim assessments.[18,19] Functional capacity test results increase the predictive validity of self-reported work ability for predicting sustained return to work from 9 to 16 percent.[17] The variability in functional capacity test results might be caused by patient-specific bio-psychosocial factors.[20] For patients experiencing chronic musculoskeletal pain, numerous studies were performed into bio-psychosocial related factors to pain, but little research was conducted into related factors to work capacity. If we could ascertain the bio-psychosocial factors that might influence functional capacity, we might be able to combine these factors to the predictable factors for functional capacity. Functional capacity requires further research to develop the construct validity in order to be able eventually to recommend health care providers involved in the return-to-work decision.[9]

Construct validity of functional capacity tests

Although the face validity is based on the physical work demands as described in the Dictionary of Occupation Titles (DOT), work related self-report questionnaires diverge from objective functional capacity measurements, the test-retest reliability of functional capacity is acceptable in patients with low back pain, and normative values per DOT category have been described in a healthy population, the construct validity of the functional capacity test is not fully unraveled yet.[19-22] Previously, functional capacity was perceived as a sum of physical factors such as muscle strength, aerobe capacity, and force angles.[9] Following the bio-psychosocial shift, functional capacity test results were then considered as tests that also express mental and social well-being.[9,11,23] Several models describe the bio-psychosocial relationship with functional capacity. The fear avoidance model describes that catastrophizing about pain causes development of chronic musculoskeletal pain through fear of movements and activity avoidance.[24] The theory of planned behavior explains behavior such as work capacity.[25] Karasek's workload capacity and workload ability model explains the influence of social factors on work capacity.[26] Studies into the integration of physical, psychological, and social factors such as the attitude of the health care provider are nonexistent. Thus, construct validity needs to be studied.

Clinical practice

Health care providers need an overview of ICF categories that are relevant to musculoskeletal pain or rehabilitation. To meet this demand, several core sets have been developed to describe the functioning and disability level of a person in a return-to-work program.[27] Examples of these core sets are the core set of low back pain, the core set of chronic pain, and the core set of vocational rehabilitation.[28-35] Such an ICF core set comprises an extensive number of factors and can be viewed as an instantaneous photograph (snap shot) of the disability status over time and not as a list of causal factors for the disability of patients with musculoskeletal pain. If we were made aware of the causal factors for prolonged musculoskeletal pain and work capacity, we could integrate the disability status into the clinical decision-making process.[27] During the first step of compiling medical history, patient identified problems are aggregated. [36] Subsequently the health care provider selects patient specific adjusted problems that are not readily mentioned by the patients. During this selection, the health care provider might decide to examine all factors of appropriate core sets and measure the entire range of functioning and inhibiting and facilitating environmental and personal factors of core sets. However, to measure all ICF core set factors is time consuming and not essential in identifying the inhibiting or facilitating factors of a disability. Secondly, the health care provider might decide to solely examine problems that, in his own opinion, are causal for the patient's functional disability. However in this clinician directed examination, factors that might be related to the disability might be missed, resulting in an imbalance between a patient's characteristics and specific intervention. Health care providers lack the overview of the extensive number of bio-psychosocial factors that are related to functional capacity. If we are made aware of the factors that are not related to functional capacity, we would save time and our diagnostic decisions and eventual patient-tailored interventions would be evidence based and patient-centered.

Twenty one percent of the Dutch population visits a physical therapist every year.[37] Over the past years, the beliefs and attitudes of health care providers and the effect of these beliefs on patients have received increased attention.[38] Twenty three percent of Dutch physical therapists believe that specific activities might result in re-injury and are more likely to advise patients to remain inactive which is not in accordance with guidelines.[39-41] In addition to the consequences of a patient's fear of injury as described in the fear avoidance model, a physical therapist's fear of injury might be projected onto the patient, resulting in lower functional capacity. The influence of a physical therapist's fear of injury on a patient's physical activity, such as work capacity, has not yet been studied and requires further investigation. If we are made aware of the influence of a physical therapist's fear of injury and the corresponding behavior, we might be able to develop a training program for physical therapists to change this belief and behavior.

In summary, there is a need for a broad overview of factors related to musculoskeletal pain and more insight into factors that influence functional capacity test outcomes.

Overall aim

The first aim of the thesis is to identify the level of evidence of risk and prognostic factors for musculoskeletal pain. The second aim of the thesis is to analyze relating factors of functional capacity in patients with musculoskeletal pain.

The main research questions in this thesis are:

Musculoskeletal pain

- What is the level of evidence of risk and prognostic factors for musculoskeletal pain? (*Chapter 2*)

Functional capacity

- What is the level of evidence for factors that associate with functional capacity test results in patients with chronic low back pain? (*Chapter 3*)
- Which factors influence functional capacity in patients with chronic musculoskeletal pain, according to scientists, clinicians, and patients? (*Chapter 4*)
- Are biological or psychosocial factors related to functional capacity tests in a healthy population? (*Chapter 5*)
- Does a physical therapist's attitude affect lifting capacity, and what is the behavior of physical therapists with an attitude of high fear of injury in the role of examiner of a lifting test? (*Chapter 6*)

Methods employed in this thesis

In this thesis, various methods were exploited in order to study the research questions. A systematic review was employed in order to build an overview of the strength of the results of previous studies on risk and prognostic factors of musculoskeletal pain. Another systematic review was performed to identify known factors related to functional capacity in patients with chronic low back pain. In order to bridge the gap between health care providers and researchers on influencing factors of functional capacity in patients with chronic musculoskeletal pain, a Delphi study was performed. New factors might be unraveled that were not previously studied. Furthermore, a cross-sectional study was performed to identify associations between bio-psychosocial factors and functional capacity in a healthy population. Finally, a controlled trial was performed to test the effect of the attitude of the examiner on the examiner's behavior and functional capacity.

Outline of this thesis

In this thesis, multiple studies are described.
In *Chapter 2*, the level of evidence of risk and prognostic factors for musculoskeletal pain is analyzed and classified according to the dimensions of the ICF. The objective of this review is to qualify and classify the evidence presented in systematic reviews and to identify missing components.

In *Chapter 3*, the level of evidence of factors related to functional capacity in patients with non-specific chronic low back pain are described by means of a systematic review.
In *Chapter 4*, a qualitative Delphi study is performed aimed to reach consensus between scientists, clinicians, and patients regarding the most important bio-psycho-social factors that influence functional capacity results in patients with chronic non-specific musculoskeletal pain. The factors are arranged in the framework of the ICF.
In *Chapter 5*, related factors to functional capacity were aggregated from a population of healthy subjects by means of a cross-sectional study. It is investigated whether biological, psychological, or social factors were influencing functional capacity in healthy persons. The ICF components of influencing factors on functional capacity may differ between healthy subjects and patients with musculoskeletal pain.
In *Chapter 6*, a double blinded randomized controlled trial was performed to measure the effect of the examiner's attitude of high fear of injury on the examiner's behavior and functional capacity of healthy subjects.
In *Chapter 7*, the general results of *Chapter 2 through 6* are integrated and reflected upon. Methodological considerations and recommendations for future research and clinical practice are also discussed.

This study is embedded in a study line of pain rehabilitation and work participation of the Department of Rehabilitation of the UMCG, the Healthy Ageing program of the UMCG, and the Hanze University of Applied Sciences Groningen, The Netherlands.

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Risk and prognostic factors for non-specific musculoskeletal pain:

A synthesis of evidence from systematic reviews classified into ICF dimensions

Pain. 2009;147:153-64

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2

Abstract

A wide variety of risk factors for the occurrence and prognostic factors for persistence of non-specific musculoskeletal pain (MSP) are mentioned in literature. A systematic review of all these factors is not available. Thus a systematic review was conducted to evaluate MSP risk factors and prognostic factors, classified according to the dimensions of the International Classification of Functioning, Disability and Health. Candidate systematic reviews were identified in electronic medical journal databases, including the articles published between January 2000 and January 2008 that employed longitudinal cohort designs. The GRADE Working Group's criteria for assessing the overall level of evidence were used to evaluate the reviews. Nine systematic reviews were included, addressing a total of 67 factors. High evidence supported increased mobility of the lumbar spine and poor job satisfaction as risk factors for low back pain. There was also high evidence for intense pain during the onset of shoulder and neck pain and being middle aged as risk factors for shoulder pain. High evidence was also found for several factors that were not prognostic factors. For whiplash-associated disorders these factors were older age, being female, having angular deformity of the neck, and having an acute psychological response. Similarly, for persistence of low back pain, high evidence was found for having fear-avoidance beliefs and meagre social support at work. For low back pain, high evidence was found for meagre social support and poor job content at work as not being risk factors.

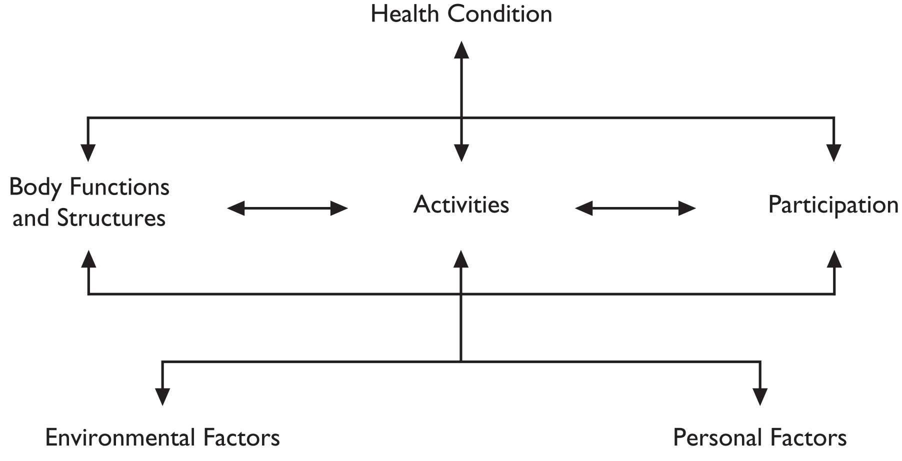
Key Words: Musculoskeletal pain; Probability; Low back; Shoulder; Neck; Systematic review

1. Introduction

Work is viewed as being beneficial for health and for social economic status [168]. However, when musculoskeletal pain (MSP) is present, work can be burdensome, resulting in reduced productivity, increased sick leave, and high costs for society [28,56,121]. Obtaining better knowledge of risk factors for the onset of MSP and prognostic factors for the persistence of MSP could provide tailored interventions [59,94,138].

In a healthy population various risk factors of MSP exist. As soon as MSP emerges, it may run its normal course; but in some people, pain lasts longer and may become chronic. These influencing factors are called prognostic factors. Several theoretical models have been proposed that describe the development and prolongation of MSP [72,122,162]. Some reflect contradictory theoretical relationships between the cause and consequence of MSP. For example, Waddell's bio-psychosociale model is based on neurophysiological or physiological dysfunction [162]. A work-related model is Kasarek's Job Control-Demand model [72]. This situation-centred psychosocial model assumes that a disbalance between high job demands and low worker control results in poor subjective health. A person-centred model is the catastrophizing hypothesis model, which posits that fear of pain results in self-limitation of activity and could therefore be a prognostic factor [122]. All these models have their own paradigm, which may possibly lead to confusion. The International Classification of Functioning, Disability and Health (ICF), however, lacks a paradigm [168]. Instead of explaining causal relationships, the ICF classifies them (Fig. 1) [168]. Therefore the ICF can be used to disentangle a diversity of relationships.

Fig. 1 *International Classification of Functioning, Disability and Health [168]*



The variety and the number of factors stated in the different ICF dimensions make it difficult for healthcare professionals to judge the relative importance of different risk and prognostic factors [27]. Moreover, several medical disciplines have their own guideline recommendations for employers and patients. These guidelines focus on different risk and prognostic factors [12,84,161]. For example, occupational guidelines for preventing low back pain (LBP) list physically or psychologically demanding work as causal factors of MSP [161]. By contrast, the Dutch physical therapist guideline for LBP lists pain behaviour, fear avoidance and patients' social environment as prognostic factors [12], whereas the clinical guideline of the Norwegian Back Pain Network lists heritage, lifestyle and low physical activity as risk factors for acute LBP [84]. The guideline recommendations are based on several levels of evidence, from authority-based judgements to systematic reviews of longitudinal and transversal studies. Currently a thorough overview of these predictive factors, regardless of specialism, is lacking. This could result in clinicians being ill informed of how to correctly advice patients and employers to appropriately consider risk and prognostic factors during treatment.

The aim of this review was to qualify and classify the evidence, presented in systematic reviews of risk and prognostic factors for non-specific MSP within the ICF. We summarised the evidence, providing a meta-perspective of existing evidence for factors. Missing components in the model may motivate further research into that specific classification domain.

2. Methods

2.1. Search strategy

A systematic review (SR) is considered to be the highest level of evidence [108]. Many overviews of risk and prognostic factors have been published. For this reason, only SRs were included in this review. To identify relevant SRs, we performed an electronic search of bibliographic literature databases (MEDLINE, CINAHL, EMBASE, PsycINFO), using keywords, MeSH and free text words (Supplementary online Appendix 1) from January 2000 up to January 2008. A sensitive search filter for SRs was used [59]. Additional references of guidelines of MSP and all identified SRs were screened for potential eligible studies.

2.2. Selection of studies

Only full reports written in English and meeting the following inclusion criteria (based on study design, population, and exposure) were selected.

2.2.1. Design

Longitudinal research is the preferred method for identifying causal relationships [94]. Therefore, SRs that summarised prospective or retrospective cohort studies were included in our present review. A SR was defined as a review of studies that systematically searched for evidence, that was based on methodological quality assessment of the included studies, and that summarised the findings according to predetermined criteria. We considered a meta-analysis to be a type of SR that uses quantitative methods.

2.2.2. Population

Studies that examined adults, aged 18-70 years, with non-specific MSP (as an outcome variable or inclusion criterion) were included. Non-specific MSP was defined as MSP not attributed to recognisable, known specific pathology (e.g., infection, tumour, osteoporosis, ankylosing spondylitis, fracture, inflammatory process, radicular syndrome, cauda equina syndrome, and pregnancy) [28,56]. For SRs analysing risk factors, we included those that examined working populations or community-based populations and that identified at least one risk factor and non-specific MSP as an outcome variable. For SRs analysing prognostic factors, we included studies that identified at least one prognostic factor for prolonged MSP. SRs that included workers on 100% sick leave at baseline assessment were excluded. Additional exclusion criteria, such as acute and chronic or severe and non-severe pain at baseline, were not formulated.

2.2.3. Exposure

We included SRs that investigated whether a person's exposure to various factors (body function and structures, activities, participation, personal and environmental factors) predicted MSP. SRs were excluded that examined the impact of treatments. If an SR summarised several factors, we only extracted the findings for factors based on longitudinal cohort studies.

2.3. Study outline

In the first stage, one reviewer (AEL) screened the title and abstract of candidate articles. In the second stage, two reviewers (AEL and RS) screened the full text of all potential relevant articles to determine whether the article met the inclusion criteria. Because the reviewers were familiar with some of the articles, no blinding of authors and institutes was performed.

2.4. Methodological quality assessment of the included systematic reviews

Two reviewers (AEL and TT) independently assessed the quality of the included SRs using the list of criteria for assessing quality, description of potential bias, internal validity, and statistical criteria (Supplementary Appendix) [6-8,68]. For each candidate SR, each criterion was rated as 'met' (+), 'unclear/partly met' (±), or 'not met' (-). The total score was calculated by summing up the numbers of 'met'. The total maximum score was 9 points. The methodological quality of an SR was labelled as 'minor limitation' if the quality score was at least 7 out of 9 points and as 'moderate limitations' if the quality score was at least 4 out of 9 points. SRs meeting less than four of the criteria were SRs with 'major limitations' [68]. The inter-rater agreement between the two reviewers was calculated with Cohen's kappa [33]. Agreement was resolved by consensus between AEL and TT. If disagreement persisted after the consensus meeting, a third reviewer (MFR) made the final decision.

2.5. Extraction of data

The following data were used for analysis: population characteristics at baseline, date of ending search strategy, number of cohorts and included subjects, study design, methodological quality assessment of included cohort studies, consistency of the available evidence of factors, range of time over which follow-up measurements were made, and outcome measurements. The cohort studies of the included SRs were checked for double counting of extracted risk or prognostic factors based on repetition of cohort studies. When we encountered more than one SR that assessed the methodological quality of the same cohort study, we extracted the cohort study assessments from the SR that was of the highest methodological quality. Identified risk and prognostic factors were classified according to ICF [168]. One reviewer (AEL) extracted the data. To verify accuracy, a second reviewer (RS) selected a random sample (n=3) from the included SRs.

2.6. Level of evidence for each risk and prognostic factor across systematic reviews

The level of evidence and strength of recommendations were assessed according to the criteria assessed by the GRADE Working group [6,68]. GRADE stands for Grading of Recommendations Assessment, Development and Evaluation. GRADE classifies the level of evidence (high, moderate, low, none) based on (1) the methodological quality of the SR, (2) the quality of the cohort studies included in the SR, and (3) the consistency of the results of the cohort studies (Table 2). The GRADE level of evidence indicates the extent to which one can be confident that a specific factor predicts MSP or the consequences of MSP.

Table 2 *GRADE level of evidence [7,68]*

Level of Evidence Quality	Based on:
High-quality evidence	One or more updated, high-quality systematic reviews · based on at least 2 high-quality cohort studies[1] with consistent[2] results
Moderate-quality evidence	One or more updated systematic reviews of high or moderate quality · based on at least 1 high-quality cohort study · based on at least 2 cohort studies of moderate quality with consistent results
Low-quality evidence	One or more systematic reviews of variable quality · based on cohort studies of moderate quality · based on inconsistent results in the reviews · based on inconsistent results in cohort studies
No evidence	No systematic review identified

1 The assessment of the methodological quality of cohort studies was extracted from the included systematic review.

2 Consistent means more than 75% of the included cohorts pointed towards the same direction.

3. Results

3.1. Literature search

The results of the search strategy are presented in Fig. 2. The literature search of databases resulted in 7937 potentially relevant articles. Excluded on title, abstract and duplicate were 7881 articles. Another 48 articles were excluded after the full text was read. The main reason for exclusion was firstly allowing cross-sectional study design in the reviewed factor of the SR, and secondly non-attendance of methodological quality rating. Screening the references of MSP guidelines, all selected articles, and all retrieved SRs resulted in one additional eligible SR. A total of nine SRs were included in the present review [35,53,55,65, 66,82,122,140,158]. No meta-analyses were produced in the search.

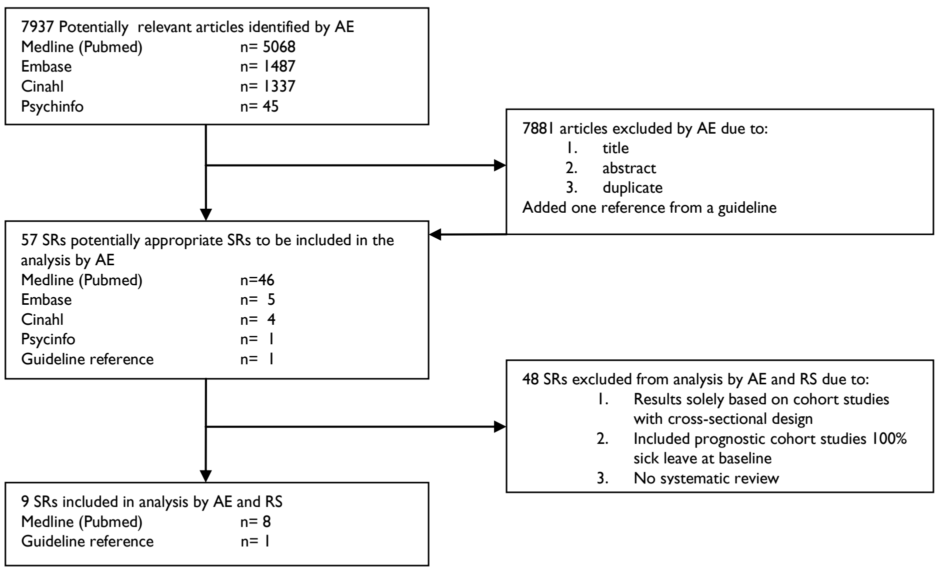


Fig. 2 *Selection of systematic reviews*

3.2. Description of systematic reviews

Supplementary Table (online) 3 presents the details of the included SRs. Nine SRs described MSP in predetermined body parts [35,53,55,65,66,82,122,140,158]. Two of the SRs included only prospective cohort studies [122,140], whereas the other seven SRs included both prospective and retrospective studies [35,53,55,65,66,82,158]. Only the risk factor body mass index (BMI) was extracted from the SR of Viikari-Juntura et al. [95,106,158,159], because the other factors assessed by these authors were based on a cross-sectional design. The SR of Scholten-Peeters et al. did not categorize the cohort studies' references for each factor [140]. This observation was confirmed (personal communication; G.M. Scholten-Peeters). Unfortunately these classifications were lost due to removal. Therefore the described cohort studies's references for each prognostic factor [15,23-25,30,38,46,47,58,60-62,73-75,101-105,114,115,117-119,125-131,137,139,146,148,163].

3.3. Double counting

Double counting was checked. Several cohort studies on whiplash-associated disorders (WAD) were duplicates. Scholten-Peeters et al. [140] included 38 cohort studies on WAD in which the subjects' accident occurred less than six days before the start of the study. Coté et al. [35] included subjects that had experienced WAD for less than six weeks [35]. Cote et al.'s SR scored less than Scholten-Peeters et al.'s SR on the methodological quality assessment. Following the preset criteria, we added one cohort study assessed by Cote et al. [82].
For LBP; the risk factor 'social support at the work place' was reviewed in two articles [55,65]. Hartvigsen et al. assessed 10 cohort studies on social support at the work place [41,42,49,63,89,92,116,143,150,170]. Hoogendoorn et al. assessed five cohort studies on the same subject [19,57,92,116,133]. Hartvigsen et al. scored 1 point more than Hoogendoorn et al. on methodological quality. Therefore, Hartvigsen's methodological quality rating of the two duplicated cohort studies was extracted [92,116]. Hamberg van Reenen et al. included three articles reporting large lumbar flexion [17,50,53,152]. Two of these articles, both rated as having high methodological quality, were related to the same cohort study [50,152]. Thus, both were mentioned but counted as one.

3.4. Participants

The number of subjects ranged from 465 to 27,923 per SR. The included population in SRs considering risk factors consisted of working and community-based subjects. The SRs considering prognostic factors included patients from private and primary care practices, hospital emergency departments, and population- and insurance-based cohorts (Supplementary online Table 3).

3.5. Risk and prognostic factors

Five SRs assessed risk factors [53,55,65,66,158]. Two of these evaluated the ICF dimension environmental factors [55,65]; two SRs addressed the dimension of body functions and structure [53,158]; and one SR assessed factors on the activity and participation dimension [66]. Five SRs assessed prognostic factors on several dimensions of the ICF [35,55,82,122,140]. One SR included cohort studies of both the risk and prognostic factors [55].
Several SRs set the cut-off points for a positive risk estimate at >2.0 and <0.5 [35,66,82,140]. One SR used the same cut-off points to indicate the strength of the association [55]. Another SR presented prognostic factors that used these cut-off points in at least one study [82]. One SR set the criteria for a positive risk or prognostic factor at a statistically significant *p*-value of 0.10 or less [53]. Three different SRs included statistical analyses in their methodological quality assessments [65,122,158].

3.6. Outcome measurements

A large variety of questionnaires were used to assess MSP in the cohort studies, ranging from self-reported pain, disability, recovery time, sick leave, incidence of LBP to incidence of claims (Supplementary Appendix 2). The incidence of MSP was measured to determine the risk factors. The consequences of MSP were evaluated for prognostic factors. The outcome measures in Hamberg-van Reenen et al.'s SR varied from incidence of MSP to filing of insurance claims due to MSP [53]. Overall for prognostic factors, a large variety of baseline assessments and follow-up measurements were used. New episodes were not specifically operationalized. Pincus et al.'s criterion for inclusion was acute LBP in patients who had no pain during the preceding three months [122].

3.7. Methodological quality of systematic reviews

The methodological quality of SRs is described in Table 4. Cohen's kappa for overall agreement between the reviewers was *K*= 0.53, which is considered to represent moderate agreement [4,86]. Full agreement for all criteria (*K*=1.00) was reached during the consensus meeting. The third assessor did not come into operation. The methodological quality rating of SRs ranged from 5 to 9 points with a median of 8 points. Seven SRs had minor limitations [53,55,65,66,82,122,140]. Since they had a minimum score of 7 out of 9 points. Two had moderate limitations [35,158]. In two SRs, selection bias could have occurred, because the selection of articles was done by one reviewer [53,65]. Three articles did not report the methods used to combine the findings, nor did these SRs combine the cohort studies appropriately [35,122,158].

Table 4 *Methodological quality of included systematic reviews [68].*

	Hartvigsen et al.,	IJmker et al.,	Kuijpers et al.,	Scholten-Peeters et al.,	Hamberg van Reenen et al.,	Hoogen-doorn et al.,	Pincus et al.,	Cote et all.,	Viikari-Juntura et al.,
	2004 [55]	2007 [66]	2004 [82]	2003 [140]	2007 [53]	2000 [65]	2006 [122]	2001 [35]	2007 [158]
1 Is the search strategy described in enough detail for the search to be reproducible?	+	+	+	+	+	+	+	+	+
2 Was the search for evidence reasonably comprehensive?	+	+	+	+	+	+	+	±	-
3 Were the criteria used for deciding which studies to in-clude in the review reported?	+	+	+	+	+	+	+	+	+
4 Was bias in the selection of articles avoided?	+	+	+	+	-	-	+	+	+
5 Were the criteria used for assessing the validity of the studies that were reviewed reported?	+	+	+	+	+	+	+	+	-
6 Was the validity of all of the studies referred to in the text assessed using appropriate criteria in analysing the studies that are cited?	+	+	+	+	+	+	+	+	+
7 Were the methods used to combine the findings of the relevant studies (to reach a conclusion) reported? (Best evidence synthesis)	+	+	+	+	+	+	-	-	-
8 Were the findings of the relevant studies combined (or not combined) and analysed appropriately relative to the primary question the review addresses and the available data?	+	+	+	+	+	+	-	-	-
9 Were the conclusions made by the author(s) supported by the data and/or the analysis reported in the review?	+	+	+	+	+	+	+	±	+
Total score	9	9	9	9	8	8	7	5	5

+ = criteria 'met'; ± = criteria 'unclear'/ 'partly met'; - = criteria 'not met'.

3.8. Methodological quality of cohort studies

The methodological quality assessment of the cohort studies was reproduced from the included SRs. The methodological quality for each risk and prognostic factor across SRs varied widely. A criterion for clearly defining the objective of the cohort study was assessed in two SRs [55,65]. One SR described a criterion about the correct statement of the research question [35]. A clear description of the study population was a criterion in five SRs [35,55,65,82,140]. Inclusion and exclusion criteria were described in six SRs [35,53,55,82,140,122]. The response rate at baseline was an assessment criterion in six SRs and varied from a reported minimum of 80% [35,53,55,65,66,82]. A response rate less than 60% was an exclusion criterion in one SR (158). The dropout-loss-to-follow-up rate was less than 20% in five SRs [65,66,82,140,122]. Two SRs qualitatively expressed the dropout-loss-to-follow-up as 'reasonable' but did not report a percentage [35,158]. Two other SRs rated the criteria positive for sufficient time between baseline and follow-up [53,55]. All included SRs described standardised methods for data collection of acceptable quality of prognostic or risk factors. One SR judged prognostic factors on clinical relevance [140]. Another SR assessed the intention of the prognostic factors, such as dose, level, and duration [35].

For the outcome measurements used in the SRs, adequate, standardised, valid, and reliable measure instruments scored one quality point in all SRs. Four SRs gained one quality assessment point, if comparison between the dropout group and the follow-up group at baseline was measured [35,53,82,122].

The data analyses described in the SRs were assessed for whether a multivariate analysis was done. A confounder control was assessed in all SRs. Three SRs gained one quality point because the number of cases in the multivariate analyses was at least 10 times the number of independent variables [53,55,56]. Two other SRs reported sufficient numbers of subjects [82] and more than 200 subjects in the analysis sample [122].

3.9. Level of evidence based on GRADE dimensions

The level of evidence for risk and prognostic factors for MSP according to GRADE was classified within the ICF dimensions (Table 5). This level of evidence was based on the methodological quality of each SR, the methodological quality of the cohort studies included in the SRs, and the consistency of the results of the cohort studies (Table 5). Highly rated evidence is described in Section 3.9.

3.9.1 Body function and structure

3.9.1.1. Risk factors

In two SRs, 15 cohort studies reported mobility of the spine as risk or prognostic factor for MSP. The results for neck mobility were inconsistent (Table 5). One SR reported increased mobility of the lumbar spine as a risk factor for LBP [53]. The two cohort studies considered in this SR were deemed to have high methodological quality and showed the same positive direction [17,50,152]. Two articles researched the same cohort and were therefore counted as one. According to the GRADE-based assessment, high evidence was found for increased mobility of the lumbar spine is a risk factor for lumbar pain.

3.9.1.2. Prognostic factors

For two SRs [82,140], that included eight cohort studies, high evidence was found that intense pain intensity at the onset of shoulder and neck pain is a prognostic factor for the duration of symptoms [82,140]. Mental functions were investigated in a population with WAD [140]. Four included cohort studies found no association between 'high acute psychological response' after a car accident and prolonged WAD. One included cohort study found a positive association. Because more than 75% of the results pointed in the same direction, according to GRADE, it can be concluded that there is high evidence that 'high acute psychological response' is not a prognostic factor for WAD.

3.9.2. Activity and participation

3.9.2.1. Risk factors

None of the included SRs examined risk factors for MSP on the activities and participation dimension.

3.9.2.2. Prognostic factors

One SR [82] identified high-activity limitations and participation restrictions at baseline, and another SR [140] identified low workload in neck muscles and driving occupation as prognostic factors for neck and shoulder disorder [140]. The results of the included cohort studies in these SRs were all in the same positive direction for prognostic factors for neck and shoulder disorder. However, they were each based on only one high methodological quality cohort study; therefore, these SRs were rated as providing moderate evidence. High evidence could not be obtained in these SRs on the activities and participation dimension of the ICF.

***Table 5** GRADE-classified level of evidence for MSP risk and prognostic factors according to ICFdimensions.*

Risk or prognostic factors					No. of cohort studies with positive or no results and methodological quality (high/low)				Quality of evidence		
ICF dimension		Factors identified	MSP of body part	QR	Pos		No results		Summarised results	Risk factor	Prognostic factor
					high	low	high	low			
Body function and structure	muscle function	poor trunk muscle strength	low back	1 +[53]	5[9,10,16,50,99, 100,149]		13[2,9,11,17,48,50,83, 88,93,99,100,110,134, 147,149,152]	4[1,32,39,90,132]	no	low	
			neck	1 +[53]			1[52]		no	moderate	
		poor trunk muscle endurance	low back	1 +[53]	2[2,3,17]	1[135]	7[2,3,48,77,83,88,93, 100,149,147]	4[1,70,32,132,135]	no	low	
			neck	1 +[53]			1[9,10]		no	moderate	
	spine mobility	increased mobility of the lumbar spine	low back	1 +[53]	2[17,50,152]				pos	high	
		reduced mobility	low back	1 +[53]	1[17,100]	1[1]			pos	low	
			neck	1 +[53]			1[52]	1[113]	no	moderate	
			neck	1 +[140]	3*	2*	1*	2*	pos		low
	pain	pain of neck or head before collision	neck	2(1+,1±)[140 0,35]	2*[141]	1*	4*	1*	no		low
		high initial pain at baseline	neck	1 +[140]	4*	1*		1*	pos		high
		high pain intensity at baseline	shoulder	1 +[82]	2[96,156]				pos		high
		concomitant neck pain	shoulder	1 +[82]	1[156]				pos		moderate
		radicular symptoms	neck	1 +[140]	1*	3*	2*	5*	no		low
		sleeping disturbance	neck	1 +[140]	2*		2*		equal		low
	body structure	angular deformity	neck	1 +[140]		1*	3*	4*	no		high
		initial disc changes	neck	1 +[140]		2*	2*		no		low
		no cause of overuse unusual activity	shoulder	1 +[82]	1[156]				pos		moderate
		no acute bursitis	shoulder	1 +[82]	1[156]				pos		moderate
		BMI	shoulder	1 ±[158]	3[95,106,159]				pos	moderate	
	body position car accident (WAD)	unprepared for collision	neck	1 +[140]	2*		2*	2*	no		low
		turned head position	neck	1 +[140]	2*		1*		pos		low
		velocity change > 10 km/h	neck	1 +[140]	1*		1*		equal		low
	pre-existing changes	pre-existing spondylosis + degenerative changes	neck	1 +[140]	2*	1*	2*	4*	no		low
	mental functions	cognitive impairments	neck	1 +[140]	1*			1*	pos		low
		speed of information processing	neck	1 +[140]	1*			1*	pos		low
		poor concentration	neck	1 +[140]	1*			1*	pos		low
		neurotism	neck	1 +[140]	1*			1*	pos		low
		increased acute psychological response	neck	1 +[140]	1*		4*	1*	no		high
Activities and participation		reduced workload on neck muscle	neck	1 +[140]	1*				pos		moderate
		driving occupation	neck	1 +[140]	1*				pos		moderate
		high disability score at baseline	shoulder	1 +[82]	1[96]	1[36]			pos		moderate
Personal factors		fear avoidance	low back	1 +[122]			8[78,80,120,124,142, 144,145,165]	1[29]	no		high

		depression	low back	1 +[122]	1[145]				pos		moderate
		previous psychiatric problems	neck	1 +[140]	1*				pos		moderate
		stress unrelated to accident	neck	1 +[140]	1*			1*	pos		low
		nervousness	neck	1 +[140]	1*				pos		moderate
		need to resume physiotherapy	neck	1 +[140]		1*			pos		low
		need for cervical collar > 12 weeks	neck	1 +[140]	1*			1*	pos		low
		older age	neck	1 +[140]	2*	2*	10*	10*	no		high
		female gender	neck	1 +[140]	3*		12*	9*	no		high
		middle age (45-54 yr)	shoulder	1 +[82]	2[31,107]				pos		high
Environmental factors	work perception	perception of work	low back	1 +[55]	1[157]	1[116]	3[43,44,63]	4[21,111,132,160,170]	no	low	
			low back	1 +[55]	3[64,154,157]	3[42,153,155]	3[19,20,34,51]	10[20,45,54,57,67,85,112,116,151,167]	no		low
		low job satisfaction	low back	1 +[65]	5[17,19,116,132,136]			1[57]	pos	high	
		stress at work	low back	1 +[55]	1[43]		1[42]	3[49,132,170]	no	low	
			low back	1 +[55]			1[42]	2[91,166]	no		moderate
		poor social support at work	low back	2 +[55,65]	2[19,133]		4[42,49,57,63]	8[41,49,89,92,116,144,150,170]	no	high	
			low back	1 +[55]	1[42]		4[64,153,154,155]	4[45,57,91,116]	no		high
		poor job content	low back	1 +[65]	1[92]		4[17,92,133,136]		no	high	
	work organisational aspects	organisational aspects of work	low back	1 +[55]	1[42]	1[92]	2[40,63]	5[21,49,89,143,150]	no	low	
			low back	1 +[55]	2[51,57]		4[42,64,153,154]	3[142,151,166]	no		low
		low job control	low back	1 +[65]			1[92]		no	moderate	
		low decision latitude	low back	1 +[65]	1[57]				pos	moderate	
		high pace of work	low back	1 +[65]	2[57,133]		1[18]		no	low	
		High-quality job demand	low back	1 +[65]	1[57]	1[14]			pos	moderate	
	work instruments	total computer use time	neck	1 +[66]	1[98]		1[79]	1[69,71]	no	low	
			upper extremity	1 +[66]	1[98]			1[69,71]	pos	low	
		mouse use time	neck	1 +[66]	1[5,26,81,87]				pos	moderate	
			upper extremity	1 +[66]	1[5,26,81,87]	1[69,71]			pos	moderate	
		keyboard use time	neck	1 +[66]	1[5,26,81,87]				pos	moderate	
			upper extremity	1 +[66]	1[5,26,81,87]				pos	moderate	
		overload at work	shoulder	1 +[82]	1[106]				pos		moderate
	social contact	social support	low back	1 +[65]		1[109]	1[19]		no	low	
		initial treatment hospital	neck	1 +[140]		1*		1*	pos		low
	crash position	crash rear-end collision	neck	1 +[140]	1*	1*	5*	7*	no		high
		accident on highway	neck	1 +[140]	1*				pos		moderate
		car stationary	neck	1 +[140]	1*		1*	1*			low
		car stationary when hit rear-end	neck	1 +[140]		1*					low
	social security services	compensation	neck	1 +[140]		1*	3*	3*	no		high

MBI = Body mass index; ICF = International Classification of Functioning, Disability and Health; MSP = musculoskeletal pain; QR = number and Quality of systematic review; + = minor limitations; ± = moderate limitations.

Results of cohort studies: pos, evidence for risk or prognostic factor; no, no evidence for risk or prognostic factor; high, methodological high quality cohort study; low, methodological low quality cohort study.

Summarised results: pos, evidence for a risk or prognostic factor; no, no evidence for a risk or prognostic factor;

*All the Cohort studies of Scholten-Peeters et al. [15,23-25,30,38,46,47,58,60-62,73-75,101-105,114,115,117-119,125-131,137,139,146,148,150,163]

3.9.3. Environmental factors

3.9.3.1. Risk factors

One high-quality SR examined low job satisfaction as a risk factor for LBP [65]. This SR included six cohort studies. Five cohort studies were rated as methodologically high quality. These five cohort studies showed positive results. One methodologically low-quality cohort study showed no results. High evidence was produced showing that low job satisfaction is a risk factor for LBP. Poor job content (defined as monotonous work, work with few possibilities for new learning and developing knowledge and skills) was rated as high evidence for not being a risk factor for low back disorder; this conclusion is based on one SR [65] that included four high-quality cohort studies showing no results. Poor social support at work (e.g., meagre social support from co-workers and supervisors, relationships at work, problems with workmates and supervisors) was reviewed in two SRs [15,18] that assessed 13 cohort studies. According to GRADE, high evidence was produced showing that poor social support at work is not a risk factor for LBP.

3.9.3.2. Prognostic factors

There is high evidence that poor social support at work is not a prognostic factor for LBP; this conclusion is based on one SR [15] that included nine cohort studies.

3.9.4 Personal factors

3.9.4.1. Risk factors

No SR was included that measured personal factors as risk factors for MSP.

3.9.4.2. Prognostic factors

Contrary to environmental factors, personal factors are recognized but not classified in the ICF [168]. Personal factors are defined in the ICF as the background of an individual's life [168]. Fear-avoidance beliefs as a prognostic factor was measured in nine cohort studies as an individual's life background and not as an impairment [122]. Therefore, in this SR, fear avoidance was classified on the personal factors dimension. One SR fulfilled our preset inclusion criteria [122]. Eight high-quality and one low-quality methodological cohort study concluded that fear-avoidance beliefs were not a prognostic factor for LBP. Following GRADE, we concluded that high evidence was present, showing fear-avoidance beliefs are not a prognostic factor for LBP. High evidence was produced showing that being female and being old age are not prognostic factors for WAD; this conclusion is based on one SR [140] that included several cohort studies. One SR [82] investigated the prognostic factor age (45-54 years) in two cohort studies rated as having high methodological quality. Following GRADE's criteria of evidence, we conclude that high evidence was produced showing that being middle aged is a prognostic factor for persistent shoulder pain.

4. Discussion

The first aim of this SR was to determine the quality of the evidence for MSP risk and prognostic factors by using findings from available SRs as a basis. There is high evidence that increased lumbar spine mobility and low job satisfaction are risk factors for the development of LBP. High evidence for prognostic factors for neck and shoulder pain are baseline neck and shoulder pain intensity, and a prognostic factor for shoulder pain is being middle aged. There is high evidence that older age, being female, angular deformity of the neck, and acute psychological response are not prognostic factors for persistent WAD. For LBP, there is high evidence that fear avoidance and poor social support at work are not prognostic factors for LBP. Poor social support at work and poor job content are not risk factors for LBP.

The second aim of this SR was to summarise the quality of evidence in terms of the ICF classification scheme to identify missing areas for further research. The ICF provides a systematic coding scheme for health information systems, establishing a common language to improve communication between different users; it also takes a neutral stand with regard to specialism and underlying theoretical models [168]. A limited number of cohort studies measured prognostic factors for MSP on the activities and participation dimension of the ICF, with all pointing towards the same positive direction for possible prognostic factors for MSP [96,36,140]. Due to the meagre number of cohort studies, none of these factors were graded as high level of evidence. In addition, no SR summarised risk factors on the ICF activities and participation dimension for the onset of MSP.
Another remarkable lack of factors could be recognized in the ICF framework. No included SRs measured risk factors on the personal dimension. Furthermore, environmental risk and prognostic factors, such as 'work perception', were only found for LBP, not pain in other body parts. Firstly, because the present SR only included SRs, our main recommendations for future research agendas are

to fill in the gaps in the ICF given in Table 5 with SRs. Secondly, if SRs are not feasible or not yet available, this table could be populated with single prospective cohort studies.

The strength of this SR lies in the number of participants included (N=119,849) and in an exhaustive search of multiple electronic databases. This SR gives an overview of the systematically reviewed risk and prognostic factor literature, which consisted of longitudinal cohort studies that were all rated on methodological quality. The results of this SR with regard to prognostic factors are of clinical relevance and should have implications for practice. Psychosocial yellow flags in acute LBP are defined as risk factors for long-term disability and work loss [76]. Identification of at-risk individuals should lead to appropriate early management targeted towards the prevention of chronic pain and disability. The definition of prognostic factor is identical to these yellow flags. High neck and shoulder pain intensity could be added as yellow flags. On the other hand, with regard to LBP, fear-avoidance beliefs and poor social support at work perhaps should be removed as yellow flags [12,16,84].

As with all SRs, one limitation of the present SR is heterogeneity, which could cause effect bias. To limit the risk of bias, two reviewers independently assessed the methodological quality of the studies with a validated instrument [68], and two reviewers performed the search strategy for the second stage. Another problem inherent to all SRs is the publication bias. Because of the extent of the issue we assessed, publications could have been missed [40]. However, since we used a comprehensive search strategy, it is unlikely that any publications were missed.

The ICF defines personal factors in terms of the particular background of an individual's life and way of living and the domain mental functions as a manifestation of pathology [168]. One could argue about the ICF classification of the factors in this review. For example, the factor 'nervousness' was classified as a personal factor dimension and not as a mental impairment. Classifying these factors differently would affect the 'umbrella overview' of the existing evidence for factors, not the results of the overall quality of this SR.
Apart from the problems discussed thus far, limitations can also arise from the problems of the included SRs. For example, in assessing risk factors for back pain, employees and community-based populations were summarised without considering the 'healthy workers effect' [97]. Indeed, workers with back pain may leave a job, resulting in a surviving workforce with healthier backs. This may introduce significant membership bias.

The outcome measurements of the primary studies were very diverse. Some measured sick leave, some measured self-reported symptoms. Self-reported physical or mental symptoms do not automatically translate to incapacity for work. One-third of people reporting physical or mental symptoms function normally at work [162]. In the included SRs, the studies with outcome measures physical symptoms and sick leave were combined. This could have led to an effect bias. However, the variety in outcome measures and the amount of included cohort studies may have equalized possible effect bias.

In this review, cohort studies searching for prognostic factors included acute and chronic, and severe and non-severe MSP at baseline. However, we think that this heterogeneity in baseline characteristics does not significantly affect the findings of the current SR. MSP is an intermittent lifetime problem, in which symptomatic periods alternate with symptom-free periods. To increase the clinical relevance, recommendations for future research should agree on outcome measures and baseline characteristics in prognostic cohort research [123].

Our recommendations for future research include performing SRs on initial pain as a prognostic factor for LBP, environmental causal factors for neck or shoulder pain, and causal personal factors for MSP. Furthermore, more methodologically high-quality cohort studies should be carried out to identify prognostic factors categorized within the ICF activities and participation dimension. Future SRs should also assess and identify risk factors within this dimension. Effect modification of several dimensions of the ICF could occur. For example, personal factors could influence an environmental outcome variable such as job content [22,37,94]. Potential confounders and mediators such as age, gender, job satisfaction, or personal factors such as depressive feelings or motivation, should be taken into account. This SR does not provide a complete overview of the factors influencing MSP in different body parts. Thus, the next step would be to research additional SRs or to fill in the gaps given in Table 5 with cohort studies. A conceptual model of illustrating the relationship between ICF dimensions in a working population should be built in order to gain insight into the coherence between the different dimensions in a specific population [13,164,169]. Without further research, we will not know whether modifying a person's risk factor would prevent MSP and reduce sick leave. Therefore, the risk factors 'increased mobility of the lumbar spine' and 'low job satisfaction' should not be used as selection criteria for engaging employees.

5. Conclusion

By applying the GRADE method of classifying the level of evidence, we determined that increased lumbar spine mobility and low job satisfaction are high evidence risk factors for LBP. There is high evidence that intense initial pain at baseline and being middle aged (45-54 years) are prognostic factors for neck and shoulder pain and for shoulder pain, respectively. Moreover, there is high evidence showing that older age, being female, angular deformity and acute psychological response are not prognostic factors for prolonged pain in WAD. High evidence also indicated that fear at early stages of pain and poor social support at work are not prognostic factors for LBP. In addition, high evidence indicated that poor job content and poor social support at work are not risk factors for LBP. Recommendations for future research are to systematically review prospective cohort studies on MSP risk factors on the ICF activities and participation dimension and personal dimension. Further recommendations include performing SRs on environmental risk factors for neck and shoulder pain and the prognostic factor initial pain for LBP. Finally, SRs on environmental risk and prognostic factors of MSP other than LBP are recommended.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.pain.2009.08.032.

Supplementary Appendix Criteria used to assess the quality of included systematic reviews [68].

1 Is the search strategy described in enough detail for the search to be reproducible?
2 Was the search for evidence reasonably comprehensive?[1]
3 Were the criteria used for deciding which studies to include in the review reported?
4 Was bias in the selection of articles avoided?
5 Were the criteria used for assessing the validity of the studies that were reviewed reported?[2]
6 Was the validity of all of the studies referred to in the text assessed using appropriate criteria in analysing the studies that are cited?[3]
7 Were the methods used to combine the findings of the relevant studies (to reach a conclusion) reported? (Best evidence synthesis)
8 Were the findings of the relevant studies combined (or not combined) and analysed appropriately relative to the primary question the review addresses and the available data?3
9 Were the conclusions made by the author(s) supported by the data and/or the analysis reported in the review?

[1] Question no. 2 could only be rated as 'met' if the electronic literature search was performed in at least Medline and if one comprehensive search was performed in another database, according to the Cochrane Handbook for Systematic Reviews of interventions [59].
[2] Question no. 5 could only be rated as 'met' if the following criteria were met: (1) A methodological quality list was shown in the text or a table, and (2) this list provided a statistically significant risk estimate ($p<0.10$), or a risk estimate of >1 or < 1.
[3] Questions nos. 6 and 8 could only be rated as 'met' if the foregoing question score was 'met'.

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Factors associated with functional capacity test results in patients with non-specific chronic low back pain: A systematic review.

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Abstract

Introduction Functional capacity tests are standardized instruments to evaluate patients' capacities to execute work-related activities. Functional capacity test results are associated with biopsychosocial factors, making it unclear what is being measured in capacity testing. An overview of these factors was missing. The objective of this review was to investigate the level of evidence for factors that are associated with functional capacity test results in patients with non-specific chronic low back pain.

Methods A systematic literature review was performed identifying relevant studies from an electronic journal databases search. Candidate studies employed a cross-sectional or RCT design and were published between 1980 and October 2010. The quality of these studies was determined and level of evidence was reported for factors that were associated with capacity results in at least 3 studies.

Results Twenty-two studies were included. The level of evidence was reported for lifting low, lifting high, carrying, and static lifting capacity. Lifting low test results were associated with self-reported disability and specific self-efficacy but not with pain duration. There was conflicting evidence for associations of lifting low with pain intensity, fear of movement/(re)injury, depression, gender and age. Lifting high was associated with gender and specific self-efficacy, but not with pain intensity or age. There is conflicting evidence for the association of lifting high with the factors self-reported disability, pain duration and depression. Carrying was associated with self-reported disability and not with pain intensity and there is conflicting evidence for associations with specific self-efficacy, gender and age. Static lifting was associated with fear of movement/(re)injury.

Conclusions Much heterogeneity was observed in investigated capacity tests and candidate associated factors. There was some evidence for biological and psychological factors that are or are not associated with capacity results but there is also much conflicting evidence. High level evidence for social factors was absent.

Key words: Review, non-specific Chronic Low Back pain, Functional Capacity

Introduction

Patients with non-specific Chronic Low Back Pain (CLBP) can be limited in their functioning because of their health condition. Functioning refers to all body functions, activities and participation as classified in 'The International Classification of Functioning, Disability and Health (ICF) [1]. Not only physical limitations determine the level of functioning in patients with non-specific CLBP, psychosocial factors have proven to have impact as well [2,3]. In clinical practice, assessments of functioning are performed by means of patient self assessment, clinical assessment and/or capacity tests. These assessments are important to make clinical decisions on choice of therapy, evaluation of interventions, and restriction of activities or return to work. In this study, we focused on factors that associate with capacity test results in patients with non-specific CLBP.

Capacity tests are standardized functional instruments that are used to evaluate patients' capacities to execute (work related) physical activities. There are many terms in the literature that refer to capacity tests, such as physical performance tasks, physical ability, and functional assessment tests. Work related capacity tests are, among others, referred to as Functional Capacity Evaluation (FCE), Functional Capacity Assessment or Work Capacity Evaluation. In the present study, the term capacity test is used as a consistent terminology for all tests that measure the highest probable level of functioning that a person may reach in an activity domain at a given moment in a standardized environment [1,4].

It is not always clear what is being measured in capacity testing. Personal factors such as age, education, coping style, motivation, fear and environmental factors such as medication or assessment setting may associate with the results of a capacity test. For the interpretation of capacity test results, it is important to take notice of such factors. There have been studies in the past decades that explored the association of factors with capacity test results in patients with chronic pain. A non-systematic review on the association between psychosocial factors and capacity tests in patients with chronic pain concluded that specifically pain related fear, self-efficacy and illness behaviour were related to measures of capacity [3]. However, the relations and underlying mechanisms are complex, because many psychosocial factors are inter-correlated. Over the years, there has been further research on capacity test results in relation to self-reported disability [5,6], cardiovascular capacity [7], pain severity [5,7,8], self-efficacy beliefs [2,9,10] and work related recovery expectations [5]. To understand the association of biopsychosocial factors with capacity test outcomes, there is a need for an overview of clinical evidence for these factors. The objective of the present review was to determine the current level of evidence for factors that associate with capacity test results in patients with non-specific CLBP. An overview level of evidence of these factors provides useful insights for healthcare workers using capacity tests in this population and researchers investigating capacity testing in non-specific CLBP.

Method

Design and Outline

The study design is a systematic review of cross-sectional studies and clinical trials that investigated capacity tests and their potentially associated factors in patients with non-specific CLBP. For the first selection of studies, one researcher (RA) performed an electronic search for potentially relevant studies. Two reviewers (RA and SEL) independently screened titles and abstracts for the second selection. The full texts of the second selection were retrieved and assessed for inclusion by both reviewers. Selection of relevant studies was based on set inclusion and exclusion criteria. In the next stage of the review, relevant studies were assessed for methodological quality and the outcomes were analyzed to determine level of evidence.

Search Strategy

To identify relevant studies, we conducted a search of bibliographic electronic literature databases (MEDLINE, CINAHL, EMBASE and PsychINFO), using keywords, MeSH terms and free text words (supplementary Appendix A). Studies from January 1980 up to October 2010 were searched. Only full reports written in English, German or Dutch and meeting the following inclusion criteria were selected.

Inclusion Criteria

Candidate studies examined a relationship between the results of a capacity test (dependent variable) and one or more associated factors (independent variable). The study population included adults with non-specific CLBP aged from 18 up to 65 years. Studies were included when at least 75% of the population had non-specific CLBP. Non-specific CLBP was defined as back pain not attributed to recognizable specific pathology (e.g., infection, tumour, osteoporosis, ankylosing spondylitis, fracture, inflammatory process, cauda equina syndrome and pregnancy) with a duration of more than 3 months. The capacity tests in the selected studies met the definition of capacity tests according to the ICF, which was adopted by a group of scientists and clinicians in the field of capacity testing [4]. Capacity tests assess 'the highest probable level of functioning that a person may reach in a domain at a given moment in a standardized environment'. Only studies that used capacity tests measuring the activity level of participants were included. Activity is the execution of a task or action by an individual. [1]

Quality Assessment

There are recommendations for reporting Meta-analysis Of Observational Studies (MOOSE) [11] and Strengthening the Reporting of Observational studies in Epidemiology (STROBE) [12,13]. However, no clearly defined tools for assessing quality and susceptibility to bias in cross-sectional studies are available [14,15]. We developed a checklist based on the key domains of assessing observational studies according to the STROBE checklist, the recommendations of Sanderson et al. (2007) [14], and von Elm (2007) [15] (Table 1). The 8-item checklist includes the following domains to assess: methods of selecting study participants, methods for measuring study variables, addressing design specific sources of bias, control of confounding variables and appropriate use of statistics. Two researchers (RA and SEL) independently performed quality assessment by scoring the checklist. Positive (+) was scored when an item was clearly described, negative (-) was scored when an item was not described, unclear (?) was scored when an item was not clearly described or incomplete. Primary authors were contacted to clarify items rated negative or unclear. One point was assigned to every scored positive item, half a point was assigned to every unclear item, and a total score was calculated. Studies were considered of high quality when at least 6 out of 8 items were rated positive. Studies were considered of low quality when 5 or less items were rated positive. The methodological quality of clinical trials was assessed with the PEDro scale. A PEDro score of at least 5 points (0-10) was considered to be of high quality [16]. Agreement between reviewers on the quality of included studies (+ /- / ?) was assessed using Cohen's kappa statistics (κ) for categorical variables and rated as poor if $\kappa \leq 0.2$; fair if $0.2 < \kappa \leq 0.4$; moderate if $0.4 < \kappa \leq 0.6$; substantial if $0.6 < \kappa \leq 0.8$; and good if $\kappa > 0.8$ [17].

Tabel 1 *Quality assessment checklist of cross sectional studies*

Item	Number	Criteria
Study population	1	Positive if source of selection of participants is clear and a representative sample of the population intended in the study was selected.
	2	Positive if inclusion and exclusion criteria were clearly described (duration pain, age, gender, employment, co-morbidities).
Measurements	3	Positive if used capacity tests are valid and reliable.
	4	Positive if instruments for associated factors are valid and reliable.
	5	Positive if assessment therapist was blinded for other test outcomes.
Analysis	6	Positive if appropriate univariate statistical method was used to establish the relationship between the associated factors and (the) capacity test result(s) according to the appropriate measurement level.
	7	Positive if appropriate multivariate statistical methods were used to establish the relative contribution of the associated factor to (the) capacity test result(s) according to the appropriate measurement level.
	8	Positive if the intended relationship between a capacity test and an influencing factor was controlled for confounding factors.

Data Extraction and Analysis

For each included study, details were extracted on study population, patient characteristics, capacity tests, measurements of the potentially associated factors and the test results. All reported associations were recalculated into R^2 to realise a homogeneous analysis. Furthermore, potential confounders included in regression analyses were extracted for evaluation.

The strength of statistical significant associations between related factors and results of functional capacity test results were rated low if $0.05 \leq R^2 < 0.25$, moderate if $0.25 \leq R^2 < 0.49$ and high if $R^2 \geq 0.50$ [1,18]. The relationships were interpreted as statistically significant when $p < 0.05$. Not significant associations or if $R^2 < 0.05$ were rated as no association. Level of evidence was reported when at least 3 studies investigated the same capacity test and potentially associated factor. High level evidence was described as consistent results in at least 2 high quality studies, moderate evidence as consistent results in at least one study of high quality, low evidence as consistent results in at least 3 low quality studies, and conflicting evidence as inconsistent results. Consistent means that at least 75% of the included studies had low, moderate, and/or high association, or at least 75% of the included studies had no association with the capacity test results. Absence of evidence was present when less than 3 studies reported on the same capacity test and biopsychosocial variable.

Results

Literature Search

The results of the search strategy are presented in Fig. 1. The literature search of databases resulted in 5534 potentially relevant studies. From the primary search, 5477 studies were excluded on title, abstract and duplicate by 2 researchers (RA en SEL). They read full texts and individually assessed inclusion of relevant studies. These assessments were compared and discussed until consensus was reached on in/exclusion of the 57 remaining studies. As a result, another 35 studies were excluded. The main reason for exclusion was firstly not meeting the targeted population of patients with non-specific CLBP. Secondly, the capacity test used in the study did not meet the intended definition of functional capacity. For example, studies that measured isokinetic trunk strength, or studies only using self-reported measurements of functional capacity were not included in our study. Thirdly, the study did not investigate a direct relationship between capacity test results and an associated factor. For example, studies that investigated a relationship between biopsychosocial factors and outcome following assessment, like return to work, were not included. Finally a total of 22 studies were included according the set inclusion criteria [5-10,19-33,36].

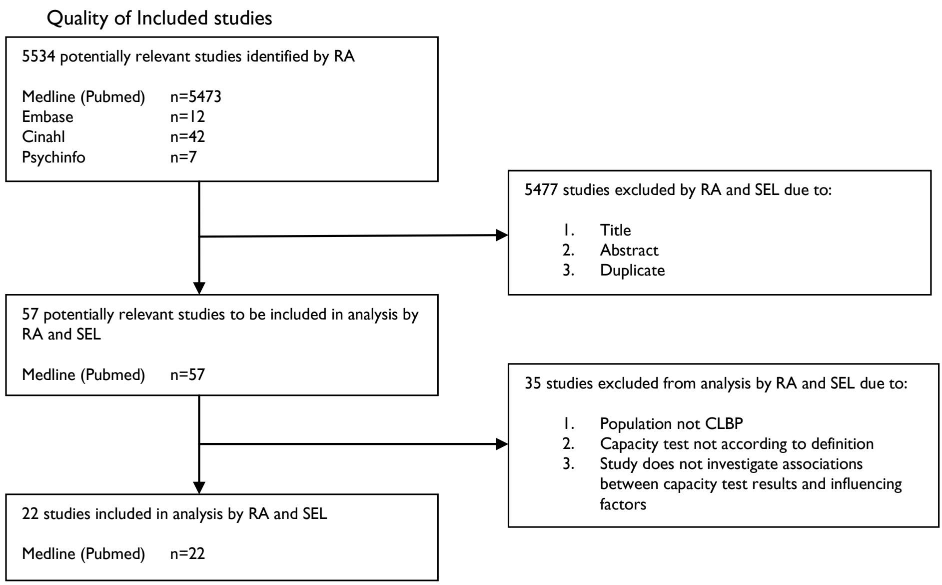

Fig. 1: *Selection of relevant studies*

Quality of Included Studies

Two researchers (RA en SL) scored the quality of included studies. Agreement on the quality assessment between the 2 investigators was high with a Cohen's kappa of κ=0,85. The quality of the studies was rated 'high' in 19 studies [5-10,19,22-28,30-32,34,36] and "low" in 3 studies [20,21,33] (Table 2).

Table 2 *Quality assessment*

	Design	1. Representative sample and clear source of selection	2. Clear inclusion/exclusion criteria	3. Valid and reliable capacity test(s)	4. Valid and reliable instruments for associated factors	5. Assessment therapist was blinded for other test outcomes	6. Appropriate univariate statistical methods were used	7. Appropriate multivariate statistical methods were used	8. Relationships were controlled for confounders	Total out of 8 items
Alschuler et al.2007 [6]	CS	+	-	+	+	+	+	+	+	7
Asante et al. 2007 [9]	CS	+	+	+	+/-	+	+	+	+	7,5
Crombez et al. 1999 [19]	CS	+	?	-	+	+	+	+	+	6
Cutler et al. 2003 [22]	CS	+	+	+	+	?	+	+	+	7
Filho et al. 2002 [21]	CS	+	-	+	+	?	+	-	-	4
Geisser et al 2000 [23]	CS	+	-	+	+	?	+	+	+	6
Gross et al. 2003 [33]	CS	+	+	+	+	-	+	-	-	5
Gross et al. 2005 [5]	CS	+	+	+	+	-	+	+	+	7
Gross et al. 2008 [36]	CT	PEDro scale								9 (0-10)
Kuijer et al. 2005 [24]	CS	+	+	+	+	+	+	+	+	8
Lackner et al. 1996 [25]	CS	-	+	+	+	+	+	+	+	7
Lackner et al.1999 [31]	CS	-	+	+	+	+	+	+	+	7
Reneman et al. 2002 [32]	CS	+	+	+	+	+	+	+	+	8
Reneman et al. 2003 [26]	CS	+	+	+	+	+	+	+	+	8
Reneman et al. 2006 [27]	CS	+	+	+	+	+	+	+	+	8
Reneman et al. 2007 [8]	CS	+	+	+	+	+	+	+	+	8
Reneman et al. 2008 [10]	CS	+	+	+	+/-	+	+	+	+	7,5
Schiphorst Preuper et al. 2008 [28]	CS	+	+	+	+	+	+	+	+	8
Smeets et al. 2007 [7]	CS	+	+	+	+	?	+	+	+	7
Teixeira da Cunha-Filho et al 2010 [20]	CS	+	+	+	+	?	+	-	-	5
Vlaeyen et al. 1995 [34]	CS	+	+	-	+	+	+	+	+	7
Wittink et al. 2001 [30]	CS	+	+	+	+	+	+	+	+	8

CS:cross-sectional study, CT: controlled trial

Description of Included Studies

Table 3 presents the population of the included studies, patient's characteristics, associations between functional capacity tests and associated factors, potential confounders, and conclusions. The capacity tests that were used in the included studies measured activities such as lifting low (i.e. lifting floor to waist), lifting high (i.e. lifting waist to overhead), walking, sit to stand, crouching, pushing, pulling and stair climbing. Lifting low was the most performed capacity test. The potentially associated factors that were investigated in the included studies were factors such as depression, pain intensity, pain related fear, fear of movement re-injury, self-reported disability, age, gender, health status, job status, pain duration, aerobic capacity, general and specific self-efficacy. In specific self-efficacy questioning closely resembles the task measured, general self-efficacy measures the subjects' expectations of their capacity in general. Patients were recruited from multidisciplinary rehabilitation centres, pain management programmes or spine clinics. The mean population age in the studies ranged from 37.0 to 45.8 years.

Sixteen studies performed univariate analysis to investigate the relationships between the results of a lifting capacity test and possible influencing factors. Multivariate regression analyses were performed in 11 studies to investigate the relative contribution of associated factors or confounders to capacity test results. Five studies performed a group comparison [8,24,26,28,29]. Groups were composed based on gender [8,26,28], high and low fear of movement/(re)injury [29], and work status [24]. One study was a randomized controlled trial [36].

Table 3 *Description of included studies*

	Study population characteristics	Factors associated with functional capacity tests							Authors' conclusions about significant associations
Alschuler et al. 2008 [6]	267 patients; 144♂/ 123♀		**Progressive Isoinertial Lifting Evaluation (PILE)**						Self-reported depression and disability had low associations with PILE results.
	The University of Michigan Spine Program, USA		**Lifting low**		**Lifting high**				
			R^2	β	R^2	β			Gender had low association with the waist to shoulder lift.
	Age†: 41.3 (8.6)	Depression (CES-D)‡	- 0.06***	- 0.25**	- 0.06**	- 0.23**			
		Self-reported disability (QBPDS)‡	- 0.22***	-	0.15***	-			Age and pain index were not associated to PILE results.
	Pain duration#: 57.8 (77.4) months	Pain Index (MPQ)‡	- 0.01	- 0.02	- 0.01	0.01			
		Age	0.00	- 0.01	0.00	0.01			
		Gender	0.00	0.07	0.04**	0.21*			
Asante et al. 2007 [9]	42 patients; 29♂/ 13♀		**Isernhagen Work Systems (IWS) - FCE**						Functional self-efficacy (predicted lifting and carrying) was associated with better results on the 3 lifting tasks.
	Rehabilitation program; Alberta, Canada (workers compensation claimants)		**Lifting low**		**Lifting high**		**Carrying**		
			R^2	β(adj)	R^2	β(adj)	R^2	β(adj)	
		Predicted floor to waist lift	0.50*	0.68**	0.18*	-	0.37*	-	Self-reported disability and pain intensity were associated (low) with test results of all three lifting tests.
	Age: 38.4 (10.2)	Predicted waist to overhead lift	0.35*	-	0.42*	0.59**	0.27*	-	
		Predicted carrying	0.49*	-	0.25*	-	0.53*	0.59**	
	Pain duration:161 (123) days	Self-reported pain disability (PDI)‡	- 0.12*	- 0.10	- 0.06	-	- 0.17*	- 0.01	The physical components of the SF-36 had low association with test results of all three lifting tests.
		Pain intensity (VAS)‡	- 0.10*	0.12	- 0.00	0.07	- 0.13*	- 0.16	
		SF-36‡(physical composition)	0.17*	0.29	0.10*	-	0.14*	0.10	
		SF-36 (mental composition)	0.00	- 0.06	0.00	- 0.02	0.00	- 0.24	
		SF-36 (physical functioning)	0.23*	-	0.08	-	0.21*	-	Age, gender, duration of injury and physical demands of work did not contribute to the three lifting tests.
		Age		-		-		-	
		Gender		-		-		-	
		Duration of injury		-		-		-	
		Physical demands work		-		-		-	

Study	Patients	Factor	Behavioural Approach Technique (BAT): Static lifting (minutes)		Conclusion
			R^2	β(adj)	
Crombez te al. 1999 [19]	31 patients; 13♂/ 24♀	Fear of movement/(re)injury (TSK)‡	- 0.24**	- 0.47**	Fear of movement/ (re)injury, self-reported pain disability, pain related fear and negative affect had a low association with static lifting results.
(Study 3)	Rehabilitation Centre; Hoensbroeck, The Netherlands	Pain disability (RDQ)‡	- 0.18*	-	
	Age: 41.6 (10.7)	Negative affect (NEM)‡	- 0.18*	-	Pain intensity, pain increase, catastrophizing, and age were not associated with static lifting.
	Pain duration†: 10.1 (8.9) years	Pain related fear (PASS)‡	- 0.11*	-	
		Pain catastrophizing (PCS)‡	- 0.26	-	Radiation into the legs, fear of movement/ (re)injury and being a women contributed significantly to poorer static lifting results.
		Pain intensity (VAS)	0.01	-	
		Pain increase	-	-	
		Age	-	-	
		Gender	-	- 0.48***	
		Radiation into legs	-	- 0.49**	

Study	Patients	Factor	Dictionary of Occupational Titles (DOT) FCE						Conclusion
			Climbing		**Crouching**		**Lifting low**		
			t/ X^2	β	t/X^2	β	t/X^2	β	
Cutler et al. 2003 [22]	188 patients; 100♂/ 88♀	Pain intensity (VAS)	3.63*	-	4.57**	- 0.26*	3.43*	- 0.27*	Pain intensity was associated with results of all three tests.
	Multidisciplinary pain treatment center, Miami, USA	Workers compensation	9.35*	- 0.96*	13.26**	- 0.84*	5.96	-	Workers compensation and state anxiety were associated with climbing and crouching results.
	Age: 40.9 (9.8)	Depression (BDI)‡	4.25*	0.02*	2.57	-	1.54	-	Depression and stress were associated to climbing.
	Pain intensity† (0-10) (sd): 5.9 (2.5)	State anxiety (STAI)‡	3.18*	-	3.02*	-	0.61	-	
		Trait anxiety (STAI)	2.47	-	2.72*	-	0.75	-	Trait anxiety was associated with crouching.
		Stress (PSS)‡	2.64*	-	1.46	-	0.08	-	

Study	Population	Variable					Conclusion
Filho et al. 2002 [21]	51 patients; 23♂/ 28♀		**Sit to Stand (SS)**	**Time to Roll (TTRL)**	**5 Minute walking (5MW)**	**50-Foot walk (50-FW)**	Self-reported disability had a low association with all four capacity tests.
	Outpatient orthopedic spine clinic; Houston, USA		R^2	R^2	R^2	R^2	Self efficacy, pain affect, pain intensity and self-reported disability had low associations with the TTRL.
		Self-reported disability (RMDQ)	0.23*	0.19*	- 0.17*	0.19*	
		Pain intensity (VAS)	0.01	0.12*	- 0.01	0.02	
	Age: 45.8 (9.8)	Pain affect (VAS)	- 0.07	0.12*	- 0.01	0.04	Aerobic capacity had a low association with the 5MW.
		Self-Efficacy (SES)‡	0.01	0.10*	- 0.03	0.04	
	Pain duration: 95 (100.4) months	Aerobic capacity (pred. equation)	- 0.07	0.00	0.11*	- 0.01	
Geisser et al. 2000 [23]	133 patients; 75♂/ 58♀		**PILE Lifting low**		**Lifting High**		Receiving compensation, involvement in litigation, pain duration, the pain index and depression had negligible or low associations with both PILE results.
	University of Michigan Spine Program, USA		R^2	β	R^2	β	
		Compensation status	- 0.04**	- 0.06	- 0.04**	- 0.01	
	Age: 41.7 (8.5)	Litigation status	- 0.07**	- 0.20**	- 0.05**	- 0.06	The TSK-2 avoidance subscale had low associations with both PILE test results.
		Pain duration	0.03*	0.06	0.04**	0.07	
	Pain duration: 65.3 (86.6) months	Pain Index (MPQ)	- 0.02	0.16	- 0.04*	0.03	Physiologic and perceived effort were moderately associated to both PILE test results.
		Avoidance (TSK)	- 0.09***	- 0.20**	- 0.10***	- 0.18*	
		Fear (TSK)	- 0.02	0.10	0.08***	- 0.05	
		Depression (CES-D)	- 0.06**	0.00	- 0.06**	0.00	Gender was associated with the waist to shoulder lift.
		Body Mass Index (BMI)	- 0.01	- 0.10	- 0.01	- 0.06	
		Metabolic Equivalent (MET)	0.00	0.09	- 0.01	0.04	
		Physiologic effort (HRmax)	0.28***	0.27**	0.31***	0.33***	Age, gender, pain, TSK (fear), BMI and MET were not associated with lifting low test results.
		Perceived effort (Borg Scale)	0.16***	0.32***	0.17***	0.32***	
		Gender	- 0.00	0.20	0.05**	0.20**	
		Age	- 0.00	-	0.00	-	Age, BMI and MET were not associated with lifting high test results.

Gross et al. 2003 [33]	321 patients; 231♂/ 90♀ Workers' compensation rehabilitation facility; Alberta, Canada Age:42 (9.9) Days from injury†: 737 (1361)	**IWS-FCE** **Lifting low** (R²) PDI: -0.27 Pain intensity (VAS): -0.20	Self reported pain disability was moderately associated with average maximum weight lifted in 6 lifting tests. Pain intensity had a low association with lifting capacity.
Gross et al. 2005 [5]	170 patients; 121♂/ 49♀ Workers' compensation rehabilitation facility; Alberta, Canada Age: 41.0 (10.9) Days from injury: 450 (821) Pain intensity (0-10): 5.0 (2.0)	**IWS-FCE** **Lifting low** (R² / β) Pain intensity (VAS): - 0.18* / - Self-reported pain disability (PDI): - 0.30* / - 0.49** Recovery expectations: 0.04* / - Support at workplace (OPP)‡: 0.00 / - Age: - / - 0.24** Gender: - / 0.25** Duration of injury: - / -	Pain intensity and self reported pain disability had low to moderate associations with lifting capacity Lifting test results were best predicted by patients perceptions of what they can and cannot do, reflected by the PDI scores and secondary by gender and age. Lifting test results were not or negligibly correlated with recovery expectations support at workplace, or duration of injury.
Gross et al. 2008 [36]	30 patients;19♂/ 11♀ University Hospital Multidisciplinary Pain Centre and local community. Age: 49.4 (16.4) Pain intensity baseline (0-10): 6.0 (2.1)	**FCE** (**Lifting low 1 rep max (kg)** / **Lifting low repetitive (time to fatigue in sec)**) Opioid administration: 29.4 (17.9) / 312 (251.4) Placebo: 25.6 (3.1) / 231 (199.9) Significance and effect size: p < 0.02 ES 0.23 (95% CI, -0.33-0.78) / P< 0.03 ES 0.40 (95% CI, -0.21-0.98)	Functional capacity of lifting low was significantly different between patients under the influence of opioid and patients administered with a placebo.

Study	Population							Conclusion
Kuijer et al. 2005 [24]	92 patients; 60♂/ 32♀	**IWS-FCE** **Material handling kg** (lifting low, overhead lifting, short carry two handed, pushing and pulling)						Functional capacity of material handling was not significantly different between working and non-working patients
	Multidisciplinary pain management programme; Groningen, The Netherlands			Mean (SD)				
	Age: 38.5 (8.7)	Men	Working	178.3 (54.1)	ns			
			Non-working	171.2 (53.8)				
	Duration of complaints: 75 (24.2) weeks	Women	Working	127.0 (38.8)	ns			
			Non-Working	114.2 (38.0)				
Lackner et al. 1996 [25]	78 patients; 49♂/ 36♀		**Work Capacity Evaluation**					Functional Self-Efficacy was low to moderately associated with all work capacity evaluation tasks.
	Community referrals from physicians		**Lifting low**	**Lifting high**	**Carrying**	**Static pushing**	**Static Pulling**	
	Age (range): 37(21-63)		R^2	R^2	R^2	R^2	R^2	Gender contributed to lifting low and lifting high.
	Median time since injury (range): 12.7 (2.4- 252 months) weeks	FSE‡ with pain expectancy controlled	0.30***	0.14***	0.24***	0.24***	0.42***	Pain contributed to lifting high and carrying
		FSE with reinjury expectancy controlled	0.34***	0.18***	0.24***	0.31***	0.40***	
		Pain expectancy with FSE controlled	-0.03	-0.05	-0.08*	-0.05	0.03	
		Reinjury expectancy with FSE controlled	-0.00	-0.01	-0.03	-0.04	-0.00	
			β	β	β	β	β	
		FSE	0.21***	0.16***	0.15***	0.37***	0.79***	
		Gender	-8.9*	-9.88**	-7.45	-12.10	-18.87*	
		Pain	-2.46	-0.77***	-2.08**	-2.85	-5.00	

Lackner et al. 1999 [31]	78 patients; 49♂/ 36♀ Community referrals from physicians Age (range): 37(21-63) Median time since injury (range): 12.7 (2.4- 252 months) weeks		**WEST 2- Work Capacity Evaluation** **Lifting low**		**Lifting high**		Functional self-efficacy and perceived pain control associated with the two lifting tasks. Perceived ability to decrease pain and anxiety were not associated with lifting low test results. Functional self-efficacy contributed to the two lifting test results. Pain intensity and gender contributed to lifting low test results.
			R^2	β	R^2	β	
		Functional Self efficacy	0.35*	0.18**	0.18**	0.16**	
		Perceived Pain control (CSQ)‡	0.12**	-	0.07*	-	
		Perceived ability to decrease pain	-	-	-	-	
		Anxiety (T-A PMS)‡	-	-	-	-	
		Pain Intensity	-	- 2.43***	-	-	
		Gender	-	- 9.58**	-	-	
Reneman et al. 2002 [32]	64 patients; 54♂/ 10♀ Outpatient university rehabilitation and occupational assessment center, Groningen, The Netherlands. Age: 38.0 (8.9) Pain intensity (0-10): 5.1(2.1)		**IWS-FCE** **Total of 14 activities**				Self reported disability measured with the OBPDS and the QBPDS were moderately associated with the IWS-FCE activities. Self reported disability measured with the RMDQ was not associated with the IWS- FCE results
			R^2	t			
		Self-reported disability (RMDQ)	0.04				
		Self-reported disability (OBPDS)	- 0.27*				
		Self-reported disability (QBPDS)	- 0.25*				
		Gender - man		3.8**			
		- women		2.9**			
Reneman et al. 2003 [26]	64 patients; ♂54/ ♀10 Outpatient rehabilitation program, Groningen The Netherlands Age (sd):38.0 (8.9) Pain intensity (0-10): 5.1 (2.1)		**IWS-FCE** **Avoidance**	**Lifting low**			Pain intensity, kinesiophobia, gender, pain duration, previous episodes of pain and sick leave were not associated with avoidance measured with lifting low and FCE-DOT.
			R^2	R^2			
		Kinesiophobia (TSK) Men	- 0.03	- 0.01			
		Women	0.04	- 0.01			
		Pain intensity (NRS)‡	- 0.05	- 0.04			
		Pain duration	- 0.02	- 0.04			

Reneman et al. 2006 [27]	**The Netherlands:** 121patients; 71♂/60♀ Outpatient rehabilitation program Age: 38.0 (9.0) Pain intensity (0-100): 51(21.4) **Canada**: 273 patients; 71♂/202♀ Workers compensations context Age: 41 (9.4) Pain intensity (0-100): 51 (21.4) **Switzerland**: 170 patients ; 79♂/93♀ Inpatient rehabilitation Age: 42 (8.5) Pain intensity (0-100: 51 (21.4)		**IWS-FCE** **Lifting low**	**Lifting high**	**Carrying**	Assessment setting had moderate to high associations with lifting results; patients from the Dutch sample lifted significant more weight than patients from the Canadian and Swiss sample. Self-reported disability, gender, age and duration of back pain contributed to lifting capacity. Pain intensity was not associated with lifting capacity.
			β	β	β	
		Assessment setting	0.52***	0.29***	0.55***	
		Self-reported disability (RMDQ)	- 0.29**	- 0.41**	- 0.29**	
		Pain intensity (VAS)	- 0.07	-	-	
		Gender	0.28**	0.31**	0.23**	
		Age	- 0.07*	-	- 0.06*	
		Duration of back pain	- 0.11**	- 0.11**	- 0.14**	
Reneman et al. 2007 [8]	Outpatient rehabilitation Program; Groningen, The Netherlands **study 1:**79 patients; 49♂/30♀ Age ♂/♀: 37.8/37.8 Pain intensity (0-10): 4.7/5.0 **study 2:** 58 patients ♂/♀: 39/19 Age♂/♀: 40.4/35.6 Pain intensity (0-10): 4.5/4.9		**IWS-FCE** **Lifting low**			There was no association between pain intensity in study 1, pain related fear (TSK), the activity scale of the FABQ and lifting low results. Pain intensity and lifting capacity were moderately associated in men in study 2. The work subscale of the FABQ had a low association with lifting capacity in men in study 2. Gender contributed to lifting test results.
			R^2	R^2	β	
		Study 1	Women	Men		
		Pain intensity	- 0.00	- 0.07	-	
		Fear of movement/ (re) injury (TSK)	- 0.03	- 0.01	-	
		Gender	-	-	0.48**	
		Study 2				
		Pain intensity	0.01	- 0.25*	- 0.29*	
		Fear avoidance (FABQ)‡ activity	- 0.00	- 0.02	-	
		Fear avoidance (FABQ) work	- 0.00	- 0.14*	-	
		Gender	-	-	0.48**	

Reneman et al. 2008 [10]	92 patients; 60♂/ 32♀ Multidisciplinary pain management programme Groningen, The Netherlands Age: 38.5 (8.7) Pain intensity (0-10): 5.0 (2.1)		**Modified Work Well FCE** **Lifting low**		**Lifting high**		**Carrying**		Specific SE was moderately associated with lifting low . Self reported disability had low associations with lifting low and carrying results. The physical component of SF-36 had low associations with lifting capacity. General SE, age, pain intensity, psychosocial distress and the mental subscale of the SF-36 were not associated with the lifting test results. Gender contributed to all lifting test results.
			R^2	β	R^2	β	R^2	β	
		Specific SE: (prediction)	0.30*	0.53*	0.07	0.15	- 0.02	- 0.18	
		General SE: (ALCOS)‡	- 0.00	-0.20	0.02	- 0.08	0.00	0.18	
		Gender	-	0.28*	-	0.51*	-	0.44*	
		Age	- 0.00	-	0.00	-	- 0.01	-	
		Pain intensity	0.02	-	- 0.00	-	0.00	-	
		Psychosocial distress (SCL -90)‡	- 0.00	-	- 0.00	-	0.00	-	
		Self-reported disability (RMDQ)	0.05*	-	- 0.04	-	- 0.08*	-	
		Health related quality of life (SF-36):							
		-physical	0.02*	-	0.04*	-	0.06*	-	
		-mental	0.00	-	0.01	-	0.04	-	
		Self Esteem (SES)	- 0.00	-	0.01	-	0.00	-	
Schiphorst Preuper et al. 2008 [28]	92 patients; 60♂/ 32♀ Multidisciplinary pain management programme; Groningen, The Netherlands Age: 38.5 (8.7) Pain intensity (0-10): 5.0 (2.1)		**Work-Well FCE** **Lifting low**		**Carrying**		**Static forward bend**		Only fear of movement/(re)injury had a low association with static forward bending Psychosocial distress, depression, general self-efficacy, self esteem, pain cognitions and coping were not associated with the Work-Well capacity tests.
			R^2 Men	R^2 Women	R^2 Men	R^2 Women	R^2		
		Psychosocial distress (SCL-90-R)	- 0.00	0.04	- 0.01	0.00	- 0.02		
		Depression (BDI)	- 0.00	0.04	- 0.01	0.00	- 0.01		
		General Self-efficacy (ALCOS-SF)	- 0.00	- 0.00	0.01	- 0.01	- 0.01		
		Self esteem (SES)	0.00	- 0.01	0.00	0.02	0.00		
		Fear of movement/ (re) injury (TSK)	- 0.00	- 0.01	- 0.03	- 0.00	- 0.06*		
		Pain cognitions (PCL-E)‡	- 0.00 to 0.06	- 0.04 to 0.05	- 0.01 to 0.03	- 0.11 to -0.00	- 0.02 to 0.01		
		Coping (UCL)‡	- 0.02 to 0.00	- 0.10 to 0.04	- 0.07 to 0.00	- 0.00 to 0.01	- 0.03 to 0.04		

Smeets et al. 2007 [7]	221 patients: 116♂/105♀ Outpatient unit of three rehabilitation centers; Brabant, The Netherlands Age : 41.6 (10.0) Duration of LBP: 56.7 (72.3) months		**IWS-FCE 5 -MW**	**50-FW**	**Sit to Stand**	**Loaded forward Reach (LFR)**	**One minute stair climbing**	**PILE Lifting**	Gender was associated with 5-MW, 50-FW, LFR, PILE. Higher pain intensity was associated with 5-MW, 50-FW and stair climbing tests. Higher VO2 max was related to Sit to Stand and stair climbing. More fear of movement/(re)-injury was related to lower PILE results. Higher self-reported depression was related to lower test results on the 5-MW, Sit to Stand, stair climbing and PILE. Higher level of catastrophizing was related with more steps climbed. More internal control was related to higher test results on the 50-MW and stair climbing. Radiating pain, age and pain duration had no associations with test results.
		Model adjusted R^2	0.21	0.22	0.17	0.13	0.34	0.19	
			β	β	β	β	β	β	
		(only significant variables were displayed)							
		Age	-	-	-	-	-	-	
		Gender	0.16*	0.24*	-	0.22*	-	0.14*	
		Pain duration	-	-	-	-	-	-	
		Radiating pain	-	-	-	-	-	-	
		Pain intensity (VAS)	- 0.20*	- 0.22*	-	-	- 0.29*	-	
		VO2max	-	-	0.16*	-	0.17*	-	
		Fear of movement/(re)-injury (TSK)	-	-	-	-	-	- 0.23*	
		Depression (BDI)	- 0.18*	-	-0.29*	-	- 0.29*	- 0.25*	
		Catastrophizing	-	-	-	-	0.28*	-	
		Internal control (PCL)	-	0.17*	-	-	0.17*	-	
Teixeira da Cunha-Filho et al. 2010 [20]	29 patients; 5♂ / 24♀ Program for low back treatment at the University Center of Belo Horizonte; Minas Gerais, Brazil Age: 39,4 (12,3) Pain intensity (0-10): 4.4 (2.6)		**Sit to Stand (SS)**	**5 Minute Walking (5MW)**	**50-Foot Walk (50-FW)**	**Timed Up and Go (TUG)**			Self-reported disability had low associations with SS and 5- MW. Pain intensity and self-efficacy were not associated with the functional capacity tests.
			R^2	R^2	R^2	R^2			
		Self-reported disability (RMDQ)	0.19*	- 0.15*	0.05	0.03			
		Pain intensity (VAS)	- 0.00	- 0.10	- 0.00	- 0.01			
		Self-Efficacy (SES)	0.04	- 0.02	0.03	0.03			
Vlaeyen et al. 1995 [29]	**Study 2:** 33 patients ; 8♂/25♀ Behavioral rehabilitation program; Hoensbroeck, The Netherlands Age: 42.4 (9.7) Pain duration (years): 10.3 (10.1)		**Behavioural Approach Technique (BAT): Static lifting (minutes)**						Fear of movement/(re)injury was associated low with static lifting capacity.
			R^2						
		Fear of movement/(re)injury	-0.19**						

Wittink et al. 2001 [30]	75 patients; 33♂/ 42♀ Outpatient pain management program at New England Medical Centre; Boston, USA Age: 39.9 (8.1) Pain duration: 40.6 (45.3) months		**Bruce treadmill walking test (Minutes walked)**	A moderate association was found between peak VO2 and minutes walked. Age, gender, mental health, and pain duration were not associated with minutes walked.
			R^2	
		Peak VO2	0.49***	
		Age	0.08	
		Gender	0.01	
		Pain intensity (NRS)	0.11	
		Pain duration	0.00	
		Mental Health (SF-36)	0.01	

*p < 0.05; ** p < 0.01 ;*** p< 0.001; ns=non significant
†Age/ pain duration/ pain intensity/ day from injury: mean (sd)
- Association not calculated or not displayed in original article
‡CES-D: Center for Epidemiologic Studies Depression Scale, QBPDS: Quebec Back Pain Disability Scale, MPQ: McGill Pain Questionnaire, PDI: Pain Disability Index, VAS: Visual Analog Scale, SF-36: Short Form (36) Health Survey, RDQ: Roland Disability Questionnaire, TSK: Tampa Scale for Kinesiophobia, PASS: Pain Anxiety Symptoms Scale, NEM: Negative Emotionality Scale, PCS: Pain Catastrophizing Scale, RMDQ: Roland Morris Disability Questionnaire, SES: Self-efficacy Scale, BDI: Beck Depression Inventory, STAI: State-Trait Anxiety Inventory, PSS: Perceived Stress Scale, HRmax: Maximum Heart Rate, OPP: Organizational Policies and Practices Scale, CSQ: Coping Strategies Questionnaire; T-A PMS: Tension-Axiety scale of the Profile of Mood States; NRS: Numerical Rating Scale, FABQ: Fear Avoidance Beliefs Questionnaire, FSES: Functional Self Efficacy Scale, ALCOS: Algemene Competentie Schaal (Dutch version of the General Self Efficacy Scale), CSL-90-R: Symptom Checklist, PCL(-E): Pain Cognition List, (experimental version), UCL: Utrecht's Coping List, OLBPDQ: Owestry Low Back Pain Disability Questionnaire.

Level of Evidence

The relation between potentially associated factors and lifting low, lifting high, static lifting and carrying that was investigated in at least 3 studies was merged in Table 4 to extract the level of evidence.

Table 4 *Evidence table*

	Lifting low	Lifting high	Carrying	Static lifting
Gender male	C	POS	C	A
Age	C	NO	C	A
Pain intensity	C	NO	NO	A
Pain duration	NO	C	A	A
Self-reported disability	NEG	C	NEG	A
Specific self-efficacy	POS	POS	C	A
Fear of movement/re-injury	C	A	A	NEG
Depression	C	C	A	A

C: Conflicting evidence,
POS: High level evidence for positive association,
NEG: High level evidence for negative association,
NO: High level evidence for no association,
A: Absence of evidence

Evidence for Factors Associated With Lifting Low

Lifting Low, Gender and Age

There is conflicting evidence that gender associates with lifting low test results. Four studies reported absent associations [6,9,23,26] and 6 studies reported a contribution of gender after regression analysis [5,7,8,10,27,31]. There is conflicting evidence for associations of age with lifting low test results. Lifting low was not associated with age in 4 studies [6,9,10,23] but age contributed to lifting test results in 2 other studies [5,27].

Lifting Low, Pain Intensity and Pain Duration

There is conflicting evidence for an association of lifting low test results with pain intensity in patients with non-specific CLBP. The only RCT in this review reported a significant difference with a moderate effect size in lifting performance between patients who were administered an opioid and patients who were administered a placebo [36]. In 5 studies low to moderate associations were found for pain intensity [5,8,9,33,36]. After regression analysis pain intensity contributed to lifting test results in 3 studies [8,22,31]. In 7 studies pain intensity had no association with lifting low test results [6-8,10,23,26,27]. There is high level evidence that lifting low test results have no association with pain duration [5,7,9,23,26]. Pain duration contributed to the results of the lifting low test in only one study [27].

Lifting Low and Self-Reported Disability

There is high level evidence for a low [6,9,10] to moderate [5,32,33] association of self-reported disability with lifting low test results. After regression analysis, self-reported disability contributed to lifting low in 2 studies [5,27].

Lifting Low and Specific Self-Efficacy

There is high level evidence for the association of specific self-efficacy with lifting low. Three studies reported a moderate association [10,25,31] and one study a high association [9]. All 4 studies reported contribution of specific self-efficacy to capacity test results after regression analysis.

Lifting Low, Fear of Movement/ (Re)-Injury and Fear Avoidance Beliefs

There is conflicting evidence for an association of lifting low test results with fear of movement/(re)injury. Four studies reported an absent association [8,10,26,28]. In one study there was a low association with fear avoidance beliefs, but absent association of fear of movement/ (re)-injury with work related activities [8]. Two studies reported contribution of fear of movement/ (re)-injury after regression analysis [7,23].

Lifting Low and Depression

There is conflicting evidence for an association of lifting low test results with depression. Two studies did not find an association [22,28]. Two studies reported a low association between depression and lifting low test results [6,23]. Two studies reported a contribution of depression after controlling for confounders [6,7].

Evidence for Factors Associated With Lifting High

Lifting High, Gender and Age

There is high level evidence that gender was associated with lifting high. One study found no association [9], and in 5 studies gender contributed to lifting high test results [6,10,23,25,27]. There is high level evidence that age has no association with lifting high test results, because all studies relating age to lifting high found absent associations [6,9,10,23,27].

Lifting High and Specific Self Efficacy
There is high level evidence that specific self-efficacy has low to moderate associations with lifting high. Two studies reported a low association [25,31] and one study [9] reported a moderate association. Two studies found a contribution of specific self-efficacy after controlling for confounders [9,31]. One study reported absent association between lifting high and specific self-efficacy [10].

Lifting High, Pain Intensity and Pain Duration
There is high level evidence that lifting high test results have no association with pain intensity in patients with non-specific CLBP [6,9,10,23,25,27]. Pain duration contributed in one study [27] to lifting high test results, in 2 other studies no associations were found [9,23]. This means there is conflicting evidence for association of pain duration with lifting high test results in patients with CLPB.

Lifting High and Self-Reported Disability
There is conflicting evidence of the association of lifting high test results with self-reported disability. Two studies reported no association with lifting high [9,10], one study reported a low association [6], one study reported a moderate association [32], and one study reported a contribution of self-reported disability after multivariate regression analysis [27].

Lifting High and Depression
There is conflicting evidence for an association of lifting high with depression in patients with non-specific CLBP. One study reported an absent association [28], 2 studies reported a low association between depression and lifting high test results [6,23].

Evidence for Factors Associated With Carrying

There is high level evidence that carrying is associated with self-reported disability [9,10,27,32]. There is high level evidence that carrying is not associated with pain intensity [9,10,25,27]. There is conflicting evidence that carrying is associated with specific self-efficacy [9,10,25], gender or age [9,10,27].

Evidence for Factors Associated With Static Lifting

There is high level evidence that fear of movement/ (re)injury has a low association with static lifting test duration [19,28,29,34]. The lifting test used in these studies was specifically designed to measure avoidance in patients with chronic (low) back pain.
Other variables such as assessment setting, aerobic capacity and pain cognitions were investigated in only a few studies. Therefore, there is not enough material to supply a substantiated level of evidence.

Discussion

The objective of the present review was to provide an overview of the current status of information on factors that associate with capacity test results. There is substantial research on factors influencing capacity test results, but there is much heterogeneity in factors and kinds of capacity tests that have been investigated.

There is conflicting evidence for many factors associated to capacity test results in patients with non-specific CLBP. The high level evidence of self-reported disability and specific self-efficacy in relation to capacity test results is an outcome of interest. It seems that patients' reports of their ability to execute activities is a factor of importance.
Similarly to our results, an earlier review in 2003 reported few psychosocial factors to be directly associated to capacity tests and other functional measures [3]. Social factors such as workers compensation, involvement in litigation, influence of the test evaluator, support from the workplace or from significant others or assessment setting are scarcely investigated in direct relation to results of functional capacity tests. Furthermore, only few studies investigated the relation between biological factors and functional capacity testing in patients with CLBP. Gender and age were related to test results but factors like muscular strength and aerobic capacity were scarcely explored. We should, therefore, conclude that there is currently absence of evidence regarding social and biological/physiological factors.

The strength of this study is the systematic approach to collect evidence from literature on the subject methodologically. This resulted in a useful overview for clinicians that use capacity tests. Researchers can benefit from this review by exploring the gaps in this research area. In the clinical setting, clinicians might use the study results in the diagnostic process when patients with non-specific CLBP have lower test results on a functional capacity test than expected.

In order to create a broad overview of related variables and get insight into the gaps in this research area, we made the choice for a fairly broad research question. As a result, interpretation of the results of all the studies that investigated capacity test results and associated factors was challenging because of the large diversity of capacity tests, potentially associated factors and diversity in measurements for each potential associated factor. This results in some points for discussion.

First, only 4 types of capacity tests were analysed for level of evidence because those tests were studied in relation to the same biopsychosocial factors in at least 3 studies. Furthermore, lifting low was measured in 3 different functional capacity tests (PILE, IWS-FCE and WEST2-Work Capacity Evalutation). We considered the possibility that biopsychosocial factors could have different associations with different capacity tests. However, in one study where this was subject of investigation; the differences in lifting between PILE and IWS-FCE could not be explained by psychosocial variables [35].

Secondly, functional capacity limiting factors could not be extracted from the reviewed studies. For example test end points were often not (clearly) operationalized and reasons for test terminations were not documented in the studies included. It is likely that this has impacted the interpretations of the primary studies and therefore also on this review.

Thirdly, many studies were not clear about, or did not mention assessment timing [5,6,19,20, 21,22,23,24,27,30,33]. Assessment timing is an important factor for interpretating the associations between biopsychosocial factors and FCE, especially those variables that may alter as a result of FCE, such as self-efficacy. However, In the 11 studies that did mention assessment timing, all predictor measures were taken prior to the FCE.

Finally, decisions on interpretation of results such as quality of included studies and level of evidence were arbitrary, but thoroughly considered. Because there is no quality assessment list available for cross sectional studies we followed guidelines from the STROBE-checklist and other recommendations on quality assessment of observational studies. Using our checklist, most studies were rated of high quality. One explanation might be that the sensitivity of our self made list was too low, which could have caused a selection bias. Because of the marked structure of reviewing there is the possibility of having excluded literature that is related to the subject of interest, but is not within our inclusion criteria.

From this review arise new areas for further research. An important next step in the research of factors influencing capacity testing is manipulating that factor in an RCT. The Gross et al. paper is one example where pain intensity was manipulated (reduced with medication) with influence on FCE test results [36]. Furthermore, we recommend other research designs to explore mechanisms behind displayed behavior, such as qualitative research on underlying motives of patients who do not reach maximal physical capacity and research on opinions of professionals working with capacity tests on what factors could influence capacity results.
Furthermore, there was a very interesting finding that did not make the final analysis because only one study performed this type of research [27]. The point of interest were social variables and has to do with the research setting. In this study, considerable differences in maximum weight handled on the various FCE items were observed between patients within a Dutch outpatient rehabilitation context, a Canadian workers' compensation context and a Swiss inpatient rehabilitation context. These differences in (financial) consequences for patients undergoing FCE, the role of evaluators and patient-evaluators interactions in different settings is still underexposed, and should be subject of further investigation.

Conclusion

Much heterogeneity was seen in investigated capacity tests and candidate associated factors. The conclusions from this review are first, that there is conflicting evidence for many factors in patients with non-specific CLBP that influence capacity test results and second, there is some high level evidence that reported factors do or do not associate with capacity test results as follows: High level of evidence was assigned to the association between lifting low and self-reported disability and lifting low and specific self-efficacy but not for duration of pain, and to the association between lifting high and gender and specific self-efficacy, but not for pain intensity and age, and to the association between carrying and self-reported disability but not for pain intensity, and to the association between static lifting and fear of movement in patients with CLBP. Other variables such as assessment setting, aerobic capacity and pain cognitions were investigated in only a few studies. Therefore, there is not enough material to supply a substantiated level of evidence. High level evidence for social factors was absent.

APPENDIX A Search Strategies

Medline (Pubmed version), Cinahl (EBSCO host), PsycINFO (EBSCO host)

1 ("Body Regions"[Mesh] OR "Musculoskeletal System/anatomy and histology"[Mesh] OR shoulder[tw] OR elbow[tw] OR hand[tw] OR extremity[tw] OR hip[tw] OR knee[tw] OR patellofemoral[tw] OR foot[tw] OR toe*[tw] OR arm[tw] OR leg[tw] OR back[tw] OR spine[tw] OR neck[tw])

2 "Pain/diagnosis"[Mesh] OR "Pain/epidemiology"[Mesh] OR "Pain/etiology"[Mesh] OR pain[tw] OR "Occupational Diseases/diagnosis"[Mesh] OR "Occupational Diseases/epidemiology"[Mesh] OR "Occupational Diseases/etiology"[Mesh] OR "Arm Injuries/diagnosis"[Mesh] OR "Arm Injuries/epidemiology"[Mesh] OR "Arm Injuries/etiology"[Mesh] OR "Back Injuries/diagnosis"[Mesh] OR "Back Injuries/epidemiology"[Mesh] OR "Back Injuries/etiology"[Mesh] OR "Hand Injuries/diagnosis"[Mesh] OR "Hand Injuries/epidemiology"[Mesh] OR "Hand Injuries/etiology"[Mesh] OR "Hip Injuries/diagnosis"[Mesh] OR "Hip Injuries/epidemiology"[Mesh] OR "Hip Injuries/etiology"[Mesh] OR "Leg Injuries/diagnosis"[Mesh] OR "Leg Injuries/epidemiology"[Mesh] OR "Leg Injuries/etiology"[Mesh] OR "Neck Injuries/diagnosis"[Mesh] OR "Neck Injuries/epidemiology"[Mesh] OR "Neck Injuries/etiology"[Mesh] OR "Tendon Injuries/diagnosis"[Mesh] OR "Tendon Injuries/epidemiology"[Mesh] OR "Tendon Injuries/etiology"[Mesh] OR "Fibromyalgia/diagnosis" [Mesh] OR "Fibromyalgia/ epidemiology"[Mesh] OR "Fatigue Syndrome, chronic/diagnosis"[Mesh] OR "Fatigue Syndrome, chronic/epidemiology"[Mesh] OR "Fatigue Syndrome, chronic/etiology"[Mesh] OR "Myofascial Pain Syndromes/diagnosis" [Mesh] OR "Myofascial Pain Syndromes/epidemiology"[Mesh] OR "Myofascial Pain Syndromes/etiology"[Mesh] NOT osteoarthritis[Mesh] NOT "Rheumatoid arthritis"[Mesh] NOT

3 "Physical capacity"[tw] OR "Physical performance"[tw] OR "Physical ability"[tw] OR "Physical activity"[tw] OR "Physical functioning"[tw] OR "Physical test"[tw] OR "Functional test"[tw] OR "Physical measures"[tw] OR "Functional performance"[tw] OR "Functional ability"[tw] OR "Functional health status"[tw] OR "Functional limitations"[tw] OR "Functional testing"[tw] OR "Disability evaluation"[Mesh] OR "Functional capacity"[tw] OR "Behavioural performance"[tw] OR "Activity level"[tw] OR "Activity limitations"[tw] OR "Work capacity evaluation"[Mesh] OR "Functional capacity evaluation"[tw] OR "Functional capacity assessment"[tw] OR "Functional assessment"[tw] OR "Physical capacity evaluation"[tw] OR "Task performance and analysis"[Mesh] OR "Employee performance appraisal"[Mesh] OR "Physical performance test"[tw] OR "Physical ability test"[tw] OR "Assessment/rehabilitation"[tw] OR Walking[tw] OR Lifting[tw] OR "Lifting capacity"[tw] OR "Reaching task"[tw] OR "Functional reach"[tw] OR "Exercise test"[Mesh] OR "Exercise test"[tw]

4 "construct validity"[tw] OR "measurement properties"[tw] OR OR "pain measurements"[tw] OR questionnaires[Mesh] OR evaluation[tw] OR evaluating[tw] OR relation[tw] OR relationship[tw] OR contribution[tw] OR contributing[tw] OR appraisal[tw] OR determinant[tw] OR determinants[tw] OR influence[tw] OR influencing[tw] OR kinesiophobia[tw] OR "fear avoidance"[tw] OR fear[tw] OR "activity avoidance"[tw] OR avoidance[tw] OR "pain-related fear"[tw] OR "illness behaviour"[tw] OR catastrophizing[tw] OR "psychological factors"[tw] OR

A "Comparative study" [Mesh] OR "Cross-sectional study"[Mesh]
OR research support AND Limits: Humans, English NOT medication

5 1 AND 2 AND 3 AND 4

Records Medline 5068, Cinahl 1337, Psycinfo 45
EMBASE (EMBASE.com - Elsevier. Records from EMBASE. Unique Medline is excluded)

1. ((‘shoulder’/exp OR ‘shoulder’) OR (‘elbow’/exp OR ‘elbow’) OR (‘hand’/exp OR ‘hand’) OR (‘extremity’/exp OR ‘extremity’) OR (‘hip’/exp OR ‘hip’) OR (‘knee’/exp OR ‘knee’) OR patellofemoral OR (‘foot’/exp OR ‘foot’) OR toe* OR (‘arm’/exp OR ‘arm’) OR (‘leg’/exp OR ‘leg’) OR (‘back’/exp OR ‘back’) OR (‘spine’/exp OR ‘spine’) OR (‘neck’/exp OR ‘neck’) OR (‘musculoskeletal system’/exp OR ‘musculoskeletal system’))

2. ((‘pain’/exp OR ‘pain’) OR (‘injury’/exp OR ‘injury’) OR (‘head and neck injury’/exp) OR (‘musculoskeletal injury’/exp) OR (‘musculoskeletal pain’/exp) OR (‘disability’/exp))

3. ((‘cohort analysis’/exp OR ‘cohort analysis’) OR (‘expectancy’/exp OR ‘expectancy’) OR (‘prevalence’/exp OR ‘prevalence’) OR (‘probability’/exp OR ‘probability’) OR (‘risk’/exp OR ‘risk’) OR (‘epidemiology’/exp OR ‘epidemiology’) OR (‘disease course’/exp OR ‘disease course’) OR (‘prognosis’/exp OR ‘prognosis’) OR (‘prediction’/exp OR ‘prediction’) OR (‘epidemiological data’/exp OR ‘epidemiological data’) OR (‘prospective study’/exp OR ‘prospective study’) OR (‘retrospective study’/exp OR ‘retrospective study’) OR (‘longitudinal study’/exp OR ‘longitudinal study’) OR (‘case study’/exp OR ‘case study’) OR (‘epidemiology’/exp OR ‘epidemiology’) OR (predict* OR prognos*))

4. ((‘meta analysis’/exp OR ‘meta analysis’) OR (‘systematic review’/exp OR ‘systematic review’))) AND [humans]/lim AND [embase]/lim AND [2000-2007]/py

5. 1 AND 2 AND 3 AND 4

Records Embase 1487

Appendix B Table 5 *Overview associations for level of evidence*

Association /ES Associated factor	Lifting low					Lifting high					Carrying					Static lifting				
	no	low	moderate	high	regression	no	Low	moderate	high	regression	no	low	moderate	high	regression	no	low	moderate	high	regression
Gender	[6,9,23,24]				[5,7,8,10, 25, 27,31]	[9]	[23]			[6,10,23, 25 ,27]	[9]				[10,27]					[7,19]
Age	[6,7,9,10, 23]				[5,27]	[6,9,10, 23,27]					[9,10]	[27]				[7,19]				
Aerobic capacity VO2max	[7]															[7]				
Work status	[24,26]					[24]					[24]									
BMI	[23]					[23]														
Pain intensity and pain index	[6,7,8,10,2 3,26,27,]	[5,9,33]	[8,36]		[8,21,31]	[6,9,10, 23, 25, 27]					[10, 25, 27]	[9]				[7,19]				
Pain duration	[5,7,9,23, 26]				[27]	[9,23]				[27]	[9]				[27]	[7]				
Radiation into legs																				[19]
Pain expectations																	[19]			
Pain cognitions	[7,28]						[31]				[28]					[7,28]				
Self reported disability		[6,9,10]	[5,32,33]		[5,27]	[9,10]	[6]			[27]		[9,10,32]			[27]		[19]			
Specific self efficacy			[10, 25, 31]	[9]	[9,10, 31, 25]	[10]	[31, 25]	[9]		[9, 31]	[10]	[25]		[9]	[9]					
General self efficacy	[10,28]					[10]					[10,28]					[28]				
Fear of movement /re-injury	[8,10,26,28]	[23]			[7,23]		[23]			[23]	[28]					[7]	[19,28,29,3 4]			[19]
Fear Avoidance	[8]	[8]																		
Catastrophizing	[7]															[7,19]				
Depression	[22,28]	[6,23]			[6,7]	[28]	[6,23]			[6]						[7,28]				
Negative affect																	[19]			

Self esteem	[10,28]					[10]					[10,28]					[28]				
State trait anxiety	[22,31]					[31]														
Stress	[10,22]					[10]					[10]					[28]				
Recovery expectations	[5]																			
Coping	[28]										[28]					[28]				
Assessment setting					[27]					[27]					[27]					
Health status	[10]	[9]				[10]	[9]					[9,10]								
Compensation status	[22,23]					[23]														
Litigation status		[23]			[23]		[23]													
Metabolic Equivalent (MET)	[23]					[23]														
Physiologic effort			[23]		[23]			[23]		[23]										
Perceived effort			[23]		[23]			[23]		[23]										
Support at workplace	[5]																			

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Factors that affect functional capacity in patients with musculoskeletal pain:

A Delphi study among scientists, clinicians, and patients

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4

Abstract

Objective To reach consensus on the most important biopsychosocial factors that influence functional capacity results in patients with chronic nonspecific musculoskeletal pain, arranged in the framework of the International Classification of Functioning, Disability and Health.

Design Three-round, internet-based Delphi survey.

Setting Not applicable

Participants Participants were scientists, clinicians, and patients familiar with functional capacity testing. Scientists were invited through purposive sampling based on the number of relevant publications in peer-reviewed journals. The scientists recruited clinicians and patients through snowball sampling.

Intervention Not applicable

Main Outcome Measures Consensus was reached if at least moderate influence (25%) was achieved and an interquartile range of no more than 1 point was reached.

Results Thirty-three scientists, 21 clinicians and 21 patients from 9 countries participated. Participants reached consensus on 6 factors that can influence the outcome of the lifting test, having a median of severe influence (50%-95%): catastrophic thoughts and fear, patient adherence to "doctor's orders," internal and external motivation, muscle power, chronic pain behavior, and avoidance behavior. Motivation, chronic pain behavior and sensation of pain were the top 3 factors affecting postural tolerance and repetitive movement functional capacity tests. Furthermore, participants reported 28 factors having a median of moderate influence (25%-49%) that could influence the outcome of lifting, postural tolerance and repetitive movement tests.

Conclusions Overall, chronic pain behavior, motivation and pain are the main factors that can influence functional capacity results. We recommend that scientists and clinicians, respectively, consider the most important factors when planning future studies and when interpreting functional capacity test results.

Key Words: Delphi technique; Lifting; Rehabilitation; Work capacity Evaluation

Introduction

In clinical practice, functional capacity (FC) tests, such as lifting, postural tolerance, and repetitive movement tests, are used to assess work-related functioning in patients with chronic nonspecific musculoskeletal pain (MSP). FC test results help clinicians to guide work-related rehabilitation and return-to-work decisions. If FC is determined to be insufficient in relation to the workload, factors responsible for a deficit must be identified. Scientists have studied a broad range of factors that may influence FC. Investigated factors include fear of movement, pain intensity, depression, sex, age, workers' compensation, previous episodes of pain, self-reported disability, and self-efficacy.[1-13] However, to date, no framework for classifying potentially influencing factors has been applied. Thus, there is a need to organize possible influencing factors into a framework.

The International Classification of Functioning, Disability and Health (ICF) is such a framework (fig 1).[14] The ICF provides a scientific basis and a common language for understanding functioning, and it can be used as a conceptual framework to measure relationships between ICF factors.[14] The ICF has been used to describe the interaction between ICF factors in several chronic health conditions.[15-20] FC is classified in the Activity component of the ICF (see fig 1).[14] The ICF also contains a Body Function and Structures component, and a Participation component, both of which describe factors that can influence FC. Other factors that might hinder or facilitate FC are Personal and Environmental factors.

List of abbreviations

FC	functional capacity
FCE	Functional Capacity Evaluation
ICF	International Classification of Functioning, Disability and Health
MSP	musculoskeletal pain

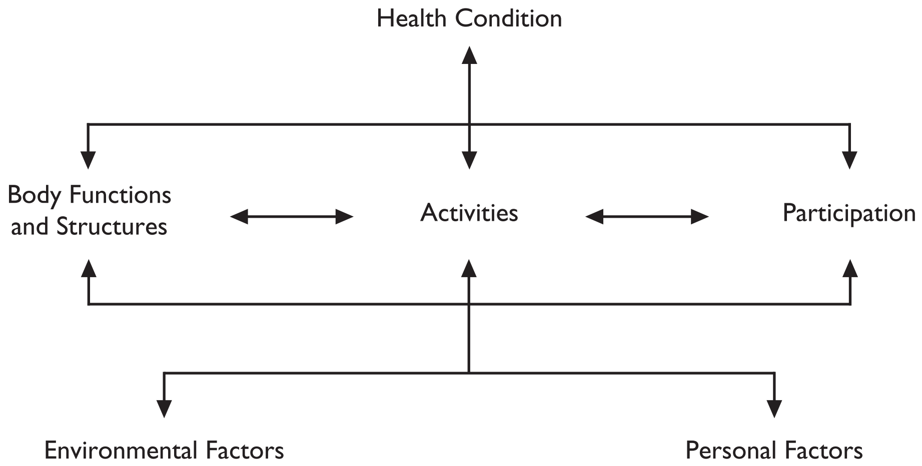


Fig 1. *The International Classification of Functioning, Disability and Health. (from World Health Organization. International classification of functioning, disability and health: ICF. Geneva: World Health Organization; 2001.)*

Experts in the field of FC Evaluation (FCE) have agreed on adopting the ICF as a framework.[21] The ICF describes some 1700 factors. The overwhelming number of categories makes it difficult for clinicians to decide on a hypothesis about factors that can influence FC test results. Unanimity among scientists and clinicians on a set of factors that potentially influence FC is crucial. In future studies, this set of factors should be included to ensure comparability among studies. In patients scoring lower or higher than expected, such a set of factors limits the number of ICF factors that a clinician has to consider. FCEs are used by clinicians worldwide and may influence decisions on whether patients with MSP can work. Thus, it is of high clinical relevance that a universal set of factors on FC become available.

After the experts agreed to use the ICF as a framework for FCE,[21] the next methodological step was to include related factors into this framework, which then could be tested scientifically. Thus, the aim of this study was to identify the most pertinent biopsychosocial factors that influence FC in patients with chronic nonspecific MSP.

Methods

Design

A Delphi study was performed from May to July 2010. The Delphi technique is a structured process, whereby experts reveal and share their opinion anonymously with other experts.[22-24] During several rounds, the experts get insight into group opinions, and based on the group's answers, they might reconsider their answers until they reach consensus.[25-27]

Participants

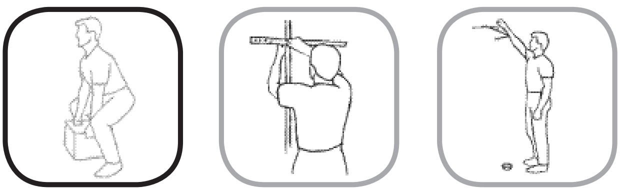
Evidence-based practice decisions are based on 3 domains: scientific research, individual clinical expertise, and individual patient characteristics.[28] With this principle in mind, we included scientists, clinicians, and patients in this study (table 1).

Table 1 *Inclusion Criteria*

1	Scientists who published in peer-reviewed international journals in the field of capacity testing in patients with musculoskeletal pain, the author was listed either at least once as a first author and once as a coauthor, or at least 3 times as a second or last author.
2	Clinicians who had conducted at least 30 capacity tests in patients with chronic nonspecific MSP, whereby these capacity tests contained lifting and/or postural tolerance and/or repetitive movements
3	Patients with chronic nonspecific MSP who underwent a capacity test that included lifting and/or postural tolerance and/or repetitive movements no more than 3 months before the survey

"Nonspecific" MSP was defined as musculoskeletal system pain (muscles, bones and cartilage) not attributed to recognizable, known specific pathology. Pain was defined as "chronic" if there was a minimum of 3 months since the initiation of pain. To ensure that only full- and part-time workers, not casual workers, were included in the study, we had to verify that all participating patients with chronic nonspecific MSP had worked a minimum of 20h/wk on a regular basis. We selected 3 FCE items to represent 3 aspects of FC (peak, duration, and repetition): lifting, postural tolerance, and repetitive movements (fig 2).

Fig. 2 *Three functional capacity tests.*



lifting *postural tolerance* *repetitive movements*

Procedure

Selection of participants and recruitment

Before this study, a workgroup of scientific and clinical experts from different countries gathered in Glasgow, Scotland at the 2008, 12th World Congress on Pain to discuss the importance of agreeing on factors that influence FC. Scientists and clinicians attending this meeting were invited to participate in our study. In addition, we performed an electronic search of bibliographic literature databases (MEDLINE, CINAHL, EMBASE, and PsychINFO) to identify other scientists who met our inclusion criteria (see table 1). Next, the included scientists were asked to recruit clinicians and patients with chronic nonspecific MSP through snowball sampling. To determine whether a candidate met the inclusion criteria, we invited each potential participant and sent a link to a webbased questionnaire assessing their eligibility to participate.[29] All participants signed an informed consent form. We guaranteed anonymity by assigning a unique Delphi number to each participant.

Fig. 3 *Structure of the Delphi process.*

	Recruitment of participants
1st Round	"*In your opinion, are there any factors that influence functional capacity test outcomes in patients with chronic musculoskeletal pain?*"→ *Open answer*
Analysis	List of answers → combined → ICF-linking rules → list of ICF factors
2nd Round	*Select factors that determine the outcome of functional capacity tests in patients with chronic musculoskeletal pain?*" → Yes/No
Analysis	Deletion of factors that less than 40% of the participants indicated as important
3rd Round	*"Please, rate the amount of* influence *the factors have on the outcome of lifting, postural tolerance and repetitive movements"* → *(0-4)*
Analysis	If the median is ≥ 2 and the inter-quartile range is ≤ 1, consensus is reached

This Delphi study consisted of 3 rounds (fig 3).

First round

The aim of the first round was to gather and define as many factors as possible. All 3 expert groups—scientists, clinicians, and patients—were invited to participate in this round. We used a web-based survey.[29] Participants were asked to liberally report as many factors as possible that, in their opinion, could influence FC. Because patients most likely lacked knowledge of medical terminology, we provided them with a separate lay version of this survey written in English.

In our first round analysis, an independent secretary gathered the questionnaire results and sent the anonymous responses to 2 authors (H.W. and S.E.L.), who have expert knowledge of the ICF. First, they aggregated the responses if possible. Second, they classified the responses according to ICF categories using ICF-linking rules (table 2).[30-32] A consensus meeting took place to resolve any disagreements. If no consensus could be reached, a third assessor (M.F.R.) made the final decision.

Table 2 *ICF-Linking Rules*

1	Each answer was linked to the most precise ICF category.
2	If one answer encompassed different constructs, the information in each construct was linked.
3	If the content of an answer was not explicitly named in the corresponding ICF category but at the same time was included in the ICF category, then the answer was linked to this ICF category, and the additional information not explicitly named by the ICF was documented.
4	If the content of an answer was more general than the corresponding ICF category, the code of the higher level was linked.
5	If the information provided by the answer was not sufficient for making a decision about the most appropriate ICF category, then this factor was linked “nd” (not definable).
6	If an answer was not covered in the ICF classification, then this item was assigned “nc” (not covered by the ICF).

Data from references 30-32

Second Round

The aim of the second round was to reduce the number of first-round factors to form a comprehensive, succinct set of factors. The list of factors and their definitions were sent to the scientists and clinicians in the second and third round. We asked them to select the factors that, in their opinion, should be included in the comprehensive set: “Select as many factors as needed and at the same time as few as possible.” Participants rated each factor on a dichotomous scale (yes/no). In our second round analysis, we removed the factors that were deemed as unimportant by 60% or more of the participants in the second round.

Third round

The aim of the third round was to reach consensus. Scientists and clinicians rated the potential influence of the factors on 3 FC tests: lifting, postural tolerance, and repetitive movements. The degree of influence was quantified using a 5-point Likert scale (table 3). This scale and its wording are based on the ICF.14 The scale reflects the extent to which a factor potentially influences FC at the group level.

Table 3 *Extend of Influence Conforming the ICF*

Quantification Number		Appropriate Qualifying Words	Extent of influence (%)
0	No influence	None, absent, negligible	0-4
1	Mild influence	Slight, low	5-24
2	Moderate influence	Medium, fair	25-49
3	Severe influence	High, extreme, strong	50-95
4	Complete influence	Total	96-100

Data from reference 14.

In our third round analysis, we calculated the median, mean, and interquartile range of each factor. The criterion of consensus was based on the agreement among participants and the degree of influence. To reach consensus, 2 criteria had to be reached. First, the interquartile range had to be no more than 1 point. Second, minimum influence on FC test outcome was required. We set the minimum criteria for influence at a moderate level of 25%. A factor rated below 25% indicated that it had little to no influence on FC outcome.[14,33] The agreed-on factors then were ranked according to their means. Because the backgrounds of the scientists and clinicians may have differed, we calculated the differences between their opinions. If the opinions of scientists and clinicians differed by 1 point on the median and scored an interquartile range of 1 point, we analyzed the differences using the Mann-Whitney test. Additionally, we described the agreed-on factors that influenced all 3 FC tests.

Results

Participants

Through the electronic database search, we identified 30 scientists in addition to the 26 Glasgow group members. The authors of the present article were excluded from participation. In April 2010, we invited the scientists to participate in this study and to complete the web-based inclusion criteria questionnaire. Thereafter, the scientists made great efforts to recruit other participants, resulting in a sample of 33 scientists, 21 clinicians and 21 patients from 9 countries and 41 institutions worldwide (table 4).

Table 4 *Characteristics of Participants*

Characteristics	Scientists	Clinicians	Patients
No. of participants			
1st Round	33 (14M; 19W)	21 (8M; 13W)	21 (7M; 14W)
2nd Round	30	18	0
3rd Round	32	18	0
Age (y)	44.7 ± 9.7	45.4 ± 8.3	45.5 ± 10.7
Country			
Canada	6	1	0
The Netherlands	13	5	5
Australia	4	4	8
United States	1	7	4
Germany	3	0	2
Finland	1	0	0
Norway	3	1	0
Switzerland	1	3	2
United Kingdom	1	0	0

NOTE. Values are n or mean ± SD. Abbreviations: M, men; W, women.

First Round

The 2 authors who analyzed the responses to the online survey differed on their classification of the following factors: depression, fear-avoidance behavior, motivation of test evaluator, support of the tester, time of day, job satisfaction, and health beliefs that load is risky. During the consensus meeting, the analyzers agreed to link these 7 factors according to the way other ICF experts linked them.[17,18] This resulted in a total of 126 factors.

Second Round

The second round took place in June 2010. Eleven percent of participants did not respond because of personal reasons. The participants advised us to remove 2 parts: chapter 4 of the ICF Activities and Participation component, because these activities are similar to our FC tests, and the ICF Body Structures component, because anatomic body parts are not influencing factors. This reduction and combination of factors resulted in a comprehensive set of 79 factors.

Table 5 *Factors That Influence FC tests With a Median of 3 (Severe Influence) or 2 (Moderate Influence) and an Interquartile Range of 1 point*

FC Test	Rank	Factor	Mean	ICF Category
Median = 3 (50%-95% influence)				
Lifting				
	1	Catastrophic thoughts and fear of reinjury, pain, movement, activities, exacerbating symptoms	2.7	b152
	2	Patient adherence to "doctor's orders"	2.6	b126
	3	Motivation, internal and external	2.6	b1303
	4	Muscle power	2.5	b730
	5	Chronic pain behavior	2.5	b164
	6	Avoidance behavior	2.4	b164
Postural tolerance		None		
Repetitive movements		None		
Median = 2 (25%-49%influence)				
Lifting	7	Previous experiences with pain, injuries, acceptance, activity limitations after previous capacity test, previous behavior of another person in pain	2.4	pf
	8	Sensation of pain	2.3	b280
	9	Individual attitude toward pain and/or capacity test	2.3	pf
	10	Similarity of capacity test with activities at work	2.2	d850
	11	Beliefs or expectancies regarding return to work	2.2	pf
	12	Anxiety	2.2	b152
	13	Self-efficacy regarding capacity test	2.1	pf
	14	Illness beliefs	2.1	pf
	15	Location of pain	2.1	nc
	16	Multiple morbidity	2.0	nd
	17	Aerobic capacity functions	1.9	b4551
	18	Muscle endurance	1.9	b740
	19	Test evaluator gives support and relationship	1.8	e355
	20	Locus of control (Internal/external)	1.8	pf
	21	Suffering	1.8	b152
	22	Attitudes of health professionals, including the test evaluator	1.7	e450
	23	Emotional functions related to work	1.7	b152
	24	Cognition or knowledge or understanding of injury process, recovery, pain and disability	1.7	b164
	25	Gender	1.7	pf
	26	Age	1.7	pf
	27	Presence of an observer like family, friends, or supervisor during the test	1.7	nc

	28	Sports	1.7	d920
	29	Joint stability	1.7	b715
	30	Numbers of days sick leave	1.6	nc
Postural tolerance	1	Motivation, internal and external	2.4	b1303
	2	Chronic pain behavior	2.3	b164
	3	Sensation of pain	2.2	b280
	4	Self-efficacy regarding capacity test	2.0	pf
	5	Avoidance behaviors	1.9	b164
	6	Similarity of capacity test with activities at work	1.9	d850
	7	Multiple morbidity	1.8	nd
	8	Coping style/maladaptive coping strategies	1.8	pf
	9	Location of pain	1.8	nc
	10	Fatigue	1.8	b4552
	11	Test evaluator gives support and relationship	1.7	e355
	12	Awareness of consequences of the test	1.7	b164
	13	Anxiety	1.7	b152
	14	Attitudes of health professionals, including the test evaluator	1.7	e450
	15	Locus of control (Internal/external)	1.7	pf
	16	Type of personality (lazy, active)	1.7	pf
	17	Suffering	1.6	b152
	18	Test evaluator's expertise	1.6	nc
	19	Presence of an observer like family, friends, or supervisor during the test	1.6	nc
	20	Number of days sick leave	1.5	nc
	21	Emotional functions related to work	1.5	b152
Repetitive movements	1	Motivation, internal and external	2.5	b1303
	2	Chronic pain behavior	2.4	b164
	3	Sensation of pain	2.2	b280
	4	Previous experiences with pain, injuries, acceptance, activity limitations after previous capacity test, previous behavior of another person in pain	2.2	pf
	5	Catastrophic thoughts and fear of reinjury, pain, movement, activities, exacerbating symptoms	2.2	b152
	6	Individual attitude toward pain and/or capacity test	2.2	pf
	7	Beliefs or expectancies regarding return to work	2.2	pf
	8	Similarity of capacity test with activities at work	2.1	d850
	9	Self-efficacy regarding capacity test	2.0	pf
	10	Multiple morbidity	1.9	nd
	11	Location of pain	1.9	nc
	12	Type of personality (lazy, active)	1.9	pf

13	Coping style/maladaptive coping strategies	1.9	pf
14	Anxiety	1.8	b152
15	Test evaluator gives support and relationship	1.8	e355
16	Awareness of consequences of the test	1.8	b164
17	Locus of control (Internal/external)	1.7	pf
18	Coordination	1.7	b7601
19	Sincerity	1.7	b126
20	Attitudes of health professionals, including the test evaluator	1.7	e450
21	Presence of an observer like family, friends, or supervisor during the test	1.7	nc
22	Muscle power	1.6	b730
23	Aerobic capacity functions	1.6	b455
24	Sports	1.6	d920
25	Number of days sick leave	1.5	nc
26	Age	1.5	pf

Abbreviations: b, body functions; d, activities and participation; e, environmental factors; NA, not applicable; nc, not covered; nd, not definable; pf, personal factors.

Fig 4. *Factors influencing FC: moderate (25%-49%) versus severe(50%-95%)*

CHRONIC MUSCULOSKELETAL PAIN

BODY FUNCTION

Chapter	ICF category		L	P	R
1 Mental	Temperament and personality	Patients adherence to "doctor's orders"*	x		
		Sincerity			x
	Energy and drive	Motivation*	x	x	x
	Emotional	Catastrophic thoughts and fear*	x		x
		Anxiety	x	x	x
		Suffering	x	x	
		Emotional functions related to work	x	x	
	Higher-level cognitive	Cognition or understanding of injury process, recovery, pain and disability	x		
		Chronic pain behavior*	x	x	x
		Avoidance behavior*	x	x	
		Awareness consequences test		x	x
2 Sensory	Sensation of pain	Sensation of pain	x	x	x
4 Cardiovascular	Exercise tolerance	Aerobic capacity functions	x		x
		Fatigue			x
7 Neuro-musculoskeletal	Stability of joint	Joint stability	x		
	Muscle power	Muscle power*	x		x
	Muscle endurance	Muscle endurance	x		
	Control movement	Coordination			x

ACTIVITIES

Functional capacity

PARTICIPATION

Chapter	ICF category		L	P	R
8 Major life areas	Remunerative employment	Similarity of test with activities at work	x	x	x
9 Community and civic life	Recreation and leisure	Sports	x		x

ENVIRONMENTAL FACTORS

			L	P	R
3 Support/relation	Health professionals	Test evaluator gives support and relationship	x	x	x
4 Attitudes	Health professionals	Attitudes of health professionals/ test evaluator	x	x	x

PERSONAL FACTORS

		L	P	R
Physical	Gender	x		
	Age	x		x
Psychological	Previous experiences	x		x
	Individual attitude towards pain of test	x		x
	Beliefs or expectancies regarding return to work	x		x
	Self-efficacy regarding capacity test	x	x	x
	Illness beliefs	x		
	Locus of control	x	x	x
	Coping style		x	x
	Type of personality		x	x

NOT COVERED- NOT DEFINED

	L	P	R
Location of pain	x	x	x
Multiple morbidity	x	x	x
Test evaluator's expertise		x	
Numbers of days sick leave	x	x	x
Presence of an observer like family, friends or supervisor during the test	x	x	x

"" indicates factors with severe influence (50%-95%); all other factors were rated as moderate influence (25%-49%). Abbreviations: L, Lifting; P, Postural tolerance; R, Repetitive movements.*

Third Round

Two scientists who did not participate in the second round participated in the third round, resulting in a response rate of 93%.

Factors that have strong influence

Scientists and clinicians reached consensus on 6 factors that influence lifting with a median of severe influence of 50%-95% (table 5): These 6 factors were all linked to the ICF Body Function component. The participants did not reach consensus on factors that strongly influenced the postural tolerance and repetitive movement tests.

Factors that have moderate influence

Consensus was reached on another 28 factors with a median of moderate influence of 25% to 49% (see table 5). The definitions of these factors and their ICF linking are described in appendix 1. Factors that influenced the outcome of all 3 tests—lifting, postural tolerance, and repetitive movements—are described in table 6. For clarification, we entered the factors of severe and moderate influence into the ICF model (fig 4).

Table 6 *Factors Indicated by Participants to Potentially Influence all 3 Capacity Tests*

ICF component	Definition	ICF category
Body function	Motivation, internal and external	b1303
	Chronic pain behavior	b164
	Sensation of pain	b280
	Anxiety	b152
Activities and participation	Similarity of capacity test with activities at work	d850
Environmental factors	Test evaluator gives support and relationship	e355
	Attitudes of health professionals, including the test evaluator	e450
Personal factors	Self-efficacy regarding capacity test	pf
Not covered	Location of pain	nc
	Numbers of days sick leave	nc
Not definable	Multiple morbidity	nd

Abbreviations: b, body functions; d, activities and participation; e, environmental factors; nc, not covered; nd, not definable; pf, personal factors.

Scientists rated the influence of age on lifting (U=190.00, $p<.05$) and on repetitive movements (U=169.5, $p<.02$) 1 point higher than clinicians. There were no other significant differences between the rating scores of the scientists and clinicians.

Discussion

This aim of the present study was to identify a set of factors that exert the most influence on FC in patients with chronic nonspecific MSP. We used the ICF during the Delphi process as a framework to obtain consistent language and to classify the factors mentioned by the participants. Both scientists and clinicians benefited from using a tool for promoting consistent language. The participants reached consensus on a set of 37 factors that could influence FC by at least 25%. Of the 37 factors, 6 were considered to have a high level (50%-95%) of influence on lifting (see table 5). The factor "catastrophic thoughts and fear" was ranked as exerting the highest effect on lifting, as reflected by the highest median. However, previous studies revealed that this factor contributed only modestly to static lifting ($.05 \leq R2 < .25$).[9,34-36] Moreover, conflicting evidence exists in literature on what extent catastrophic thoughts and fear affects dynamic lifting.[5,7-10,37] The results of this Delphi study and the conflicting evidence indicate that more research is needed on catastrophic thoughts and fear in relation to dynamic lifting.
The factor "patient adherence to 'doctor's orders'" was ranked as having the second highest effect on FC. To our knowledge, no FC research on this factor exists. Thus, further research is recommended. The factors "motivation", "chronic pain", and "avoidance behaviors" also were ranked as having strong influence on lifting. Further research on instruments that measure motivation and avoidance behavior is recommended. "Muscle power" was ranked as having the fourth highest effect on FC. To our surprise, the relationship between muscle power and capacity tests has not been studied in patients with chronic nonspecific MSP, even though strength training is regularly advised in patients with low-capacity results. Overall, we advice clinicians to consider these 6 factors if a patient scores lower than expected on a lifting test.

With respect to factors that could affect postural tolerance and repetitive movements tests, participants reached only a moderate level of consensus on factors embodied by the fear-avoidance model, such as fear, chronic pain behavior, and avoidance behavior. This suggests that these concepts influence these 2 FC tests to a lesser degree than lifting tasks. Furthermore, participants classified patient adherence and motivation as having less influence on postural tolerance and repetitive movements than on lifting tasks. We advice conducting further research on this pattern.

Motivation, chronic pain behavior, and sensation of pain were ranked as the top 3 factors to influence the outcome of all 3 capacity tests. To date, no study of which we are aware has evaluated the direct influence of motivation on FC. Chronic pain behavior is defined as any and all outputs of the individual that a reasonable observer would characterize as suggesting pain.[38,39] One of these outputs might be submaximal physical output during testing. Some authors have described and tested observational criteria to differentiate between maximal and submaximal effort during a lifting test,[40-42] whereas others have measured chronic pain behavior with a standardized observational scale.[43,44] To objectively judge patients' capacity scores, we advise clinicians to use observational pain behavior assessment tools.

Study Limitations

One methodological issue that might have caused sampling bias was the snowball style of participant recruitment, whereby participating scientists subsequently invited clinicians and patients. We relied on the scientists to verify inclusion criteria pertaining to the clinicians and their patients. The English language used in this study might have also caused sampling bias against recruiting participants, especially patients, from the 5 non-English-speaking countries. There was a tradeoff in using multiple versus single language tests. We discussed the pros and cons of multiple language questionnaires during the preparation of this study and came to the conclusion that combining and defining translated constructs would create greater bias.

Another possible limitation might be the relatively large proportion of scientists in our study sample. We addressed this problem by analyzing the group of scientists and the group of clinicians separately, which resulted in only 1 factor, age, that scored significantly higher in the scientist group. In healthy populations, age does indeed influence lifting[45]; however, in populations with chronic low back pain, age seems to have no influence.[2,6,8,10,37,46] Lastly, some expert clinicians might have been inadvertently excluded, if their working environment did not have an invited scientist who could have recruited them. Overall, in our view, the worldwide generalizability of this study outweighed any limitations resulting from possible sampling biases.

Another study limitation might be validity.[47] Validity of the set of factors can be measured by assessing the stability of the responses between the second and third Delphi rounds. In this study, validity was 62%, which was considered to be moderate.[48] Some factors were combined on the basis of participants' recommendations and ICF classification. For example, although the factors "evaluator gives support and relationship," "evaluator's expertise," and "attitudes of health professionals" are often considered as a single factor, "test evaluator," in our study, we considered these 3 factors separately. Choosing a different framework might have led to a different ranking order. Yet, like a previous study, we used ICF-linking rules, and 2 authors independently analyzed the factors to limit analysis bias.[21] Furthermore, changing the 60% cutoff point in the second round analysis might have changed the final results, although other studies[49,50] were more strict in setting their cutoff points to 75% to 80% agreement.

Patient Inclusion

Patients participated only in the first round of the study. We viewed clinicians as experts in evaluating FCEs by virtue of their mastery in their clinical practice. Similarly, we viewed scientists as experts of the scientific literature by virtue of their mastery of the literature and of their professional interaction with other scientists (eg, by means of congresses). On the other hand, we viewed patients as experts in experiencing FCEs by virtue of their personal experience. Thus, we included patients in our Delphi study because, owing to their unique perspective, they might have generated new factors that were not mentioned by the other experts.

Previous studies [51,52] have validated the Delphi results of clinicians and scientists on patient groups, resulting in 55% and 71% new factors, respectively. Contrary to these studies, we decided to invite patients to participate in the first round in order to enrich our knowledge about patients' experiences early on in the study. To our knowledge, inclusion of these 3 groups simultaneously has not been done before. A supplementary factor that was described by the patient group was "mental stress because of the care of pubertal children or other dependent family members." Assisting household members, such as in child care or parent care, was not mentioned by the other 2 expert groups and was therefore a unique contribution of the patient group. However, the clinicians and scientists eliminated this factor in the second round.

Strength of the Study

In general, the strength of Delphi studies lies in the absence of group dynamics and hierarchical structures, which are often seen in focus group meetings.[25,47,53,54] We approached scientists, clinicians, and patients in the field of FCE from all over the world. Their opinion was combined in group consensus. We stress the importance of this group consensus. There is considerable research interest in the ICF activity level. The results of this study might lead to new research areas and conformity of confounders. The ICF gives clear definitions of variables. As a consequence, the results of future FCE studies might be summarized. Finally, the most important feature of this study is its high response rate of 93%,[55] which supports the validity of the set of factors influencing FC.

Conclusion

The participants reached consensus on 6 factors that exert strong influence on lifting in patients with chronic nonspecific MSP: catastrophic thoughts and fear, patient adherence to "doctor's orders," motivation, muscle power, chronic pain behavior, and avoidance behavior. The factors motivation and chronic pain behavior, in addition to the factor sensation of pain, were identified as the most important factors to influence postural tolerance and repetitive movements tests, at a moderate level. We recommend that scientists consider all these factors for further research. In addition, we recommend that clinicians consider these factors in their clinical decision-making process.

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APPENDIX 1: Third-round factors, ICF categories, and additional information

Factor		ICF category	Additional information
Body functions			
Patient adherence to "doctor's orders"	b126	Temperament and personality functions	Patient adherence to "doctor's orders" stating that physical activity should be limited. Adherence means devotion
Sincerity	b126	Temperament and personality functions	Being open and truthful.
External motivation	b1303	Energy and drive functions	Mental functions that produce the incentive to act; the conscious or unconscious driving force for action. Based on (1) financial rewards. Financial rewards (money that you receive for working); or (2) motivation to return to highly wanted work (or to be released from unpleasant work).
Internal motivation	b1303	Energy and drive functions	Based on (1) effort (use of physical or mental energy, hard work, "he got an 'A' for effort," exertion); (2) competitive behavior (direct struggle between individuals for environmental necessities or for a common goal); or (3) ambition (strong desire for success).
Anxiety	b152	Emotional functions	A state of apprehension, uncertainty, and fear resulting from the anticipation of a realistic or fantasized threatening event or situation, often impairing physical and psychological functioning
Catastrophic thoughts and fear of reinjury, pain, movement, activities, exacerbating symptoms	b152	Emotional functions	People who catastrophise about pain have extremely and exaggeratedly negative beliefs about pain, thinking the worst about pain and appraising pain as very threatening. (Fear avoidance model).[56] Fear is a feeling of agitation and anxiety caused by the presence or imminence of danger.
Suffering	b152	Emotional functions	Feelings of mental or physical pain
Cognition or knowledge of understanding of injury process, recovery, pain and disability	b164	Higher-level cognitive functions	
Chronic pain behavior	b164	Higher-level cognitive functions	Chronic pain behavior is the overt, motoric factor of chronic pain syndrome and is defined as the interaction between the chronic pain patient and his/her direct environment.[38]
Avoidance behavior	b164	Higher-level cognitive functions	Fear avoidance is the avoidance of movements or activities based on fear.[39]
Awareness of consequences of the test	b164	Higher-level cognitive functions	
Sensation of pain	b280	Sensation of pain	
Aerobic capacity functions	b4551	Exercise tolerance functions	Aerobic capacity functions relate to the extent to which a person can exercise without getting out of breath.

Fatigue	b4552	Exercise tolerance functions	Functions related to susceptibility to fatigue, at any level of exertion
Joint stability	b715	Stability of joint functions	
Muscle power	b730	Muscle power functions.	
Muscle endurance	b740	Muscle endurance functions	Functions related to sustained muscle contraction for the required period of time.
Coordination	b7601	Control of voluntary movement functions	Control of voluntary movement functions. Functions associated with control over and coordination of complex voluntary movements
Activities and Participation			
Similarity of capacity test with activities at work	d850	Remunerative employment	
Sports	d9201	Sports	
Environmental factors			
Test evaluator gives support and relationship	e355	Health professionals	Includes instruction, feedback, encouragement, doctor-patient confidentiality, but also the quality of the relationship, the amount of interaction with the patient, and the appropriateness of communication
Attitudes of health professionals, including the test evaluator	e450	Individual attitudes of health professionals	
Personal factors Psychological			
Type of personality	pf		Lazy, active
Illness beliefs	pf		Beliefs regarding illness. The common sense model describes the representations of an illness with existing schemata (the normative guidelines that people hold), enabling the patients to make sense of their symptoms and to guide them in any coping actions. Leventhal and colleagues described five components of these illness representations: identity, cause, time line, consequences, curability/controllability.[57] Classified according to A. Cieza.[18]
Health and pain beliefs	pf		Something believed or accepted as true
Self efficacy regarding capacity test	pf		Belief that one is capable of performing the capacity test in a certain manner to attain certain goals
Beliefs or expectancies regarding return to work	pf		
Locus of control	pf		"Locus of control" refers to the extent to which individuals believe they can control events that affect them. "Internal control" is the term used to describe the belief that control of future outcomes resides primarily in oneself while "external control" refers to the expectancy that control is outside of oneself, either in the hands of powerful other people or due to fate/chance.

Individual attitude toward pain and/or capacity test	pf	An attitude is a disposition to respond favorably or unfavorably to an object, person, institution, or event [54]
Coping style/ maladaptive coping strategies	pf	Coping style is a person's characteristic strategies used in response to life problems, stressful events or traumas. These can include thoughts, emotions or behaviors.
Previous experiences with pain, injuries, acceptance, activity limitations following previous capacity test, previous behavior of another person in pain	pf	Previous experiences with pain and injuries, such as; duration or recovery time from those pain or injuries, the successfulness of previous rehabilitation efforts, and periods of pain in the last weeks or months. Previous experiences with acceptance. Activity limitations following capacity testing.
Personal factors Physical		
Gender	pf	
Age	pf	
Not definable		
Multiple morbidity	nd	Other diseases
Not covered		
Numbers of days sick leave	nc	
Location of pain	nc	
Test evaluator's expertise	nc	Expertise is skill or knowledge in a particular area
Presence of an observer like family, friends or supervisor during the test	nc	

Abbreviations: b, body functions; d, activities and participation; e, environmental factors; nc, not covered; nd, not definable; pf, personal factors.

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Construct validity of functional capacity tests in healthy workers

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5

Abstract

Background Functional Capacity (FC) is a multidimensional construct within the activity domain of the International Classification of Functioning, Disability and Health framework (ICF). Functional capacity evaluations (FCEs) are assessments of work-related FC. The extent to which these work-related FC tests are associated to bio-, psycho-, or social factors is unknown. The aims of this study were to test relationships between FC tests and other ICF factors in a sample of healthy workers, and to determine the amount of statistical variance in FC tests that can be explained by these factors.

Methods A cross sectional study. The sample was comprised of 403 healthy workers who completed material handling FC tests (lifting low, overhead lifting, and carrying) and static work FC tests (overhead working and standing forward bend). The explainable variables were; six muscle strength tests; aerobic capacity test; and questionnaires regarding personal factors (age, gender, body height, body weight, and education), psychological factors (mental health, vitality, and general health perceptions), and social factors (perception of work, physical workloads, sport-, leisure time-, and work-index). A priori construct validity hypotheses were formulated and analyzed by means of correlation coefficients and regression analyses.

Results Moderate correlations were detected between material handling FC tests and muscle strength, gender, body weight, and body height. As for static work FC tests; overhead working correlated fair with aerobic capacity and handgrip strength, and low with the sport-index and perception of work. For standing forward bend FC test, all hypotheses were rejected. The regression model revealed that 61% to 62% of material handling FC tests were explained by physical factors. Five to 15% of static work FC tests were explained by physical and social factors.

Conclusions The current study revealed that, in a sample of healthy workers, material handling FC tests were related to physical factors but not to the psychosocial factors measured in this study. The construct of static work FC tests remained largely unexplained.

Keywords: Lifting, Physical endurance, Validity, Work capacity evaluation, Work

Background

Functional Capacity (FC) represents the highest probable level of activity that a person may reach at a given moment in a standardized environment [1,2]. FC is classified within the activity component of the International Classification of Functioning, Disability and Health (ICF) framework [2]. Within ICF, physical activities are influenced by personal factors, environmental factors, body functions, and participation [2] (Figure 1). Thus, FC is considered as a multidimensional construct.

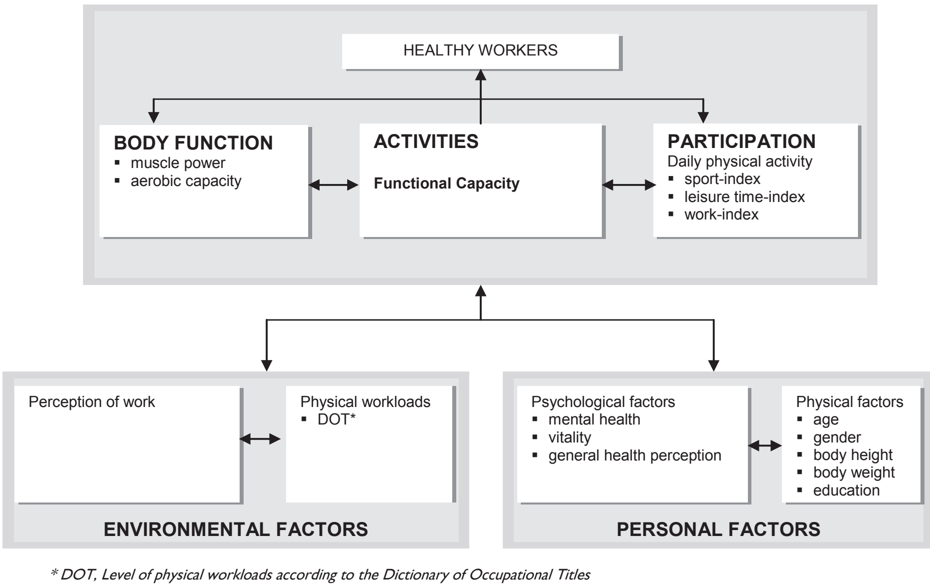

Figure 1: *Classification of measures used in this study, according to the International Classification of Functioning, Disability and Health.*

Functional capacity evaluations (FCEs) are assessments of work-related FC such as lifting and static work. Numerous researchers have adopted the ICF and support the consideration of ICF domains when interpreting FC test results [1]. FCEs facilitate the reasoning process for clinicians and assist them in determining if further examination is required [1]. FCEs also assist clinicians in pre-employment screening for healthy workers. In rehabilitation, FCEs assist in selecting diagnoses, recommending ability to work, constructing appropriate treatment plans, and evaluating those treatment plans [3-6].

Several theories and models corroborate the multidimensional construct of work-related FC [7,8]. According to several biopsychosocial viewpoints, optimal work performances are influenced by a worker's health perception and accomplished in the absence of personal factors such as depression and nervousness [9,10]. The Demand Control Model postulates that environmental factors including 'a worker's perception of a heavy workload' and 'work-related stress' need to be at a minimum in order to perform optimally at work [11,12]. Biomechanical models demonstrate relationships between the body functions of muscle power and aerobic capacity with FC test results [3]. Finally, the association of FC tests with participation in daily living activities such as sport, physical work, and leisure time is generally assumed. Until now, the assumed relationships have not been tested in healthy persons. It is of importance to conduct analyzes of the latter assumed relationships in a sample of healthy workers, in order to understand what we are actually testing [13], which is important theoretically to unravel the construct of FC and to develop valid FC tests for healthy workers. Construct validity is the ability of an instrument to measure a construct [14]. Within the ICF, the FC construct is multidimensional, whereby, one process of FC construct validation is to ascertain how various ICF dimensions may be related to FC test results in healthy workers [14]. From a clinician's perspective, in healthy workers during pre-employment screening, knowledge of related factors is necessary to identify the necessity of additional testing. From a researcher's perspective, a comprehensive set of factors related to FC test results in healthy workers may perform as a reference to compare patients´ relationships between FC tests and ICF factors.

The aims of this study were to test relationships between FC tests and other ICF factors in a sample of healthy workers, and to determine the amount of statistical variance in FC tests that can be explained by these factors.

The strength of expected relationships between material handling FC tests (lifting low, overhead lifting, and long carrying) and static work FC tests (standing forward bend and overhead working) with ICF factors are described as hypotheses 1 to 15 in Table 1.

Table 1 Hypotheses regarding the strength of relations between Functional Capacity tests and ICF factors measured in this study

Hypotheses	ICF components	Relationships	Factor
H1	Body function	At least fair	1. muscle power
H2	Body function	At least fair	2. aerobic capacity
			Daily physical activities
H3	Participation	Low	3. sport-index
H4	Participation	Low	4. leisure time-index
H5	Participation	Low	5. work-index
H6	Environmental factors	Low	6. perception of work
H7	Environmental factors	Low	7. physical workloads (DOT)
			Perceived health status
H8	Personal psychological factors	Low	8. mental health
H9	Personal psychological factors	Low	9. vitality
H10	Personal psychological factors	Low	10. general health perceptions
H11	Personal physical factors	At least fair	11. age
H12	Personal physical factors	At least fair	12. gender
H13	Personal physical factors	At least fair	13. body height
H14	Personal physical factors	At least fair	14. body weight
H15	Personal physical factors	Low	15. education

The value of significant ($P_{bonf} < .002$) correlations were interpreted as being low when Pearson, Spearman, or point-biserial correlations between FCEs with ICF factors are ≤ 0.25 and fair when $0.25 <$ Pearson, Spearman, or point-biserial correlations ≤ 0.50 [14]; DOT, Level of physical workloads according to the Dictionary of Occupational Titles [35]; H hypothesis, ICF International Classification of Functioning, Disability and Health.

Methods

Study sample

During a two-year period, a total of 403 healthy workers (20–60 years of age) executed a 12-item FCE after written informed consent was obtained and the rights of the subjects were protected [15]. We consecutively sampled a series of healthy workers who were employed for at least 20 hours per week and who had taken less than two weeks of sick leave due to musculoskeletal complaints or cardiorespiratory diseases in the year prior to the testing. Prior to the FCE, all workers completed a comprehensive set of questionnaires at home. The Medical Ethical Committee of the University Medical Center Groningen, the Netherlands, approved the research protocol of this study.

Measures

The variables measured in this study were classified according to the ICF model (Figure 1) [2,16].

Activities

Functional capacity

Functional capacity was measured with five FCE tests, selected to cover a range of physical activities: (1) lifting low; (2) overhead lifting; (3) carrying (material handling tests); (4) standing forward bend; and (5) overhead working (static work tests). These were quantified according to the following:

1. Lifting low: Lifting a plastic receptacle from table to floor five times within 90 seconds as the weight is increased in increments 4–5 times.

2. Overhead lifting: Lifting a plastic receptacle from table to crown height five times within 90 seconds as its weight is increased in increments 4–5 times.

3. Carrying: Carrying a receptacle with two hands for 20 meters as the weight is increased in increments 4–5 times.

4. Standing forward bend: For as long as possible, manipulating nuts and bolts while standing, bent forward 30-60° at the trunk, while wearing a five-kilo gram weight around the upper thoracic area.

5. Overhead working: For as long as possible, manipulating nuts and bolts at crown height while wearing a one-kilogram wrist weight.

A detailed description of the FCE test protocol is published elsewhere [15] and can be requested from the corresponding author. Evaluators (male and female) were third- or fourth-year physical therapy bachelor's degree students who had received two days of intensive FCE protocol training [15].

The endpoint of testing could be achieved in several manners. First, the subject could express the desire to terminate the activity. Secondly, the evaluator could end the test because the subject's safety is in jeopardy. Tertiary, 85% of the age-related maximal heart rate was attained. The test-retest reliability of healthy subjects is good for lifting low (ICC = 0.85; 95% CI: 0.89-0.98); overhead lifting (ICC = 0.89; 95% CI; 0.77-0.95); carrying two handed (ICC = 0.84; 95% CI: 0.68-0.93); standing forward bend test (ICC = 0.93; 95% CI: 0.85-0.97); and overhead working (ICC = 0.90; 95% CI: 0.80-0.95) [17,18].

Body function

Muscle Power

Handgrip strength was measured by the JAMAR hand dynamometer (model PC 5030; Sammons Preston Rolyan, Chicago, IL). Isometric handgrip strength was measured using a protocol where subjects were tested in a seated position with the shoulder adducted and elbow flexed 90°. Forearm and wrist were in the neutral position. In previous studies, the test-retest reliability for handgrip strength (intraclass correlation coefficient [ICC] = 0.97; 95% confidence interval [CI]: 0.94-0.99), intra-, and interrater reliability were good (ICC = 0.85-0.98) in healthy subjects [18,19]. The mean of three measurements of the second grip span of the dominant hand will represent the handgrip strength of the subject [20]. Muscle strength of knee flexion and extension, elbow flexion and extension, and glenohumeral abduction were acquired three times utilizing the Break Method [21,22]. The mean will represent muscle strength. In previous studies, the interrater reliability of the hand-held dynamometer was good for elbow flexion (ICC = 0.95; 95% CI: 0.87-0.98) [23]; elbow extension (ICC = 0.89; 95% CI: 0.74-0.96) [23]; shoulder abduction (ICC = 0.89; 95% CI: 0.74-0.96) [23]; and knee extension (r_p = 0.90) [24]. Elbow measurements were taken with the subject lying in a supine position and elbow flexed 90°, whereby the hand-held dynamometer was situated proximal to the carpus. Knee force was measured with the subject in a sitting position with the knee flexed 90°, whereby the hand-held dynamometer was situated proximal to the calcaneus for flexion and talus for extension. During the shoulder (glenohumeral) abduction test, the shoulder was abducted 90°. The hand-held dynamometer was situated proximal to the lateral epicondyle of the humerus.

Aerobic Capacity

In order to estimate maximum oxygen consumption (VO_{2max}), a submaximal Bruce Treadmill Test was performed [25]. Beginning at a speed of 2.7 km/h, the speed and slope increased at three-minute intervals until 85% of the estimated age-related maximum heart rate (220 – age) was attained. VO_{2max} was predicted employing the following equation:

$$VO_{2max} = 16.62 + 2.74 \text{ (min exercise)} - 2.584 \text{ (men = 1; women = 2)} - 0.043 \text{ (age)} - 0.0281 \text{ (body weight/kg)}.$$

This formula predicted 86% of the VO_{2max} through gasometric measurements [26]. The reproducibility of the prediction equation in healthy men and women is good (r = 0.99) [26].

Participation

Daily Life Physical Activities

In order to measure self-reported physical activity associated with work, sport, and leisure, subjects completed the Dutch language version of the Baecke Physical Activity Questionnaire (BPAQ) [27]. Answers are indicated using a five-point Likert-Scale [27]. The BPAQ consists of three subscales: the work-index, the sport-index, and the leisure-time index. The work-index represents energy expenditure during work and was based on subjects' workload level, answers to questions regarding working positions, and performance during work. The sport-index was calculated by multiplying the energy expenditure level of the sport with the number of hours per week and proportion of the year in which the sport was played. Higher scores represent greater physical activity [27,28]. The leisure-time index was comprised of four questions (e.g., "During leisure time, I watch television"). The test-retest reliability is good for the work index (ICC = 0.95), the sports index (ICC = 0.93), and the leisure-time index (ICC = 0.98) [29].

Environmental factors

Perception of Work

The questionnaire of psychosocial workload and work-related stress (VBBA) includes the Dutch Language version of Karasek's job content questionnaire which is based on the demand control model [9,11,12,30-32]. It consists of 108 questions, each scored on a four-point Likert Scale, measuring six dimensions, including twelve scales and two separate scales of physical effort and job insecurity (Table 2). Each of the scales, with the exception of commitment to the organization ($\alpha = .72$), has high internal consistency (Cronbach's alpha ≥ .80.) Unidimensional reliability, analyzed by the Mokken model, is good $H(t) \geq .40$ [32,33]. The scales range from 0 to 100, whereby, a score of 100 indicates minimal job variety, decision latitude, social support, job security, job satisfaction, and high psychological and physical workloads or stress.

***Table 2** Structure of Dutch questionnaire of Perception of work [32]*

Dimensions	Scale	Example question
Psychosocial Workloads		
psychological workloads	working pace	"Do you have to work fast?"
	emotional work-load	"Is your work mentally stressful ?"
job variety	alternation in work	"Do you get to do a variety of different things on jour job?"
	learning possibilities	"Do you learn new skills in your work?"
decision latitude	skill discretion	"Do you have the freedom to decide how to do your job?"
	decision authority	"Can you make your own decisions concerning your work?"
social support	co-worker support	"Can you ask your colleagues for help?"
	supervisory support	"Can you ask your supervisor for help?"
Work stress		
stress	emotional exhaustion	"When I come home they have to give me a break"
	worrying	"During leisure time, I worry about my work"
job satisfaction	job task satisfaction	"Generally, I find it pleasant to start the working day"
	commitment to organization	"Work at this organisation is very attractive"
Physical load	physical load	"Do you find your work physically heavy?"
Perception of job insecurity	job security	"Do you need more job security for the year coming?"

Physical Workload

Workers were classified into four levels of physical workload, according to the Dictionary of Occupational Titles (DOT) including sedentary, light, medium, and heavy work [34,35].

Personal factors

Perceived Health Status

Perceived health status was measured with the Rand 36-item Health Survey (Rand-36) [36-38]. In this study, the scales mental health, vitality, and general health perceptions were included [36-38]. The mental health scale measures feelings of depression and nervousness; the vitality scale measures feelings of energy and tiredness; the general health perception scale assesses an individual's belief of being healthy. The internal consistency of the mental health, vitality, and general health scales was good (α = 0.81-0.85) in a Dutch population [37,38]. The construct validity is satisfactory [38]. Answers must be given on a five-point Likert scale, varying from "always" to "never." Each scale was transformed to a range of 0–100 [36]. Higher scores indicated better mental health, vitality, or general health perception.

Physical Personal Factors

Age, gender, body height, body weight, and level of education data were culminated using questionnaires.

Statistical analyses

Descriptive statistics were used to describe the population characteristics. We investigated whether each of the questionnaires was affected by floor or ceiling effect by recoding variables (0 = 0; >0 = 1) in cases the median matched the lowest or highest point of a scale. Two authors assessed normality of distributions utilizing histograms [39,40]. Missing data were excluded on a pair-wise basis. Scatter plots between FC test results and ICF factors were created. To answer the research question regarding the relationships between FC test results and other ICF factors, we calculated Pearson (r), Spearman (ρ), or point-biserial correlation coefficients (r_{pbi}). To avoid Type I errors, we used Bonferroni's correction [39]. The value of Pearson (r), Spearman (ρ), and point-biserial correlations(r_{pbi}) were interpreted as being strong for significant (P_{bonf} < .002) correlations when $r, \rho, r_{pbi} > 0.75$; moderate when $0.50 < r, \rho, r_{pbi} \leq 0.75$; fair when $0.25 < r, \rho, r_{pbi} \leq 0.50$; and low when $r, \rho, r_{pbi} \leq 0.25$ [14]. The values of the correlation coefficients between FC test results and ICF factors, described in hypotheses 1 to 15 will be tested (Table 1). Inter-correlations between ICF factors which were strong ($r, \rho, r_{pbi} > 0.75$; $P_{bonf} < .002$) were determined. Each of the FC tests were linearly regressed on the Body function, Participation, Environmental and Personal variables by the minimum Bayesian Information Criterion (BIC), which is strongly consistent in finding the best model and often provides interpretable results for practical purposes [41,42]. To evaluate the proportion of variation of FC tests explained, the coefficient of determination (Multiple R-squared) and its variant adjusted for the degrees of freedom, were evaluated for the complete model as well as for the model selected by minimum BIC. The latter provides an impression of the amount of variance explained by the smaller and better interpretable model.

Results

Descriptive statistics

A total of 403 workers (209 males and 194 females) were tested. Means, standard deviations, and medians of sample characteristics are depicted in Table 3. All variables were normally distributed, with the exception of co-worker support, supervisory support, worrying, job task satisfaction, and job security. For the latter variables, non-parametric statistics were employed.

***Table 3** Characteristics of healthy workers (n = 403)*

	Total* n = 403	Male* n = 209	Female* n = 194
Body function			
Muscle power			
handgrip strength (kg)	41.0(12.5)	50.4(9.5)	31.3(6.1)
knee flexion (N)	226.4(65.3)	261.4(63.0)	189.0(43.4)
knee extension (N)	311.1(108.1)	360.0(105.4)	258.8(83.8)
elbow flexion (N)	229.2(57.9)	269.7(46.5)	185.3(30.6)
elbow extension (N)	157.8(44.1)	185.9(38.0)	127.3(26.7)
glenohumeral abduction (N)	152.2(45.5)	181.0(37.3)	118.0(26.9)
Aerobic capacity (ml/min/kg)	33.8(7.4)	36.7(7.1)	30.6(6.4)
Functional capacity			
Material handling			
lifting low (kg)	37.5(15.5)	48.1(13.2)	26.2(7.8)
overhead lifting (kg)	16.3(6.4)	20.7(5.2)	11.6(3.3)
carrying (kg)	39.6(14.2)	49.2(11.8)	29.3(8.0)
Static work			
standing forward bend (sec)	374.6(304.9)	356.8(273.7)	393.5(334.5)
overhead working (sec)	247.2(113.1)	269.2(122.4)	223.6(97.0)
Participation			
sport-index†	2.9(1.2)	3.0(1.2)	2.8(1.1)
leisure time-index†	3.1(0.6)	3.1(0.7)	3.3(0.6)
work-index†	2.8(0.7)	2.9(0.7)	2.8(0.7)
Environmental factors			
Perception of work			
working pace‖	38.3(12.6)	38.5(12.6)	38.1(12.6)
emotional work-load‖	25.8(14.6)	25.5(13.7)	26.2(15.6)
alternation in work‖	40.3(19.3)	40.1(19.3)	40.4(19.4)
learning possibilities‖	48.3(23.6)	49.5(22.9)	46.9(24.2)
skill discretion‖	28.3(27.2)	28.1(27.5)	28.5(27.0)
decision authority‖	32.4(26.1)	29.7(27.2)	35.2(24.8)
co-worker support‖	0.0(0.0-100.0)§	0.0(0.0-100.0)§	0.0(0.0-66.7)§
supervisory support‖	0.0(0.0-87.5)§	0.0(0.0-100.0)§	0.0(0.0-77.8)§
emotional exhaustion‖	21.3(25.6)	20.3(25.0)	22.4(26.3)
worrying‖	0.0(0.0-100.0)§	0.0(0.0-100.0)§	0.0(0.0-100.0)§
job task satisfaction‖	11.1(0.00-100.0)§	11.1(0.00-100.0)§	11.1(0.0-100.0)§
commitment to organization‖	33.1(22.8)	31.4(23.4)	34.9(22.0)
physical load‖	20.6(19.1)	21.4(19.8)	19.8(18.3)
job security‖	0.0(0.0-100.0)§	0.0(0.0-100.0)§	0.0(0.0-100.0)§
physical workloads (DOT) ‡	2(1–4)§	2(1–4)§	2(1–4)§
Personal factors			
mental health¶	71.8(9.6)	72.9(8.8)	70.7(10.4)
vitality¶	67.5(12.5)	68.8(12.0)	66.1(12.9)
general health perceptions¶	80.0(25.0-100.0)§	75.0(35.0-100.0)§	80.0(25.0-100.0)§
Physical personal factors			
age (years)	41.4(10.6)	42.2(10.8)	40.6(10.3)
body height (cm)	176.8(9,3)	183.0(6.8)	170.1(6.5)
body weight (kg)	75.0(13.0)	81.8(11.9)	67.6(9.9)
education (0–6) #	5.0(1–7)§	4(2–7)§	5(1–7)§

Abbreviations: kg, kilograms; N, Newton; sec, seconds; cm, centimeters.
* Mean (Standard deviation) of variables.
§ Median (Range)
† Measured with Baecke Physical Activity Questionnaire (range 0–5) [27].
|| Dutch questionnaire of perception of work (VBBA) (range 0–100) [32].
‡ DOT Level of physical workloads according to the Dictionary of Occupational Titles [35].
¶ Rand-36 (range 0–100) [38].
# Level 1: primary school not completed; level 2: primary school completed; level 3: school for lower general secondary education finished; level 4: intermediate vocation education finished; level 5: higher vocation education finished; level 6: higher education finished.

Table 4 shows correlation coefficients among the five FC variables and all explanatory variables. No strong correlations were discovered within FC and other variables. The following significant and strong inter-correlations between explanatory variables were found: Gender is strongly correlated with handgrip strength (r_{pbi} = 0.77; $P_{bonf} < .002$). Elbow flexion inter-correlated significantly and strong with elbow extension (r = 0.78; $P_{bonf} < .002$), shoulder abduction (r = 0.79; $P_{bonf} < .002$), and handgrip strength (r = 0.76; $P_{bonf} < .002$). Worrying inter-correlated significant and strong with job security (r = 0.99; $P_{bonf} < .002$)

Table 4 *Correlations between the variables lifting low, overhead lifting, carrying, standing forward bend, overhead working and ICF variables*

		r, ρ, r_{pbi}	Functional capacity									
			Material handling						Static work			
			Lifting low		Overhead lifting		Carrying		Standing forward bend		Overhead working	
			Total	♂;♀	Total	♂;♀	Total	♂;♀	Total	♂;♀	Total	♂;♀
	Body function											
H1	Muscle power											
	handgrip strength (kg)	r	0.68**	0.29**;0.32**	0.72**	0.37; 0.35**	0.68**	0.30**;0.32**	−0.03	0.00; 0.02	0.26**	0.10; 0.22**
	knee flexion (N)	r	0.53**	0.25**;0.21**	0.52**	0.22**;0.22**	0.55**	0.26**;0.32**	−0.04	−0.02; 0.01	0.16**	0.06; 0.05
	knee extension (N)	r	0.49**	0.24**;0.27**	0.45**	0.17*; 0.21**	0.48**	0.19**;0.34**	0.03	0.04; 0.09	0.18**	0.11; 0.03
	elbow flexion (N)	r	0.64**	0.26**;0.25**	0.66**	0.28**;0.30**	0.66**	0.29**;0.34**	−0.03	0.05; 0.00	0.15**	0.02; -0.01
	elbow extension (N)	r	0.64**	0.37**;0.20**	0.66**	0.38**;0.26**	0.63**	0.35**;0.21**	−0.07	−0.04; -0.02	0.14**	0.01; -0.00
	glenohumeral abduction (N)	r	0.66**	0.31**;0.24	0.66**	0.38**;0.22*	0.70**	0.40**;0.34**	0.04	−0.09; 0.07	0.22**	0.10; -0.03
H2	Aerobic capacity (ml/min/kg)	r	0.42**	0.21**;0.23**	0.40**	0.17*; 0.19*	0.43**	0.21**;0.23**	0.13**	0.10; 0.23**	0.28**	0.16; 0.03**
	Participation											
H3	sport-index†	r	0.17**	0.18*; 0.20**	0.14**	0.11; 0.18*	0.16**	0.13; 0.23**	0.11*	0.07; 0.16	0.19**	0.14; 0.24**
H4	leisure time-index†	r	0.11*	0.03; 0.06	−0.12*	0.04; -0.00	−0.08	0.10; 0.05	0.04	−0.04; 0.09	0.09	0.14; 0.12
H5	work-index†	r	0.13*	0.10; 0.13	0.15**	0.14*; 0.12	0.13**	0.11; 0.12	0.07	0.09; 0.07	−0.02	−0.06; 0.00
	Environmental factors											
H6	Perception of work											
	working pace‖	r	0.01	−0.06; 0.01	0.00	−0.02; -0.01	−0.07	−0.17; -0.03	0.09	0.09; 0.09	−0.00	0.03; -0.06
	emotional work-load‖	r	0.01	−0.08; 0.22**	−0.00	−0.09;0.18	−0.00	−0.09; 0.16	0.12*	0.01; 0.20**	0.10*	0.23; 0.22**
	alternation in work‖	r	−0.06	−0.03; -0.19**	−0.02	0.00; -0.07	−0.06	−0.02; -0.18	−0.12*	−0.06; -0.18	−0.17**	−0.12; -0.25**
	learning possibilities‖	r	0.01	−0.05; -0.04	0.04	0.02; -0.02	0.03	−0.01; -0.03	−0.10*	−0.14; -0.07	−0.14**	−0.09; -0.24**
	skill discretion‖	r	0.00	0.02; -0.00	−0.03	0.01; -0.12	−0.01	0.02; -0.06	−0.07	−0.10; -0.04	−0.20**	−0.22**;-0.18
	decision authority‖	r	0.00	0.01; -0.0	−0.05	0.03; 0.06	−0.06	0.03; 0.03	−0.07	−0.09; -0.07	−0.16**	−0.19**;-0.08
	co-worker support‖	ρ	−0.03	−0.02; -0.05	0.01	0.00; -0.03	−0.05	−0.16; -0.02	0.00	0.08; -0.07	−0.08	−0.01; 0.02

	supervisory support‖	ρ	0.02	−0.03; 0.09	0.04	−0.01; 0.05	0.05	0.00; 0.08	−0.01	−0.06; 0.05	−0.07	−0.13; -0.01
	emotional exhaustion‖	r	−0.05	−0.07; 0.05	−0.04	−0.06; 0.07	−0.07	−0.13; 0.05	0.13*	0.08; 0.17	−0.01	−0.06; 0.08
	worrying‖	ρ	0.03	0.02; 0.04	0.04	0.04;0.05	0.02	−0.03; 0.05	0.07	0.08; 0.06	0.03	−0.01;0.07
	job task satisfaction‖	r	0.05	0.03; 0.02	0.05	0.05; -0.02	0.04	0.00; 0.03	−0.08	−0.05; -0.08	−0.11*	−0.10; -0.16
	commitment to organization‖	r	−0.08	−0.02; -0.07	−0.07	0.01; -0.08	−0.05	0.04; -0.06	−0.02	−0.04; -0.01	−0.03	−0.00; -0.04
	physical load‖	r	0.08	0.08; 0.03	0.09	0.12; 0.04	0.07	0.07; 0.02	0.04	0.03; 0.05	0.00	−0.03; 0.03
	job security‖	ρ	0.05	0.08; -0.06	0.03	−0.02; -0.07	0.00	−0.05; -0.07	−0.08	0.00; -0.18	−0.08	0.02; -0.17
H7	physical workloads (DOT) ‡	ρ	0.19**	0.13; 0.10	0.21**	0.16; 0.13	0.20**	0.14; 0.10	0.07	0.10; 0.07	0.03	−0.03; 0.02
	Personal factors											
H8	mental health¶	r	0.06	−0.01; -0.07	0.10	0.07; -0.05	0.10	0.06; -0.03	0.00	−0.01; 0.02	−0.03	−0.04; -0.07
H9	vitality¶	r	0.06	0.01; -0.08	0.10	0.09; -0.07	0.08	0.05; -0.04	−0.06	−0.06; -0.05	0.03	0.03; -0.02
H10	general health perceptions¶	ρ	−0.02	0.11; -0.05	0.01	0.18**;-0.01	0.01	0.05; -0.05	0.01	0.09; -0.03	0.05	−0.12; 0.05
	Physical personal factors											
H11	age (years)	r	0.05	−0.16*;-0.13	−0.01	−0.12; -0.06	−0.07	−0.23**;-0.11	−0.06	−0.13; 0.02	0.00	−0.02; -0.01
H12	gender	r_{pbi}	0.71**		0.72**		0.71**		−0.06		0.20**	
H13	body height (cm)	r	0.62**	0.24**;0.30**	0.58**	0.12; 0.20**	0.61*	0.23**;0.26**	−0.02	−0.08; -0.01	0.15**	−0.02; 0.04
H14	body weight (kg)	r	0.53**	0.27**;0.22**	0.52**	0.23**;0.19**	0.49**	0.18**;0.18	−0.16**	−0.14; -0.17	−0.01	−0.12; -0.20**
H15	education (0–6)#	ρ	−0.07	−0.15; 0.14	−0.06	−0.13; 0.16	−0.03	−0.09; 0.22	0.10	0.00; 0.18	0.12	0.14; 0.15

Abbreviations: r Pearson's correlation coefficient, ρ Spearman rho, r_{pbi}, Point-biserial correlation coefficient.
* Correlation is significant at the $P < .05$ level (2-tailed).
** Correlation is significant at the $P_{bonf} < .002$ level (2-tailed).
† Measured with Baecke Physical Activity Questionnaire [27].
‖ Dutch questionnaire of perception of work (VBBA) [32].
‡ DOT Level of physical workloads according to the Dictionary of Occupational Titles [35].
¶ Rand-36 [38].
# Level 1: primary school not completed; level 2: primary school completed; level 3: school for lower general secondary education finished; level 4: intermediate vocation education finished; level 5: higher vocation education finished; level 6: higher education finished.

Hypotheses tested

Material Handling FC tests

Moderate and fair correlations were found between material handling tests regarding gender, body weight, body height, muscle power, and aerobic capacity (Table 4). Low correlations were determined between all three material handling FC tests and the sport-index, similar to physical workloads. Furthermore, low correlations were encountered between the work-index with overhead lifting and carrying. No significant correlations were found between material handling FC tests and all other participating, environmental, and psychological personal factors. Hypotheses 1, 2, 3, 5, 7, and 12 to 14 were not rejected (Table 1). The remaining hypotheses 4, 6, 8 to 11, and 15 were rejected.

Static Work FC tests

Fair correlations were ascertained between overhead working with aerobic capacity and handgrip strength. The sport-index and four scales of the perception of work correlated low to overhead lifting. For standing forward bend, all hypotheses were rejected. For overhead working, hypotheses 1 to 3 and 6 were not rejected (Table 1). Hypotheses 4, 5, and 7 to 15 were rejected.

Regression analyses

Job security, worrying, co-worker, and supervisory support were recoded as dichotomous variables. The results of the multivariate regression analysis are demonstrated in Table 5.

Table 5 *Regression analyses of ICF-factors on material handling and static work functional capacity*

		B value	*SE*	*t*	*P value*
Material handling					
Lifting low	constant	−58.88	12.74	−4.62	<.001
***R^2* = 0.62**	gender (male)	8.58	1.62	5.30	<.001
	body height (cm)	0.26	0.08	3.21	0.001
	body weight (kg)	0.14	0.05	2.65	0.008
	glenohumeral abduction strength (N)	0.05	0.02	2.60	0.01
	elbow extension strength (N)	0.07	0.02	4.61	<.001
	aerobic capacity (ml/min/kg)	0.28	0.08	3.47	0.001
	sport-index†	1.21	0.45	2.68	0.008
	physical workloads (DOT) ‡	1.72	0.58	2.97	0.003
Overhead lifting	constant	−1.93	1.40	−1.37	0.17
***R^2* = 0.62**	gender (male)	3.95	0.65	6.09	<.001
	handgrip strength (kg)	0.13	0.03	4.99	<.001
	elbow extension strength (N)	0.04	0.01	5.91	<.001
	aerobic capacity (ml/min/kg)	0.10	0.03	3.46	0.001
	physical workloads (DOT) ‡	0.79	0.23	3.44	0.001
Carrying	constant	−48.56	11.69	−4.15	<.001
***R^2* = 0.61**	gender (male)	6.09	1.6	3.81	<.001
	body height (cm)	0.26	0.07	3.80	<.001
	handgrip strength (kg)	0.17	0.06	2.78	0.006
	glenohumeral abduction strength (N)	0.06	0.02	3.37	0.001
	elbow extension strength (N)	0.07	0.02	4.46	<.001
	aerobic capacity (ml/min/kg)	0.27	0.068	4.00	<.001
	physical workloads (DOT) ‡	1.53	0.52	2.92	0.004
Standing forward bend	constant	439.36	109.63	4.01	<.001
***R^2* = 0.05**	body weight (kg)	−3.86	1.13	−3.41	0.001
	aerobic capacity (ml/min/kg)	5.66	2.04	2.78	0.006
	emotional exhaustion‖	1.57	0.58	2.73	0.007
Overhead working	constant	177.01	39.54	4.48	<.001
***R^2* = 0.15**	body weight (kg)	−1.52	0.49	−3.09	0.002
	handgrip strength (kg)	2.65	0.56	4.74	<.001
	aerobic capacity (ml/min/kg)	2.88	0.77	3.74	<.001
	skill discretion‖	−0.77	0.19	−4.04	<.001

R^2, adjusted R square; B value, unstandardized regression coefficient; SE Standard error; P value, empirical significant level; constant, outcome of the FC tests with all other factors being zero; † Measured with Baecke Physical Activity Questionnaire; ‡ DOT Level of physical workloads according to the Dictionary of Occupational Titles [35]; || Subscale of the Dutch questionnaire of perception of work (VBBA) [32].

Material Handling

The regression models explained 61% to 62% of the variance in the material handling FC test results. In material handling tasks, the explanatory variables were physical factors: gender, body height, body weight, muscle strength, aerobic capacity, sport-index, and physical workloads.
The regression model for lifting low FC test can be interpreted as follows. On average (Table 5), 1 cm taller increases lifting low by 0.26 kg; 1 kg heavier increases lifting low by 0.14 kg; 1 kg (10 N) more shoulder abduction muscle strength increases lifting low by 0.5 kg and 1 kg (10 N) elbow extension muscle strength increases lifting low by 0.7 kg, 1 ml/min/kg more aerobic capacity increases lifting low by 0.28 kg; 1 point higher on the sport-index associates with 1.21 kg more lifting capacity; and 1 point heavier physical workloads increases lifting low by 1.72 kg.

Static Work

The regression model explained 5% to 15% of the variance in the static work FC test results. In static work tasks, the explanatory variables were body weight, aerobic capacity, handgrip strength, emotional exhaustion, and skill discretion (Table 5).
The regression model for standing forward bend FC test can be interpreted as, on average (Table 5), 1 kg less body weight increases standing forward bend by 3.86 seconds; 1 ml/min/kg more aerobic capacity increases standing forward bend by 5.66 seconds; 1 point higher on the emotional exhaustion scale (range 0–100) increases standing forward bend by 1.57 seconds.

Discussion

The aim of this study was to determine the construct validity of FC tests by gaining insight into related ICF factors in healthy workers [1]. In this study, performed with a healthy population, physical factors influenced FC tests more than the measured psychological or social factors. For material handling, the physically modifiable factors of muscle strength, aerobic capacity, sport-index, work-index, and body weight were significantly associated with material handling tasks, as were the non-modifiable factors of gender and body height. The variance of material handling test results in healthy workers was largely explained by physical factors only. It may be noted that the models found by minimum BIC are best but do not exclude models explaining little less variance e.g.

muscle strength is replaced by another, based on strong inter-correlations. The variance of static work FC test results was only minimally explained by physical factors and perception of work.
This is the first study into the construct validity of work-related FC tests in a sample of healthy persons. Patients' relationships between FC test results and ICF factors differ from healthy workers. In a sample of patients with chronic pain depression was, contrary to current results, significant but low correlated to material handling FC tests [43-45]. The latter studies utilized measurements of depression that were strongly related to the mental health scale of the RAND-36 of this study (r = 0.81) [27,36,46]. However, an explanation for finding no associations between FC tests and mental health scale in our study might be, beside the absence of chronic pain, that the small variance encountered of the mental health scale may explain the current results (Table 3). In patients with chronic pain, similar to the results in this study, there is also high evidence that gender correlates with overhead lifting [10,43,47-49]. In our healthy sample, age did not contribute to the explanatory models of FC tests. However, previous studies have described an average decline of 20% in physical work capacity between the ages of 40 and 60 years [50,51]. In healthy populations, material-handling tasks can be regarded as tests of muscle strength, which is, in part, genetically determined [3,52,53]. Similarly, we observed that male subjects lifted 4.9 kg to 10.3 kg more weight than female subjects in all lifting tasks. The functional interdependence of oxygen transport and muscle activity could be indicative of the relationship between aerobic capacity and lifting tests discovered in our study as lifting tests are known to place an increased demand on the aerobic system [54]. As for muscle strength, to the best of our knowledge, no study has yet been conducted into the relationship between muscle strength and FC test results in patients with chronic pain. It is recommended to do so in future studies in a sample of patients with chronic pain.
The theoretical construct of work-related FC tests was built upon assumed relations between FC test results and other ICF dimensions. These relations were based on the ICF model [2], researchers' consensus [1], and the demand control model [11,55]. Other bio-psychosocial factors than those measured in this study could possibly be related to FC test results. For example, in patients with chronic pain, there was high evidence that self efficacy relates to FC tests, but a study of self efficacy in healthy workers is nonexistent [7]. For social factors, literature is available that substantiates the influence of the therapeutic alliance and evaluator's fear of injury beliefs on the self-rated activity level of patients, however, a study with objective measurements in a healthy population is missing [56-58]. Furthermore, in regard to personal factors, in patients with

chronic low back pain, fear of movement/(re)injury correlated low with static lifting [7,59-62], but the Tampa Scale of Kinesiophobia (TSK) was not measured in current study. Finally, in regard to the domain body functions, muscle endurance was not measured in this study and may correlate with static work FC tests, especially low back muscle endurance [63].

Limitations

The cross sectional design is not suitable for prediction of future work performance or future work disability. Therefore no conclusions to bio-psychosocial factors that may possibly be influencing future work performance or work disability can be made based on this cross section study. Although the evaluators were well instructed in the test protocol, the results of this study may differ from a sample that was evaluated by experienced evaluators. The last limitation is that other FC tests might give other results.
A particular strength of this present study is the size of the study population (n = 403) and the existence of factors from each component of the ICF. In this study, psychological factors were defined according to the background of an individual's life and living, and therefore, were indicated as personal factors within the ICF framework and not as an impairment in mental function [1,2]. Physical activity such as sport activity was classified as a participation component. Had we classified these variables differently, however, the study results would not vary.

Recommendations

We recommend researchers to replicate this study in a different sample of healthy workers to analyze the robustness of current observations. Further study into the effect of training muscle strength and aerobic capacity on work-related FC tests in healthy workers is also recommended. The empirical evidence of the current study supports fair correlations of FC tests with aerobic capacity. By contrast, in patients with chronic pain, aerobic capacity does not correlate with FC [45]. The transition from healthy workers into patients and the change in the amount of association between aerobic capacity and FC test results and pain might be interesting for the prognosis of developing chronic pain. Therefore, we recommend measuring aerobic capacity and FC tests in a cohort study of healthy workers. Based on the results of this study, we recommend that clinicians, during pre-employment screening in healthy persons, test muscle strength, and aerobic capacity if a worker scores lower on a material handling and static work FC test than the reference values. Results of this study imply no direct recommendations for clinicians working with patients, but indirectly, the results may be useful to clinicians to be aware that the operationalization of the FC construct in healthy workers differs from patients.

Conclusions

In healthy workers, it appears that the construct of material handling FC tests is comprised of the physical factors of muscle strength, aerobic capacity, gender, body height, body weight, sport and physical workloads, but, is not comprised of the psychosocial factors included in this study. The construct of static work FC tests remains largely unexplained. Because of the cross sectional design and the healthy study sample in this study, the results should not be interpreted as predictors for future work performance, nor should they be generalized to patients.

Abbreviations

FC, Functional capacity; ICF, The international classification of functioning, disability and health framework; FCE, Functional capacity evaluations; ICC, Intraclass correlation coefficient; BPAQ, Baecke Physical Activity Questionnaire; DOT, Dictionary of occupational titles; *r*, Pearson's correlation coefficient; *ρ*, Spearman rho; r_{pbi}, Point-biserial correlation coefficient; BIC, Bayesian information criterion; TSK, Tampa Scale of Kinesiophobia; R^2, Adjusted R square; B value, Unstandardized regression coefficient; SE, Standard error; P value, Empirical significant level.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

RS has made substantial contributions to conception and design, acquisition of data, and analysis and interpretation of the data, drafting the manuscript and critically revising it with important intellectual content. JHB participated in the design of the study, drafting the manuscript and critically revising it with important intellectual content. HW drafted the manuscript and critically revised it for important intellectual content. RD acquired data, drafted the manuscript, and critically revised it with important intellectual content. CvdS drafted the manuscript and critically revised it with important intellectual content. MR has made substantial contributions to conception and design, acquisition of data, and analysis and interpretation of the data, drafting the manuscript and critically revised it with important intellectual content. All authors read and approved the final manuscript.

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Effect of physical therapist's attitude on lifting capacity

Physical Therapy (Accepted, contingent on some revisions)

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Abstract

Background Physical therapists (PTs) attitude toward fear of injury during physical activities influences PT's recommendations to patients to avoid daily physical activity. Little is known on the transferability of a PT's attitude to a patient's actual lifting capacity.

Objective The purpose of this study was to determine how a PT's fear of injury attitude influences lifting capacity of healthy persons and to describe the behaviors of high and low fear examiners during a lifting capacity test.

Design The study was a double blinded, randomized controlled study.

Methods Subjects (n=256; 105 male) were PT students who performed a lifting capacity test. Examiners (n=24) were selected from second year PT students. Subjects in Group A (n=124) were tested in the presence of examiners with a high fear of injury who received a short biomedical lecture; Group B (n=132) with a low fear of injury who received a short bio-psychosocial lecture. Differences between Groups A and B in lifting capacities were analyzed using an unpaired t-test. Behaviors of high and low fear examiners were video recorded and analyzed using a uniquely constructed observational guide.

Results Mean (SD) lifting capacity in Group A was 32.1 (13.6) kg; in Group B, 39.6 (16.4) kg. Mean difference was 7.4 kg (95% CI= 3.7 to 11.2; $p < 0.01$). Examiners with a higher fear of injury attitude focus more on pain, lifting avoidance, guarding behavior, stronger control of the test protocol, reassurance, and hesitation.

Limitations Generalizability to PTs and patients with pain should be studied.

Conclusions PT examiner' fear of injury attitude has substantial influence on the lifting capacities of healthy persons. It is recommended to clinical practice to be aware of PTs' attitude and behaviors. PT instructors should be aware of the impact of their attitude and behaviors when instructing PT students.

Introduction

Examining strenuous physical activities, such as lifting capacity, is a challenging task for physical therapists (PTs). Even when PTs are trained as examiners in administration of standardized lifting tests, differences still appear in PTs' instructions and interpretations of test results.[1-4] The implications of these differences can be substantial, because lifting capacity tests are utilized in pre-work screening to determine clinical decisions on choices of therapy, evaluation of interventions, and return to work. Therefore, it is important to unravel the effect of differences between PTs which might be explained by differences in PTs´ attitude toward fear of injury during physical activities. PTs with a high fear of injury have an irrational fear of physical movements from a feeling of vulnerability to painful injury.[5-13] PTs with a biomedical orientation believe that the lumbar spine must be protected from overstrain.[5-13] Both beliefs tend to an attitude to advise patients to avoid physical activities as compared to PTs with a low fear of injury attitude.[5-13] The effect of PTs fear of injury attitude on instructions during a physical test and the influence to patients´ strenuous physical activities has not been previously studied.

Contrary to the knowledge gab of the influence of PTs attitude on strenuous physical activities, the relationship of patients' fear of movement beliefs to patients' strenuous physical activities of maximal lifting has frequently been investigated.[14-19] Several studies demonstrated no relationship between patients' fear beliefs and the results on lifting tests[14-17] while other studies found a weak relationship.[18,19] It is hypothesized that foregoing, inconsistent associations between a patient's fear of movement and results of a lifting test may be explained by the transferability of a PT's fear to the patient and the resulting lifting capacity.[7] Because of assumed relationships between a PT's fear of injury attitude and a patient's behavior mediated by the patient's beliefs.[6,7,10]

Another knowledge gap in scientific literature concerns the explicit behaviors that PTs with high fear of injury attitude demonstrate to their patients.[20] Most studies regarding health care providers' behavior are focused on improving the medical interview but not on how therapist's fear of injury is translated in their demeanor such as hesitation or protective behavior (Fig. 1).[21-24] If PTs obtain additional insight into the influence of beliefs and observed behavior concerning fear of injury and the attendance of biomedical lessons, it could be possible to enhance PTs' recommendations to remain active and, therewith, PTs' adherence to the best evidence as described in guidelines, specifically, to improve patients' activity levels during an episode of low back pain.[10,25-27]

This study targeted two objectives:

1. To determine the influence of PT examiner's fear of injury attitude on lifting capacity in healthy persons.
2. To describe the behavior of examiners with a high and low fear of injury attitude during a lifting test.

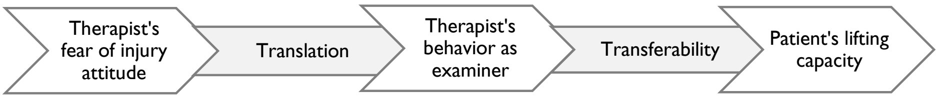


Fig. 1. *Model of the relationship between physical therapist's fear of injury attitude and patient's lifting capacity*

Methods

Subjects

Subjects were healthy, first and second year PT students at the Hanze University Groningen, The Netherlands, between the ages of 17-35 years old who signed an informed consent. One or more positive responses to the Physical Activity Readiness Questionnaire (PARQ) were employed as exclusion criterion.[30] Demographic characteristics including age, gender, weight, subject's fear of injury, and self-efficacy were registered.

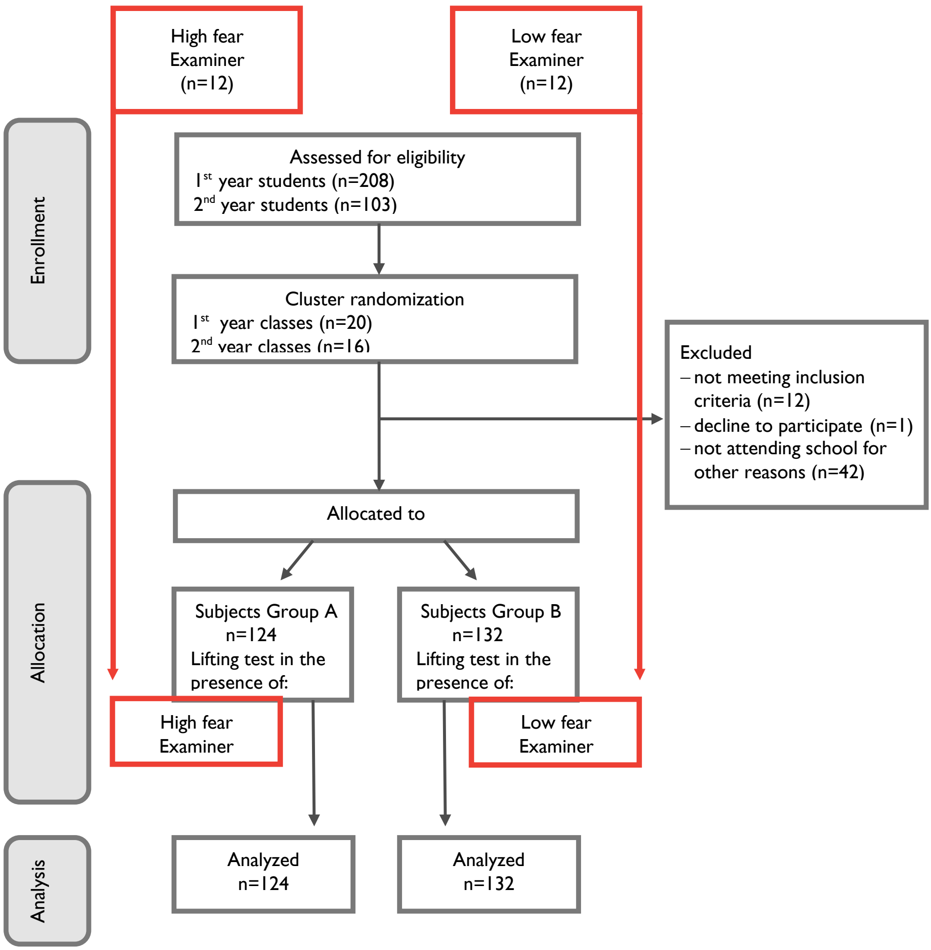
Examiners

In total, 24 second year PT students were trained in the administration of a standardized lifting test by two experienced therapists (MR and RS). These examiners were purposely selected out of all second year students (N=150) based on their fear of injury as scored with the Tampa Scale of Kinesiophobia among the health care provider (TSK-HC).[28,29] The 12 students that obtained the highest TSK-HC scores and the 12 students that obtained the lowest TSK-HC scores were selected as examiners. In conjunction to the training, the highly fear examiners attended an injury focused lecture focusing on the biomechanical determinants of back pain, while the low fear examiners attended an ability focused lecture focusing on the positive training effect of lifting and the weak association between spinal structure damage and lifting.[13] Procedures were followed to ensure that the examiners of both groups were not aware of the lecture and training program of the other group.

Design

A double blinded, cluster randomized cross sectional study was performed (Fig. 2). A randomization of parallel classes (clusters), of which one school class is comprised of an average of 10 students, occurred. Twenty classes of first year students (n=208) and 16 classes of second year students (n=103) were randomized into Groups A and B with a table of random numbers by a researcher not involved in the study and blinded to the identity of the examiners. The subjects of the two groups performed lifting tests: Group A in the presence of a highly fear examiner; Group B in the presence of a low fear examiner. The medical ethical Committee of the UMCG provided a waiver for this study.

Fig. 2. *Flow Chart*



Procedure

In April 2012, the subjects of the two groups performed a lifting test during an education lecture in evidence based practice. Subjects were made aware of performing this lifting test during this lecture through the study manual. Subjects were unaware of the examiner's attitude and group allocation. To avoid contamination bias of the content of the examiners' lectures, both groups were kept separate until the end of the testing day. Following the lecture, the subjects were guided by instructors to and from the testing rooms. The guiding instructors were unaware of the examiners' attitudes. The tests were performed and video-taped in separate, soundproof rooms. The subjects completed questionnaires to measure potential confounders (fear of movements/injury (TSK-G) and self-efficacy) in the presence of an instructor who was blinded for examiner's attitude before entering the testing rooms.

Sample size

The estimate of the sample size was based on the standard deviation of a previous published sample size of 216 healthy Dutch subjects in the category between 18-35 years of age.[30] The clinical relevant difference was set at one-half of the standard deviation (7.4 kg). With a two-sided 5% significance level, a power of 80%, and a dropout rate of 15%, this resulted in an appropriate sample size of 150 subjects.

Measurements

Lifting capacity

Lifting capacity was measured with the lifting test according to the standard WorkWell protocol.[30,31] According to instruction, the subject lifted a plastic box from the table to the floor, and vice versa, in five repetitions within 90 seconds.[30] This procedure was repeated four to five times whereby the weight was increased stepwise. The test-retest reliability of this lifting protocol in healthy subjects was good (ICC = 0.95; 95% CI: 0.89-0.98).[31] After each repetition, the subject's perceived load and the examiner's observed load during lifting was assessed using the Borg CR-10 scale.[32] Reliability and validity of effort observations were good.[32] The endpoint of the test could be achieved in four ways. First, subjects could express that he or she wished to terminate the activity. Secondly, 85% of maximum age related heart rate was attained. Thirdly, the examiner stopped the test if safety could not be guaranteed. Finally, the examiner estimated that the subject had accomplished his maximum lifting performance.

Fear of injury

Examiners fear of the possibility of back injury through physical activity was measured with the TSK-HC.[28,33,34] Subject's fear of injury was measures with the TSK-G. The Dutch version of the TSK-G is reliable and valid.[28,35]

Specific Self-Efficacy

Specific self-efficacy is highly associated with lifting capacity.[15,36-38] To control for differences between the groups of subjects at baseline, we measured specific self-efficacy with an 11 point numeric rating scale. "How much weight can you lift in comparison to other people of your own age and sex?" (Anchors: -5, far below average; 0, average; +5, far above average).

Observational guide

We constructed an observational guide by following a three step iterative process focused on describing the behavior of examiners with high and low fear of injury during a lifting test (Tab.1).[39] After construction, this guide was validated in the fourth step. The construction and validation of the observational guide are described in Appendix 1.

Table 1 *Final observational coding guide*

States	
Interaction distance	The distance between the examiner and subject is a. Close, 1.00 mtr. b. Normal, 1.00-1.20 mtr. c. Far, >1.20 mtr. d. Unclear
1. Eyecontact	a. Towards body position of subject b. Towards subject, not directly towards subject's body position c. Away from subject d. Unclear
2. Body orientation	a. Examiner takes a position in which he can see and check subject's back position. b. Examiner does not takes a position in which he can see and check subject's back position c. Unclear
Facial expression	a. Worried [58] b. Neutral c. Unclear
Events	
Examiner focuses on	Examiner conveys……
1. Pain	Pain and well-being. Symptom-focused talk to the subject.
2. Lifting avoidance	Words that express avoidance of maximal amount of kg lifting (Heavy, low-key, being unable, can you still maintain, this was exhaustive, take your own speed).
Guarding behavior	
3. Injury avoidance techniques	The word safety, safe, or synonyms
Ergonomic lifting techniques:	
4. Ergonomic verbal instruction	
5. Ergonomic physical demonstration	
Strong control	Strong teacher regulation on the standard protocol.[64]
6. Procedural time talk to subject	Talk about the timeline in the procedure, for example, begin signal, count during lifting, end signal.
7. Examiner's decision	The examiner decides about the amount of extra kg lifting. The examiner mentions the amount of weight in the box.
8. Humor	Any humorous expression unrelated to the lifting test, pain, avoidance, guarding behavior or strong control.
9. Reassurance	Reassurance of the test procedure.
10. Hesitation	Communication of examiner's hesitation (mmm, eh, maybe, Would you like to try another 5 kg?).

Mtr., meter

Data-analyses

All statistical analyses were performed using SPSS software, version 20. Demographic characteristics were summarized by descriptive statistics. Baseline comparisons between subjects of Groups A and B were executed with an unpaired t test for continuous data, Mann-Whitney U test for ordinal data, and chi-square tests for categorical data.[40] All statistical analyses were performed at the individual subject's level. Difference in kilograms lifted and 95% Confidence Interval (CI), between the two subject groups were analyzed utilizing the unpaired t-test after checking for normality and equality of variances.[41] Mean frequency of the examiner's behavior, scored with the observational guide by two analyzers, represents the frequency of behavior of highly and low fear examiners and will be described.

Results

Two hundred and fifty six subjects were tested; 124 in the presence of highly fear examiners (TSK-HC range 36-48), and 132 in the presence of low fear examiners (TSK-HC range 25-29). Each examiner tested 4 to 14 subjects. Twelve subjects did not meet the inclusion criteria due to low back pain, illness, other physical injuries, and an operation the next day.

Objective 1: To determine the influence of examiner's fear of injury attitude on lifting capacity.

Differences in baseline characteristics between subjects in Group A and Group B were non-significant (Tab. 2).

Table 2 *Subjects' baseline characteristics*

	Group A	Group B	P	Mean Differences between groups (95% CI)
	Tested in the presence of;			
	High fear examiner	Low fear examiner		
Gender, n (% female)	124 (60.5)	132 (57.6)	.73	na
Age, y	20.5 (2.5)	20.5 (2.4)	.84	-0.1 (-0.7 - 0.5)
Weight, kg	69.8 (8.9)	71.0 (9.8)	.33	-1.2 (-3.5 -1.2)
Fear of injury (TSK-G)	30.7 (4.7)	30.4 (4.6)	.68	0.2 (-0.9-1.4)
Self-efficacy, median (range)	0 (-3;5)	1 (-3;5)	.15	na

All measures are expressed as means (SD) unless stated otherwise; TSK-G, Tampa Scale for Kinesiophobia among the general population; 95% CI, 95% confidence interval, na, not applicable

Test results are depicted in table 3. There was a significant difference in lifting capacity between Group A and Group B. Mean difference between the groups was 7.4 kg (95% CI = 3.7 to 11.2; $p < 0.01$).

Table 3 *Test results*

	Group A	Group B	P	Mean Differences between groups (95% CI)
	Tested in the presence of;			
	High fear examiner	Low fear examiner		
Lifting Capacity, kg	32.1 (13.6)	39.6 (16.4)	.000	7.4 (3.7 -11.2)
Borg CR10 subjects	8.2 (2.2)	9.3 (2.4)	.000	1.1 (0.5 -1.6)
Borg CR10 examiners	8.4 (2.0)	8.9 (2.2)	.06	.51 (0.0 – 1.0)

All measures are expressed as mean (SD); 95% CI, 95% confidence interval; Borg CR 10, assessment of perceived load

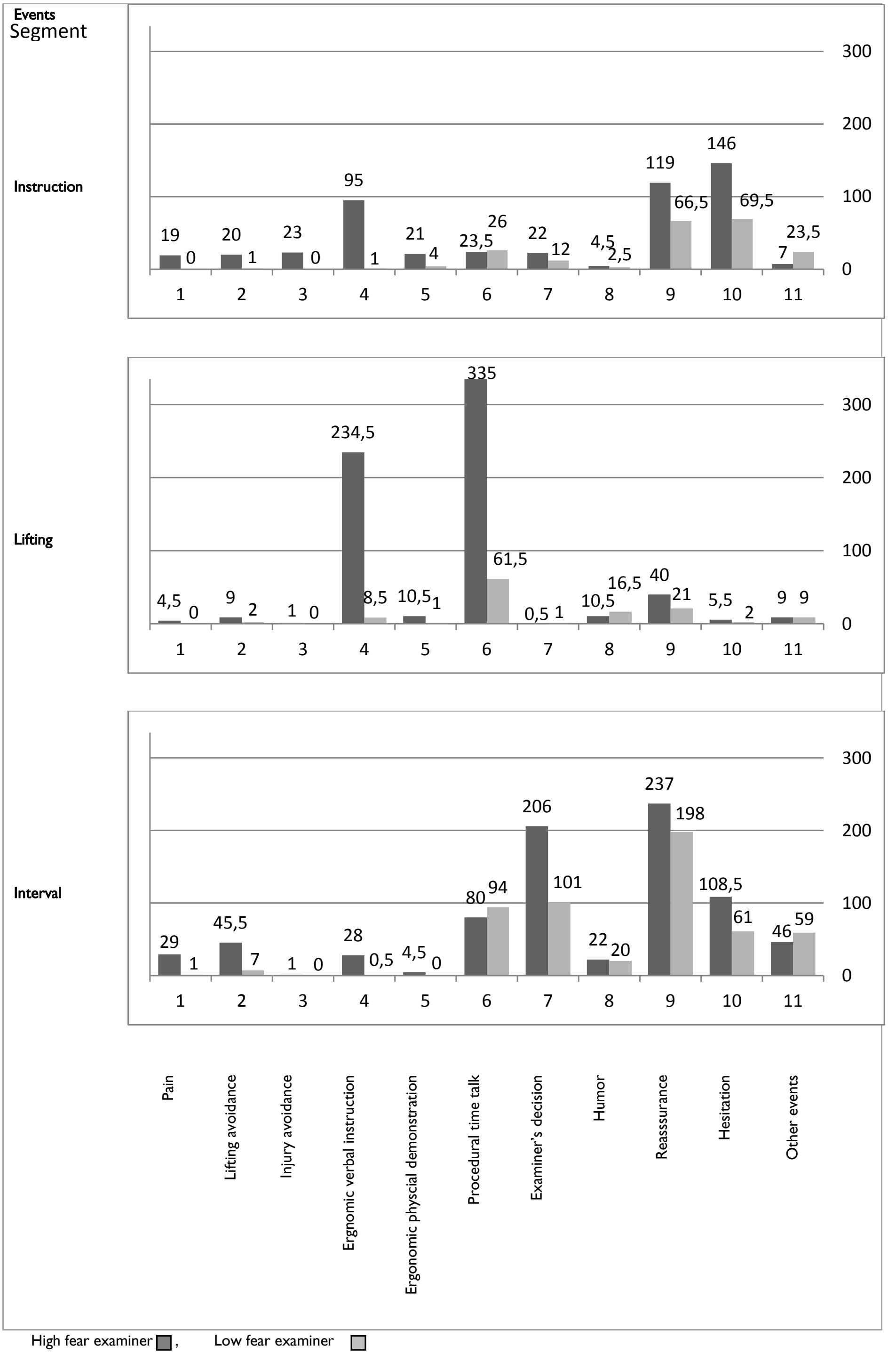
Objective 2: To describe the behavior of examiners with high and low fear of injury attitude during a lifting test.

Two hundred and thirty lifting tests were videotaped. (105 high fear examiners; 125 low fear examiners). States: During every segment the dominant state, eye contact and body orientation was described (Tab. 4). Main differences between high and low fear examiners were described during the lifting segment. Eye contact of the high fear examiner during the lifting segment was directed toward the body position of the subject as well as examiner's body orientation that was directed toward checking the subject's back position during lifting. Events: A total of 2.838 events were transcribed. High fear examiners demonstrated more events (n=1.968) than low fear examiners (n=870). The events are described per segment (Fig. 3).

Table 4 *Frequencies of states of high and low fear examiners during several segments of the lifting test*

		Instruction		Lifting		Interval	
	Examiner's fear of injury	High	Low	High	Low	High	Low
States (%)							
1.	Eyecontact						
	a. Towards body position of subject	0	0	68.8	0	1.4	0
	b. Towards subject, not directly towards subject's body position	93.8	97.8	3.9	74.3	65	67.5
	c. Away from subject	0	0	0.4	1.8	1.1	1.4
	d. Unclear	0	0	0	0	0	0
	Missing	6.2	2.2	26.9	23.9	32.5	31.3
2.	Body orientation						
	a. Can check subject's back position during lifting.	2.1	0	69.1	21.9	1.1	7.0
	b. Cannot check subject's back position.	91.7	97.9	3.8	54.2	66.8	62.2
	c. Unclear	0	0	0	0	0	0
	Missing	8.3	2.1	27.1	23.9	32.1	30.8

Fig. 3. *Number of events of high and low fear examiners during several segments of the lifting test*



Instruction segment

Symptom-focused talk such as pain was more frequently communicated in high fear examiners during the instruction segment than in low fear examiners (Fig. 3), e.g. "Please describe when you experience pain". Lifting avoidance was more frequently communicated in high fear examiners, e.g. "It can really be too heavy, and then you stop". The total mean number of guarding behavioral events is five in the low fear examiner group compared to 139 in the high fear examiner group, e.g. "If I think it is not safe anymore for your back", or "Please watch your technique". Expressions of reassurance were more frequent in high fear examiner. An example of reassurance was using words like "okay".

Lifting segment

The high fear examiner focused more on guarding behavior by communicating 'ergonomic verbal instructions of lifting techniques', and the examiner took influential control over the performance of the lifting test by expressing more 'procedural talk', e.g. "Once more" (Fig. 3).

Interval segment

The main differences are the higher number of 'examiners' decisions' in high fear examiners: Example: "I will put 10 kg in the box" (Fig. 3).

Discussion

Our study indicates that PT examiners' fear of injury attitude is significantly, relevantly, and negatively related to subjects' performances on a lifting test. The second aim of this study was to identify examiners' behavior with high and low fear of injury. High fear examiners focused more on pain, lifting avoidance, guarding behavior, stronger control behavior, reassurance, and hesitation of the protocol than low fear examiners.

This study underpins the relationships described in the fear avoidance model and the transferability of PTs' fear avoidance beliefs on patients' activities. [12,33,42,43] Our extensive analyses of examiners' behaviors revealed that high fear examiners managed their fear by problem focused coping techniques such as guarding behavior and strong control behavior as expressed by ergonomic advices and counting during lifting.[44] Furthermore, our content analyses exhibited that avoidance of injury and avoidance of movements are two different constructs (Tab. 6). The results of this experiment added an important supplement to the fear avoidance model by demonstrating the transfer of the fear of injury of a PT to avoidance behavior of the patient. A previous study described conflicting evidence of the influence of fear avoidance of patients in lifting capacity, however, a PT's fear of injury was not measured in previous studies.[45] Now that we are aware that a PT's fear of injury attitude influences lifting capacity, we recommend measuring a PT's fear during future studies.

Several studies described the behavior of health care workers during medical communication, the behavior of children, parents, or spouse during medical procedures or the behavior of an adult with pain during a lifting task.[21,46-49] Previous studies on medical communication were focused on initiating patient conversation or reducing fear during a medical procedure. The behavior depicted in our study during a lifting test differs from the results in previous studies. Contrary to the results of medical communication studies,[21,24,49] social emotional support was only minimally indicated in this study. Additionally, nonverbal behaviors such as facial expression, non-goal oriented arm hand movement, or gestures were again only minimally indicated in this study. The differences between the behavior depicted in previous studies and the results of this study could possibly be due to the short interaction time during this physical test (10 min.) and the context of this study. As a response to this, we constructed a new observational guide. During the short contact time, high fear PT examiners demonstrated more events, were more directed at providing ergonomic education, and expressed additional reassurance such as stating 'okay' more often that low fear PT examiners.

The strength of this study lies in the number of subjects and its rigorous design whereby participants (subjects, examiners, and analyzers) were blinded for the aim of the study and a randomization procedure dividing the subjects into two groups. This study filled two gaps of literature. First, the gap of knowledge of explicit fear avoidance behavior of PTs is addressed. Secondly, this study complemented the knowledge of transferability of health care workers' attitude into patients' activities. The results of this study are of clinical relevance and should have impact on the clinical practices. PTs should be made aware of the impact of their communication of safety through the use of verbal and nonverbal expressions and physical demonstrations, as these may lead to a 'safety paradox'. By explicitly or implicitly stressing safety, one may actually transfer a message of un-safety. The patient may receive a message of 'this activity can be unsafe' which may, subsequently, lead to avoidance of the activity. There may be circumstances in which this is the target of the PT however, generally in patients with non-specific low back pain, these types of attitude and behaviors are not consistent with professional guidelines.[25-27] We recommend reducing the amount of fear avoidance expressions in the patient-therapeutic interaction, especially among PTs that score high on the TSK-HC, if the aim of this interaction is to increase the level of activity of the patient. With our findings we recommend PT instructors to become aware of the impact of biomechanical lessons on PT student's behavior and the effect on future patient's strenuous physical activities. [13]

Limitations of this study are, first, generalizability. Subjects were healthy persons, not patients with pain. As pain is a transmitter in the relationship between fear and activity, it is hypothesized that the influence of high fear PTs may be stronger on patients with pain.[50] Therefore, it is recommended to describe the PT's fear of injury beliefs in future studies on patient's functional capacity. A second limitation is that the examiners were not experienced physical therapists. No differences were found on the TSK-HC in years of experiences of PTs. [28] We hypothesized that, if the examiners would have been physical therapists, the effect of PTs' behavior on lifting capacity might be higher based on the authority of the PT, however this should be tested in future studies. A fourth limitation is the dualistic prognostic indicators as there was examiner's high or low fear of injury in addition to examiner's biomechanical or bio-psychosocial lecture. No firm conclusions might be drawn about causal factors (examiner's fear of injury or the attendance of a biomechanical lecture) of examiner's attitude during the lifting test.[13] A fifth limitation could possibly be the qualitative hermeneutic approach of the analyzing process of PTs' behaviors. In order to avoid analytical bias, mixed methods of analyses were performed that eventually led to a reliable, initial draft of an observational guide designed by two analyzers independent of each other. Furthermore, seven experts validated the guide. Additionally, two independent, blinded analyzers transcribed the events anew. Eventually, the interrater reliability was high in event codes. The state codes that were, to a lower extent, reliable were excluded from the descriptive behavior. In this study the TSK-HC was chosen as an instrument to measure fear avoidance beliefs of PT examiners. This questionnaire expresses the fear avoidance beliefs of the health care provider.[29] Other questionnaires regarding pain attitude and beliefs could have been selected, but these questionnaires focus on treatment preferences in patients with pain while, in the current study, a sample of healthy persons was included.[51]

Conclusion

Fear of injury attitude of PT examiners has substantial influence on lifting capacity of healthy persons. PT examiners with a high fear of injury attitude focus more on pain, lifting avoidance, and guarding behavior, show a more influential control of the test protocol, and express more reassurance and hesitation compared to PT examiners with lower fear of injury attitude. Recommendations for further studies include investigating the influence of PTs' behaviors in patients with pain and to study the effect of applying one separate event of the observational guide. A recommendation to practice is to be aware of the therapists' attitude and behavior during patient-therapeutic interaction. A recommendation to PT instructors is to be aware of the impact of their beliefs and behaviors when instructing PT students.

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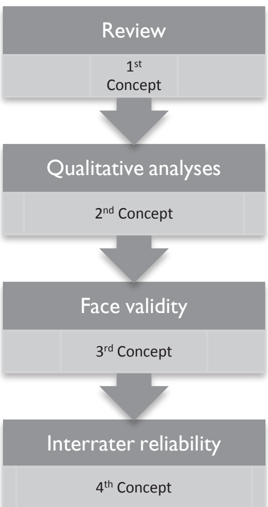
APPENDIX 1

Construction of observational guide aimed to describe examiners' fear avoidance behaviors during a lifting test (Fig. 4).

Fig. 4. *Four methods in constructing and validating the observational guide.*



Method

1st Concept

The first concept of the observational guide was constructed by reviewing the literature and extracting examiners' explicit behaviors on medical communication.[21,23,24,52-59] States and events were separated.[60] A state is a nonverbal behavior that spreads out over time which the analyzer chose to record as dominant behavior during the entire segment.[60] An event is a temporary verbal or nonverbal state, which the analyzer recorded in frequencies.[60]

2nd Concept

The second concept of the observational guide was constructed by analyzing videos qualitatively using the first concept as a framework.

Segments

Each video was divided into three segments. The segment 'Instruction' began directly with the first contact between the subject and examiner. The lifting segment began the moment the subject touched the box. The interval segments began the moment the subject released the box.

Analyses

Two analyzers (AB and SL) independently and qualitatively analyzed six videos per examiner, three videos of high fear examiners and three videos of low fear examiners. The analyzers began by employing the first concept as a framework and removing the codes, i.e. the smallest meaningful unit of expression, that were not able to discriminate between the high and low fear examiners.[61] As medical interviews focus on information-gathering (history taken) rather than on information-giving behavior of the health care provider,[24] in this study, the verbal behavior was additionally scored using a hermeneutic inductive approach of structural coding of particular words that were expressed by high fear examiners in contrast to the low fear examiners.[60] This process is analyzed utilizing a directed content analysis method.[62] The analyzers developed new definitions to clearly distinguish behavior of low and high fear examiners.[60] At the end of this second method, a consensus meeting occurred to discuss the disagreements between the analyzers. If no consensus could be realized, a third person (CvdS) made the final decision. Finally, the second concept of the observational guide will be a table of verbal and nonverbal events and states.

3rd Concept

To impersonalize our hermeneutic approach, the third concept of the observational guide was constructed by asking experts in the fear avoidance model and/or behavioral coding to validate the second concept. Experts' adjusted codes were added to the second concept of the behavioral observational guide if both observers observed a discrepancy of the occurrence of these new codes between high and low fear examiners, based on three videos per examiner.

4th Concept

The fourth concept of the observational guide aimed to determine the Interrater reliability of the behavioral codes of the third concept between two fourth year PT students. All codes from the third concept of the observational guide were entered in SPSS. Two fourth year PT students, blinded for examiners' fear of injuries, were trained by one analyzer in coding videos by the behavioral observational guide within one day. Forty eight videos, two of each examiner, were randomly selected out of all video tapes by a student independent of this study by drawing lots. For behavioral events, any behavioral event occurring at a moment in time during each segmental trial was rated.[60] For behavioral states, the dominant behavior that occupied the greatest portion of the observational segment was rated.[60]

Interrater reliability

Interobserver agreements between the two analyzers were calculated by means of Cohen's Kappa coefficient. Finally, the frequencies of the events or rates with at least a moderate interrater agreement ($K > 0.41$) were described in the result section of the article.

Results

1st Concept

Table 5 shows a review of behavioral states and events of literature. The interrater reliabilities of both the Medical Communication Behavior Systems (MCB) and the Roter interaction analysis system (RIAS) were > .70 on behavior occurring more frequently than 2% of the time. 24 Examiners' answers on subjects' cues or concerns could be coded according to the Verona coding of health provider systems.[49,63]

APPENDIX ***Table 5*** *A review of behavioral states and events of medical communication literature*

Nonverbal	Examiner shows………	
State		
Immediacy behavior[23] 1. Body orientation	A sense of involvement[23] Body orientation of interviewer to interviewee[56] 1. 0 degrees 2. Between 0-90 degrees 3. Between 90-180 degrees 4. 180 degrees (side by side)[56]	involved posture[23] The degree to which the interviewer's shoulders and legs are turned toward, rather than away from, the interviewee.[56] Angle of interaction between physician and patient[55] 1. Always from (back towards patient) 2. Directly facing (face-to face with patient) (=direct bodily orientation[23]) 3. Parallel, facing patient at angle[56]
	Body lean[56] 1. None 2. Forward[23] 3. Backward 4. Sideward[56]	Forward leaning: Forward leaning is defined as posture that involves bending forward or sitting closer to the patient when it is not necessary in order to carry out a physical therapy task. This position conveys involvement and a concentrated focus on the interaction partner.[23,53]
	Sitting closer[23] Open body position[23] 1. Arm and legs uncrossed[23] (= stance)[55] Closed body position 2. Arm and legs crossed[23] (across chest or stomach) [56] 3. One hand touches himself Arm position[56] 1. Symmetric[56] 2. Asymmetric[56] 3. Crossed (across chest or stomach)[56]	Open positions consisting of knees apart, legs stretched out, elbows away from body, hands not touching, legs uncrossed, etc., and closed positions consisting of legs crossed at either knees or ankles, hands folded on lap, arms crossed, etc
2. Interactions distance between physician and patient[55]	1. 4 foot, too far 2. <2 foot, too close 3. 2,5-4,0 foot optimal[56]	
Event		
3. Touches subject	The touch has a purpose of instruction or reassurance (intimacy) touching also communicates power[54] An instrumental/affective expression of physician's helpfulness and empathy for patient (excludes physical exam): can include handshake,[23] hand hold on patient neutral body part, helps with dress items and getting on/off table.[56]	Either the physical therapist or the patient has physical contact with the other party.[23,53]
a) Some touching[23]	1. Instrumental for purpose of instruction[54] 2. ´Sham" instrumental (for the purpose of instruction)	
b) Warm touching[23]	Communication of warmth and daring. To buildrapport.[23] This touch aims to reassure.[54]	
4. Touches himself: non-goal oriented arm hand movement[56]	1. Hand touches own body 2. Manipulation of objects (pen, etc.) 3. Writes on, flips through, or points at medical record 4. Other arm/and movements 5. Hand on the body for > 2 seconds 6. Hands are off the body[56]	
5. Gesture[56]	1. Arm movement used for emphasis or illustration 2. A gesture or gesture cycle that is two seconds or longer. 3. Cessation of the gesture state[56] 4. Affirmative gestures[56]	

6.	Face/head movements	Affirmative head nods[23,56] frequent nodding[23] Frequent smiling[23] smiles[56]	Head nods are defined as a sign of attentiveness in conversation or as reinforcing what has been spoken.[23,53] Smiling: smiling in this context is an expression of friendliness.[23,53]
7.	Facial expression	Facial expressions,[54] Perkins photos[58]	Recognize distinct emotional states from facial expression[54]
8.	Eye contact	1. Direct toward interviewee[56] 2. Both interviewee and interviewer looking at the same thing (body part)[56] 3. Away from examinee[56] 4. Toward medical record[56]	Eye gaze: Either the patient of the physical therapist gazes directly at the face of the other party.[23,53] Eye contact refers to doctor making and maintaining gaze with patients[55] Gaze[54] = excessive eye contact star that may be arousing or threatening if the context is negative[54]
Verbal		**Examiner shows…………**	
		This reflects the specific emotional and motivational states of practitioners.	Voice, tone, intonation
1.	Tone of voice [54]		
2.	Task-focused communication[21]	Patient question-asking and information giving and counseling[61]→ that has the function of gathering data to understand patients' problems and education and counseling to provide information to patients about their illness and motivate them to adhere to treatment[61].	Asking questions, giving instruction and direction, and giving information
	a. Data gathering[61]	Questioning behavior[56] 1. Provider open-ended question[56] 2. Provider closed-ended question[56] 3. Provider open-ended immediately followed by closed-ended[56]	Open-ended question-medical: what can you tell me about the pain / the amount of kg?[61] Closed ended questions medical: Does it hurt? [61] Ask patients' opinion or judgment[61]
	b. Patient education and counseling[61]	Supportive information giving (advice, support, sharing medical data)[56] about posture, ergonomic and lifestyle factors and other forms of self-management.[53] Explaining the risks, benefits and alternative treatments, gaining consent for any techniques performed, evaluating their outcome.[53] Giving advices, clarification and suggestions[53] Directive provider (instructive, command).[56]	Information = statements providing factual information about the patient's condition or medical topic[24] Advice/suggestion = Statements Providing advice or suggestions on what the patient should do.[24] Clarifications = Statements designed to define or explain jargon in layman's terms (Down's syndrome is…) [24]
3.	Social and emotional support[61]	Expression of concern, optimism, empathy, laughter and joking, and social chit-chat, or concern/worry.[61] Affective behaviors function to build a relationship[61] Socio-emotional communication (i.e., positive, negative, emotional, partnership building, and social exchanges). Emotional probes[53]	Emotional probes = (affective behavior) Questions designed to elicit patient's feelings or emotional state (How are you feeling at this point?).[24]
	a. Rapport building & relationship[61]	1. Social talk (nonmedical chitchat) 2. Positive talk (agreements, jokes, approvals, laughter (you are doing great). Reassurance and support.[53] provider shows support/gives advice.[56] Compliments [61] 3. Negative talk (disagreements, criticisms). Withholding back-channel[61] as an effective mechanism for bringing communication to an abrupt end. Disapproval,[53] disruption[53], jargon[53]. Interruptive speech[61] disagreement, Process[56] 1. Provider provides a facilitative interjection[56] 2. Provider interrupts[56] 3. Patient interrupts[56] 4. Emotional talk (empathy, concern, asking for reassurance, partnership, self-disclosure). Reflection of feelings, checks for understanding, asking for reassurance.[53] Empathic statements	Checks for understanding = Statements to elicit and/or assess patient's knowledge or understanding of the circumstances involved in the situation (what do you know about…..)[24] Reassurance/support (affective behavior) = Statements aimed at restoring patient confidence (This kind of thing is oftentimes beyond our control…)[24] Reflection on feelings = Attempts to restate patient feelings in a non-evaluative manner.[24] Disapproval = Rejection or criticism of patient: sarcasm; ignoring of patient feelings Disruption = baby crying, comments/admonitions to children (sit still).[24] Jargon = The use of any technical term that is probably unfamiliar to the layman.[24]

		[56]as: paraphrase, interpret, recognize or name the other's emotional state[61] Provider asks for patient's opinion or questions.[56]	
b.	Activating & partnering [61]	Participatory facilitators (asking for patient opinion, asking for understanding, paraphrases, back channel, ask for reassurance) (E.g.. What do you think it is? Do you follow me? Let me make sure I've got it right. Uhuh, right, go on, hmm.[61]	Encourage/acknowledges = Non-evaluative acceptance of patient behavior (Tell me more, go on, etc.) To explore the therapeutic interaction in order to enhance patient satisfaction.
		Encouragement and acknowledgment[53], restatement[53]	Encouragement of patients expression (ask for patient's questions/opinion) Restatements = Repeating back to the patient the essence of verbalizations and thoughts. [24] Activation strategies.[61] Asking for patient's opinion, paraphrase and interpretation. Function to express patient's expectations.[61] Agreement[61]
		Back channels[61]	Back channels are the "undertalk" that a listener embeds within a speaker's narrative, signaling interest, attentiveness and the expectation that the speaker should continue.[61] The function of back channels is to encourage a speaker to continue a speech stream through cues of interest and attentiveness. The withholding of back-channels is an effective mechanism for bringing communication to an abrupt end.[61] Utterance, other than a speech mannerism.[24]
		Signal acceptance and accord [61] Procedural talk (orientations, transitions, Procedural questions and information) (E.g. I will first look at your rash and then take your blood pressure. I'll be back in a minute. Well, ok, now……[61] Topic of conversations[56]	
		Silence[24]	periods of no verbalizations
4.	Reactions on subjects' cues/concerns	Verona Coding system[49,63]	Examiner´s answers on cues or concerns. Examiner reduces space for the subject to tell more about fear.[49,63] Examiner increases space to tell more about fear.[49,63]
5.	Unclassifiable[24] / Overage[61]	Does not fit other categories	

2nd Concept

The analyzers required three consensus meetings and analyzed 18 videos in total. Several codes could not discriminate and were, therefore, removed from the initial behavioral guide based on literature (Tab. 5). The states 'Body orientation' and 'Body lean' were merged to 'Examiner takes a position in which he can see and check subject's back position' (Tab. 6). 'Eye contact' was changed from an event to a state. 'Patient education' was divided into 'Ergonomic lifting technique' and 'Strong control of standard procedure' (Tab. 6).[64]

APPENDIX ***Table 6*** *Second concept of the observational coding guide based on hermeneutic analyses*

Nonverbal codes		
		The distance between the examiner and subject is
1.	Interaction distance	a. Close, 1.00 mtr.
		b. Normal, 1.00-1.20 mtr.
		c. Far, >1.20 mtr.
2.	Eyecontact	a. Towards body position of subject
		b. Towards subject or not directly towards subject's body position
		c. Away from subject
		d. Unclear
3.	Body orientation	a. Examiner takes a position in which he can see and check subject's back position.
		b. Examiner does not takes a position in which he can see and check subject's back position
		c. Unclear
4.	Facial expression	a. Worried
		b. Neutral
		c. Unclear
Verbal codes		
1.	Safety	A secure situation that, given the characteristics of the person, is not expected to cause injury. Examples: "Maybe you can still lift but it is not safe", "We're going to measure maximum load in a safe manner", "I can also say stop when it is no longer safe." This also comprises avoidance of lifting behavior.
2.	Complaint	The experienced pain or other symptoms that occur during the test. Examples:"How is your back", "Do you feel your back".
3.	Heavy	The perceived load by the number of kg lifting. Examples: "How heavy was this?"; "How does all that weights feel?"; "Yes that was pretty tough". This also comprises fatigability. Functions related to susceptibility to fatigue, at any level of exertion.[70] Examples: "I cannot longer", "You can still lift?".
4.	General well-being	A person's perception of being healthy Examples: "How are you feeling", "Does it feel all right?"
5.	Ergonomic lifting technique	Techniques means for lifting or moving loads, such as the position of the legs and back in order to avoid injuries. Lifting technique is divided into the following three codes:
		a. Verbal instruction. Example: "Keep your back straight"
		b. Physical demonstration by the examiner
6.	Strong control of the standard protocol	1. Instructions by
		a. A starting signal
		b. Counting during lifting segment
		c. A stop signal
		2. Examiner puts the extra weights in the box
		3. Examiner decides about the amount of kg in the box (Contrary to the subject decides)

mtr., meter

3rd Concept

Seven experts advised us to apply, besides the framework of medical literature, the framework of patient's pain behavioral assessments.[47,48,65-69] Experts also advised us to modify the latter framework from scoring a patient's focus into scoring the examiner's focus and to apply the modified framework to the videos. The experts advised to merge 'Ergonomic lifting' and 'Safety' to 'Guarding behavior' and to merge 'Complaint' and 'General well-being' to a 'Pain' code (Tab. 6 and 7). Furthermore, they advised us to adjust codes from observational guides used in the parental-child interaction literature, which are; 'Humor', 'Reassurance' of good performance of the test according to the protocol, and expressions of 'Hesitation' during the standard protocol. [47,48,65] With this additional information, the analyzers analyzed six new videos. Both analyzers observed differences in occurrence between high and low fear examiners. The latter codes were added to the final observational guide (Tab. 1).

4th Concept

Interrater reliability

Interobserver agreement of the states were; Interaction distance $K = 0.31$ ($p = 0.00$), Eye contact $K = 0.87$ ($p = 0.00$), Body orientation $K = 0.57$ ($p = 0.00$), and Facial expression $K = 0.03$ ($p = 0.21$). The interobserver agreement of the event codes was $K = 0.83$ ($p = 0.00$).

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General Discussion

7

7.1 Main results

The primary foci of this thesis were to first identify the level of evidence of risk and prognostic factors for musculoskeletal pain and, second, to analyze biopsychosocial factors related to functional capacity. Five studies were performed. The main research questions are discussed in this Chapter. Methodological considerations, recommendations to health care providers, teachers, and researchers will be also discussed.

With this thesis, robust evidence was ascertained for a range of risk and prognostic factors for musculoskeletal pain. In contrast, this thesis revealed robust evidence for certain risk and prognostic factors to be rejected. Now that we are aware of these factors, health care providers can make targeted recommendations to healthy persons and patients with musculoskeletal pain which might lead to reduced absenteeism. In healthy persons, physical factors are related to functional capacity. In patients with musculoskeletal pain, psychosocial factors appear to be more important. Based on these results, health care providers can narrow the examination for persons with lower functional capacity test results.

The first aim of this thesis is answered with a systematic review of systematic reviews (Chapter 2). The study revealed a high level of evidence of factors for being or not being a risk or prognostic factor for musculoskeletal pain. Only systematic reviews that included studies with a longitudinal cohort design were included to identify causal relationships. The persistence of low back pain was not caused by the patient's fear-avoidance beliefs or by the social factor of meager social support at work. On the other hand, the social factor of poor job satisfaction and the body function factor of increased mobility of the lumbar spine were risk factors for acquiring low back pain but not meager social support nor poor job content. There was moderate evidence for depressive symptoms being prognostic for chronic low back pain. A gap in research was discovered, at that time, regarding activity and participation level. Work had been perceived as beneficial for health but neither functional capacity nor type of work achieved the inclusion criteria of this systematic review (Chapter 2).[1] The following studies in this thesis endeavor to answer the need for more research into related factors of physical work ability.

The second aim of the thesis is answered by means of four studies reflected in Chapters 3 through 6. A systematic review (Chapter 3) was performed among patients with chronic low back pain. This systematic review enlightened evidence for factors being or not being related to functional capacity tests. The functional capacity tests employed in this thesis are divided into lifting tests (amount of kg lifting high, lifting low, and carrying) or postural tests (duration of overhead working, working forward bend, or static lifting). Lifting low was related to self-reported disability and specific self-efficacy but not to pain duration. Lifting high was related to gender and specific self efficacy but not to age or pain intensity. Carrying was related to self-reported disability but not to pain intensity. Static lifting was related to fear of movements.

To supplement the list of related factors to lifting tests or postural tests that were previously under study, the participants of the Delphi study agreed on an extended number of factors that were, in their opinion, related to functional capacity test outcomes in patients with chronic musculoskeletal pain (Chapter 4). Some of the factors were previously studied such as fear avoidance. Certain other factors such as a patient's adherence to doctor's orders, internal and external motivation, and muscle power had not been studied before. The participants classified the latter factors as severely influencing (50%-95%) lifting test results. Furthermore, the participants reached consensus on several factors of moderate influence (25%-49%) such as attitudes of health professionals which include the test examiner.

In the fourth study of a healthy population, related factors were ascertained in several ICF components (Chapter 5). Muscle power, aerobic capacity, and male gender were low in this population related to lifting functional capacity tests. Symptoms of depression and nervousness, older age, and lower work perception were not related (Chapter 5). Contrary to a population of patients with chronic low back pain, psychosocial factors in a healthy population were not related to a functional capacity test but physical factors were.

The fifth study answers the alleged relationship between a physical therapist's attitude and the functional lifting capacity of healthy persons and describes physical therapist's behavior (Chapter 6). A physical therapist's attitude was constituted by the examiner's fear of injury and the attendance in a biomechanical lecture. In this double blinded randomized controlled trial, the examiner's attitude contributed substantially to the subject's maximal lifting capacity (Chapter 6). Physical therapists with a stronger concern for the possibility of back injury were more focused on pain, lifting avoidance, guarding behavior, and stronger control of the test protocol, reassurance, and hesitation.

Figure 1 Profile of related factors of functional lifting low capacity of patients with chronic low back pain in an ICF model reflecting the main results of Chapter 2 and 3.

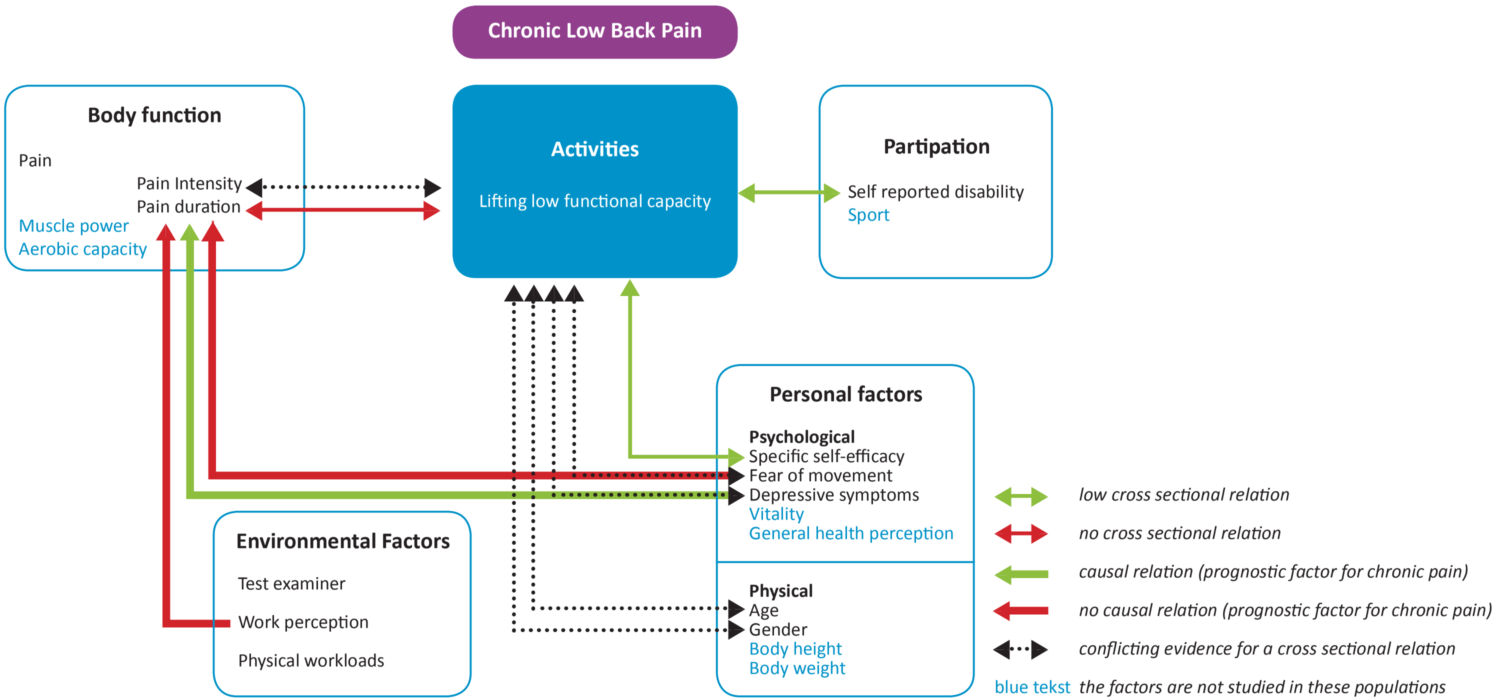
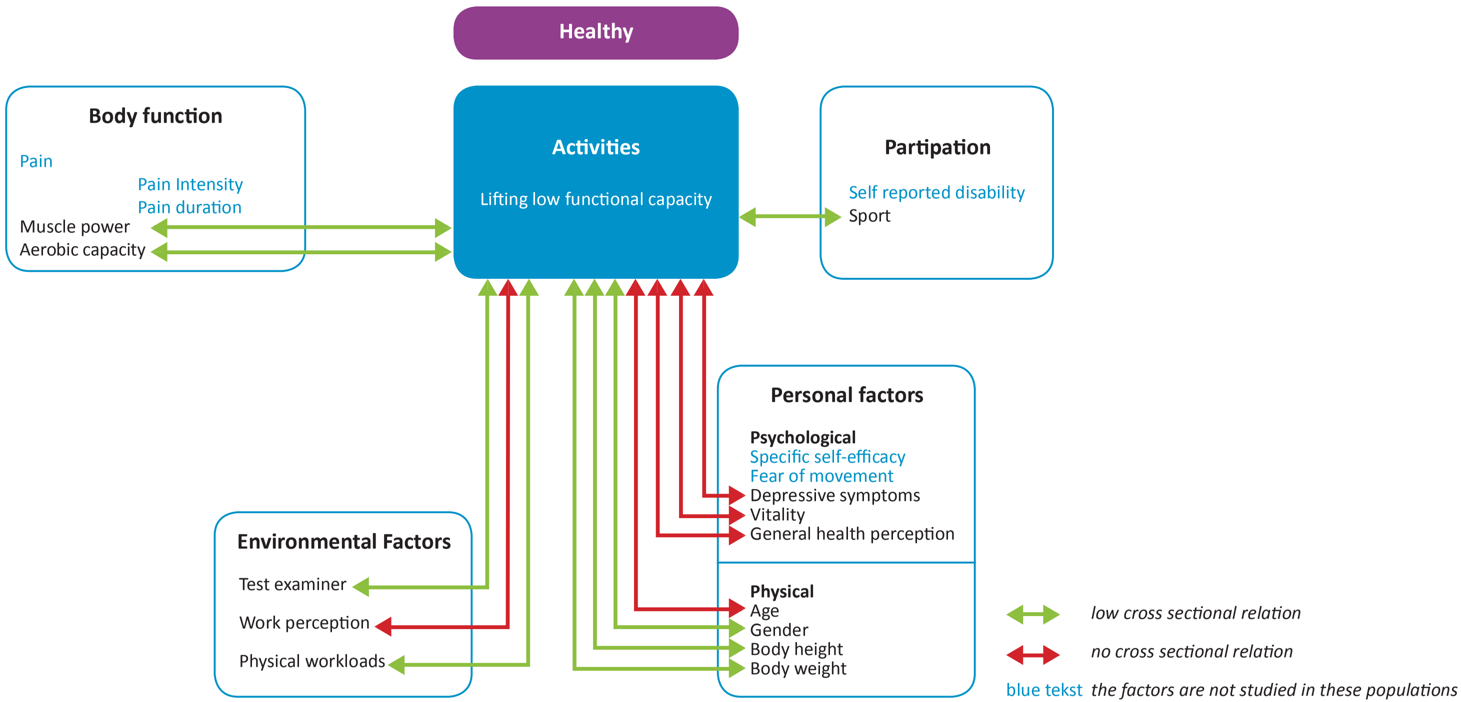


Figure 2 Profile of related factors of functional lifting low capacity of healthy persons in an ICF model reflecting the main results of Chapter 5 and 6.



7.2 Syntheses of the study results of lifting low functional capacity tests

There was heterogeneity between the factors under study in this thesis. Nevertheless there are parallels between studies. Lifting low functional capacity was an outcome measure in four of the five studies. The factors that were measured in relationship to lifting low functional capacity can be synthesized in two ICF models. One model of the relationships of functional capacity in a healthy population (Fig. 2; based on Chapters 5 and 6) and another model of the relationships in a population with chronic low back pain (Fig. 1; based on Chapter 3). Figure 1 was adjusted with the results of causal relationships of sustained pain of Chapter 2. The clinimetric properties of instruments measuring the related factors will be extracted from previous literature, since only instruments with good clinimetric properties contribute to a strong functional capacity construct.

Body function

In a healthy population, muscle power and aerobic capacity are related to functional lifting capacity (Fig. 2; Chapter 5). Measurements of muscle power and aerobic capacity have good clinimetrical properties.[2-4] Therefore, we might conclude that, in a healthy population, the lifting low functional capacity construct contains muscle power and aerobic capacity.

In patients with chronic low back pain, pain duration was not related to lifting low, and pain intensity indicated conflicting evidence (Chapter 3). Pain intensity and duration measurements are known to have good validity and reliability.[5,6,7,8] Thus, in patients with chronic low back pain, the lifting low functional capacity construct does not contain pain duration. Studies regarding pain intensity are ambiguous.

In patients with chronic non-specific musculoskeletal pain, according to the Delphi participants, muscle power severely influences functional lifting capacity and aerobic capacity moderately influences (Chapter 4), but these factors have not yet been studied in patients with chronic low back pain (Chapter 3).

Activities and Participation

The sport index measures sport participation.[9] In a healthy population, sport participation was low related to lifting low functional capacity (Fig. 2; Chapter 5). The clinimetric properties for the sport index are good.[9] This signifies that, in a healthy population, the lifting low functional capacity construct comprises sport participation.

In patients with chronic low back pain, sport participation was not measured in the previous studies that were included in the systematic reviews of causal relationships to sustained pain nor in relationship to functional capacity (Chapters 2 and 3) within this thesis. The participants of the Delphi study agreed that sport was of moderate influence on lifting capacity (Chapter 4).

In patients with chronic low back pain, self reported disability was related to functional lifting low capacity (Fig 1; Chapter 3). Self reported disability (Chapter 3) was measured with the Quebec Back Pain Disability Scale (QBPDS), the Roland Morris Disability Questionnaire (RMDQ), and the Pain Disability Index (PDI) (Chapter 3). The clinimetric properties of these questionnaires are good.[10-14] Summarizing, in patients with chronic low back pain, the construct of lifting low functional capacity comprises self reported disability.

Personal factors

Depressive symptoms

Depressive symptoms are defined as the mild form of depression characterized by the temporary presence of depressive symptoms, such as sadness, depression, fatigue, and low self-esteem. In patients with low back pain, depressive symptoms were measured with valid and reliable questionnaires from the Center for Epidemiological Studies Depression scale (CES-D) or the Beck Depression Inventory (BDI).[15-17] In patients with chronic low back pain there is conflicting evidence that depressive symptoms are related to lifting low functional capacity (Fig. 1; Chapter 3). Additionally, there is evidence that depressive symptoms were a prognostic factor for chronic low back pain (Chapter 2) based on one high quality cohort study that measured depressive symptoms with the 'negative view of self' subscale of the BDI.[20] Summarizing, there is conflicting evidence that the functional capacities construct in patients with chronic low back pain comprise depressive symptoms.

In a healthy population, symptoms of depression and nervousness were not related to lifting low functional capacity (Fig. 2; Chapter 5). Symptoms of depression and nervousness were measured with the valid and reliable mental health scale of the Rand 36.[17-19] Thus, in a healthy population, the lifting low functional capacity construct does not comprise depressive symptoms and nervousness.

Fear of movements

Fear avoidance models express that fear of pain causes the development of chronic musculoskeletal pain through activity avoidance and depression.[21-23]

There are four constructs in literature to measure fear.[24] First, pain-related fear is defined as fear of pain, injury, or physical activity and can be measured by the Fear of Pain Questionnaire or the Pain and Anxiety Symptoms Scale. Second, kinesiophobia, an excessive, irrational fear of physical movements from a feeling of vulnerability to painful injury or re-injury, can be measured with the Tampa Scale of Kinesiophobia (TSK).[23,24] Third, fear of movements is defined as a specific fear of movement and physical activity that is (wrongfully) assumed to cause re-injury.[22] Kinesiophobic is more excessive than fear of movements. Lastly, fear-avoidance beliefs that can be measured by the Fear-Avoidance Beliefs Questionnaire or the Fear-Avoidance of Pain Questionnaire. Fear-avoidance beliefs are not defined in literature.[24] The questionnaires of the four constructs are related to each other but we do not exactly know which fear construct they measure.[24] Based on this lack of construct, despite the linking rules, it is difficult to classify fear in the ICF.[25]

In a healthy population, as described in Chapter 6, the functional capacity construct comprises the health care provider's attitude (Fig. 2; Chapter 6). The health care provider's attitude was constituted by higher scores on the Tampa Scale for Kinesiophobia for Health Care Providers (TSK-HC) in addition to the attendance to a short biomechanical lecture.

In the populations of patients with chronic low back pain discusses in Chapter 3, fear was measured with the TSK and appeared to indicate conflicting evidence for a relationship to lifting low. Thus, in patients with chronic low back pain, it is not clear that fear of extra pain caused by physical activities, as questioned with the TSK, is correlated to lifting. Therefore, in chronic low back pain patients, it is not clear that the functional capacity construct includes patient's TSK-results.

Additionally, there is a high level of evidence that fear is not a prognostic factor for the duration of chronic pain based on nine cohort studies (Fig. 1; Chapter 2). The next step after fear, in the fear avoidance model, is activity avoidance and depression which subsequently leads to sustained chronic pain. Activity avoidance can be measured by utilizing functional capacity tests. Based on the results in this thesis, symptoms of depression are, indeed, a causal factor for chronic low back pain (Fig 1; Chapter 2), but the relationship between observational activity avoidance ascertained from a lifting low functional capacity tests and symptoms of depression is conflicting in patients with chronic low back pain in this thesis (Fig 1; Chapter 3). Fear (of movements) is also not predictable for the persistence of chronic low back pain (Fig. 1; Chapter 2).

Environmental factors

In healthy persons, the functional capacity lifting low construct comprises the test examiner's attitude as well as physical workloads (Fig. 2; Chapter 6) but not work perception (Fig. 2; Chapter 5). Chapter six was the first study into the effect of the test examiner on an observational test. Until now, we have not known the effect of test examiner's attitude on other observational tests. It is striking that, in patients with chronic low back pain, the relationship between environmental factors, such as work perception, and functional capacity are under researched in patients with chronic low back pain.

7.3 Methodological considerations

Strengths and limitations

The designs of the studies of this thesis were diverse. Two studies indicated a high level of evidence based on systematic review designs (Chapters 2 and 3). Limitations of the latter design were heterogeneity in measurements of risk and prognostic factors, and in outcome measures between included studies. Both strength and limitations were stronger in the study of Chapter 2 in which a systematic review of systematic reviews was performed. In attempting to distinguish the strongest evidence, heterogeneity might have biased the results.

Chapter 4 is a Delphi study. This Delphi study reflects the merged opinion of health care providers and researchers from all over the world. Therefore, the level of evidence is low. Until further studies confirm the results of this study, health care providers are not yet recommended to adjust the numerous factors that are mentioned in the results of the study. Strength of this Delphi study was the inclusion of health care providers, researchers, and patients. However, patients only participated in the first round of the study.

The strength of the cross sectional study of Chapter 5 lies in the number of participants and diversity of factors. A limitation of a cross sectional design is that causal relations cannot be detected. Another limitation is the incongruence of the factors mentioned in this study compared to the factors of the other studies for this thesis.

Chapter 6 had a strong randomized controlled study design. Blinding of examiners and subjects was guaranteed. Blinding is difficult in many physical therapy studies. A limitation was the dualistic prognostic indicators including the examiner's high or low fear of injury in addition to the examiner's biomechanical or bio-psychosocial lecture. No firm conclusions can be ascertained regarding causal factors (the examiner's fear of injury or the attendance of a biomechanical lecture) of the examiner's attitude during the lifting test. [27] Another limitation was that the population included no health care providers but, instead, physical therapy students and the subjects were healthy persons, not patients.

Other limitations occurred in this thesis. The influencing factors that were measured in the studies of this thesis were not congruent between studies, resulting in the results of this thesis not being able to reveal factors that might be responsible for the transition from healthy to chronic pain. Most of the studies on influencing factors of functional capacity were administered to patients with chronic low back pain. This thesis omits reviews of populations of patients with other musculoskeletal pain.

7.4 Implications of the results

Clinical implications

The results of this thesis lead to practical recommendations. In patients with chronic low back pain, if the aim of treatment is to resume work activities, we recommend measuring functional capacity lifting low.[28,29] If the results of the lifting low functional capacity test is lower than the lowest valid case of a norm group of working healthy persons,[30] we advise additionally measuring self reported disability (QBDS, RMDQ, PDI), depressive symptoms (CES-D, BDI), irrational fear of physical movements (TSK), pain intensity (VAS), and specific self-efficacy of the patient and fear of movements of the test examiner (TSK-HC). If the aim of treatment is to avoid sustained pain, we recommend additionally measuring prognostic factors including depressive symptoms (BDI-subscale 'negative view of self') but not necessarily fear of movement or work perception. During pre-employment screening, if a healthy worker scores lower than the job specific norm values, health care providers may examine muscle power, aerobic capacity and the TSK-HC of the test examiner. There is high-quality evidence that being middle aged is a prognostic factor for sustained shoulder pain (Chapter 2). Therefore, during the initial contact with a patient with acute shoulder pain, health care providers may inform a middle age patient (45-54 years) that the pain might sustain. Health care providers communicated their beliefs through behavior as described in Chapter 6. It is recommended to screen the health care provider's behavior during a Functional Capacity Evaluation employing the observational guide of Chapter 6.

Recommendations for education

Now that we are aware of the influence of a lecture on the biomechanics of the spine over the student's fear of movement on the student's behavior, teachers must be made aware of the influence of biomechanical lectures on a physical therapist's behavior. The biomechanical lecture on top of a student's fear of movement might provoke patients to remain inactive which might subsequently lead to a patient's non-adherence to guidelines and, therewith, prolonged or recurred musculoskeletal pain and sick-leave. A health care provider's expertise is one of the pillars in evidence based practice clinical decision making.[31,32] Kinesiophobic beliefs may lead to inappropriate clinical decision making. A physical therapist's own reflection on his kinesiophobic beliefs has been considered to be a first step in the clinical reasoning process of physical therapists.[33] The ability of awareness and reflection on practitioner's beliefs and behavior should be trained during a physical therapy study. Role modeling is also an important and effective phenomenon in medical education.[39] Therefore, it is recommended to consciously integrate the cognitive behavioral approach into the biomechanical lectures, especially in case-based learning of patients with chronic musculoskeletal pain.[40] Current study results, in addition to previous studies,[27,34-38] might justify the recommendation to label a kinesiophobic health care provider as not fully competent to practice.

Recommendations for further study

The general research agenda of functional capacity has recently been formulated by the Functional Capacity Evaluation workgroup.[41] Other recommendations for further study from this thesis are, first, further study regarding the effect of analgesics in patients with high initial neck or shoulder pain. Second, further study into symptoms of depression as an accelerant (a catalyst) in the relationship between pain and functional capacity is recommended. Third, further study to the relationship between muscle power and functional capacity in patients with musculoskeletal pain is recommended. Fourth, based on this thesis, it would be recommendable to perform a systematic review of risk and prognostic factors of musculoskeletal pain on the ICF activity and participation level. The search strategy of the study of Chapter 2 was completed in 2008. After 2008, two systematic reviews with minor limitations studied risk factors.[42,43] The results of those studies were not comparative, supporting conflicting evidence for sport participation, heavy physical loads, and working with a bent trunk position being a risk factor for low back pain.[42,43] Fifth, in order to unravel the effect of a health care provider's attitude, repeat the study design of Chapter 6 without biomechanical and psychosocial lessons, which indicates doing so with only a group of high and low TSK-HC scored health care providers. Six, further study into effective implementation strategies of fear of movement reduction in kinesiophobic physical therapists is recommended. Additionally, it is recommended to further study the factors mentioned in the Delphi study.

Patient-therapeutic interaction

Beliefs are only one aspect that influence a health care provider's behavior and may influence patient's activities.[44] Health care providers' values, emotions, needs and skills are other aspects that might influence the communication between practitioner and patient.[44] The non-verbal and verbal communication occurs in a specific context such as the physical environment of a rehabilitation center or physical therapy practice and in the framework of the treatment goals such as returning to pleasant or unpleasant work. Studies revealed the effect of a health care provider's empathic behavior on therapeutic adherence and patient conversation during history taking.[45,46] Until now, the influence of the perception of the patient-therapeutic working alliance has been only minimally researched when activity and participation are the aims of treatment and, therewith, the outcome measure of treatment results, but the results of previous studies are promising.[47,48] There are three central components of the concept working alliance: agreement on goals, tasks, and the quality of the personal relationship between patient and therapist.[19,50] The transferability of a therapist's beliefs on functional capacity (Chapter 6) emphasizes the necessity to study the effect of interaction elements on a patient's activity and participation level. Further study into the effect of working alliance is recommended.

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Summary

Musculoskeletal pain is caused by risk factors for acquiring pain and prognostic factors for the persistence of prolonged pain and is the number one causal reason for restricted participation at work. Many studies have been performed on the reasons for acquiring and the continuance of musculoskeletal pain, however, a comprehensive overview does not exist. Musculoskeletal pain may result in a reduction of the ability to perform physical work.

To determine whether a person's functional capacity is high enough to perform work, standardized functional capacity tests can be executed. One example of functional capacity tests is to measure lifting capacity. These tests are defined as an evaluation of the capacity of activities that is used to make recommendations for participation in work while considering the person's body functions and structures, environmental factors, personal factors and health status. How many of the latter components that should be taken into account are unclear. The results of this study can support health care professionals providing care to patients in the field of work participation by making informed decisions during diagnostic procedures.

The first primary theme of this study is to identify the level of evidence of risk and prognostic factors for musculoskeletal pain. The second main theme of this thesis is to analyze relating factors of functional capacity.

The specific research questions are:

Musculoskeletal pain

- What is the level of evidence of risk and prognostic factors for musculoske letal pain?

Functional capacity

- What is the level of evidence for factors that associate with functional capa city test results in patients with chronic low back pain?
- Which factors influence functional capacity in patients with chronic muscu loskeletal pain according to scientists, clinicians, and patients?
- Are biological or psychosocial factors related to functional capacity tests in a healthy population?
- Does a physical therapist's attitude affect lifting capacity, and what is the behavior of physical therapists with an attitude of high fear of injury in the role of examiner of a lifting test?

There are five studies within this thesis that answer the above questions. Chapters 2 through 6 describe these studies. Chapter 7 describes the main findings of this thesis, discusses the main findings, and provides recommendations for clinical practice and education. Recommendations for further research are provided.

Chapter 2 is a review and presents literature regarding risk and prognostic factors for acquiring or the continuance of nonspecific musculoskeletal pain. Nine systematic reviews were included by means of an extensive search strategy in electronic databases. The included studies were methodologically appraised and merged according to the GRADE best-evidence synthesis. The result was that 67 factors were studied. There is high evidence that increased range of motion of the lumbar spine and low job satisfaction are risk factors for acquiring low back pain. There is also high evidence that intensive initial shoulder pain and being middle aged are prognostic factors for prolonged shoulder pain. This study also revealed high evidence for specific factors not being a prognostic factor. For whiplash, these factors include older age, female gender, angular deformity of the neck, and an acute psychological reaction immediately after the accident. Furthermore, there is high evidence that fear of pain, injury and/or movement is not a prognostic factor for the persistence of low back pain.

Chapter 3 presents a review intended to provide an overview of factors that are related to functional capacity in patients with chronic low back pain. Functional capacity tests were divided into lifting low, lifting high, carrying, and static lifting capacity. The 22 included studies had a cross-sectional or Randomized Controlled Trial design and were published between 1980 and 2010. The methodological quality of the studies and the level of evidence were determined from the factors that were investigated. There was high evidence of several factors and also conflicting evidence. The conclusion of this review was that there was heterogeneity between the studies and the factors that might influence functional capacity in patients with chronic low back pain.

Chapter 4 describes a Delphi study aimed at achieving consensus between 33 scientists, 21 clinicians, and 21 patients worldwide regarding factors that might influence functional capacity in patients with musculoskeletal pain. Consensus was reached on 6 factors that can severely (50-95%) influence, according to the participants, the outcome of the lifting test. These factors include: catastrophic thoughts and fear, patient adherence to "doctor's orders", internal and external motivation, muscle power, chronic pain behavior, and avoidance behavior. Motivation, chronic pain behavior, and sensation of pain were the top 3 factors that influence postural tolerance and repetitive movement functional capacity tests. Additionally, participants agreed on 28 factors of moderate (25%-49%) influence on functional capacity.

Chapter 5 is a cross-sectional study of the construct validity of functional capacity in healthy workers. Clarification of the construct validity of functional capacity is beneficial in specifying the concept of functional capacity. If construct validity is evident, we may be able to take related factors into account during the clinical reasoning within the diagnostic process in healthy persons. The population consisted of 403 healthy workers that performed static and dynamic functional capacity tests. The explainable variables were muscle strength tests, aerobic capacity test, personal factors (age, gender, body height, body weight, and education), psychological factors (mental health, vitality, and general health perceptions), and social factors (perception of work, physical workloads, sport-, leisure time-, and work-index). The pre formulated hypotheses were analyzed by means of regression analyses. There were moderate correlations between dynamic functional capacity tests and muscle strength, gender, body weight, and body height. Static overhead working correlated moderately with aerobic capacity and handgrip strength and low with the sport-index and perception of work. Regression analyses revealed that 61% to 62% of dynamic functional capacity was explained by physical factors. Five to 15% of static functional capacity was collectively explained by physical and social factors. We concluded that, in this sample of healthy workers, dynamic functional capacity is related to physical factors and not to psychosocial factors. The construct of static functional capacity remains mostly unexplained by the factors measured within this study.

Chapter 6 is a double blinded Randomized Controlled Trial. Previous studies demonstrated that the attitude of physical therapists affects the advice given to patients with low back pain regarding staying active. It was unclear whether the attitude of the physical therapist was transferable to lifting capacity of healthy persons. All first and second year students from the Hanze University of Applied Sciences Groningen were invited to participate within this study. Prior to this study, all second-year students filled in questionnaires of the relationship between performing activities and low back pain (fear of injury). The 24 students with the highest and lowest scores on the questionnaire were trained as examiners of a functional capacity lifting test in order to test the lifting capacity of first-year students. In addition to the training of the test protocol, the 12 students with the highest score (Group A) attended a short repetition of the biomechanics of the lower back. The 12 students with the lower scores (Group B) attended a short repetition of the effect of training and sport activities such as lifting. Students of Group A (n = 124) were tested in the presence of an examiner with an elevated fear of injury attitude and students of Group B (n = 132) in the presence of an examiner with a low fear of injury attitude. The observable behavior of the examiners was captured on video in order to observe and analyze their behavior. The mean lifting capacity in Group A was 32.1 kg. (SD 13.6) and, in Group B, 39.6 kg. (SD 16.4). The mean difference between Groups A and B was 7.4 kg. (95% CI= 3.7 to 11.2; $p < 0.01$). The behaviors of the examiners were qualitatively and quantitatively analyzed by means of an observational guide designed for this study. Examiners with an attitude of elevated fear of injury attitude focused more on pain, lifting avoidance, guarding behavior, stronger control of the test protocol, reassurance, and hesitation. Based on the results of this study, it can be concluded that a fear of injury attitude of an examiner in conjunction with a short biomechanical lesson influence the functional capacity lifting test of healthy persons.

Chapter 7 provides two syntheses of the results of studies within this thesis regarding the relationships between lifting functional capacity and factors affecting lifting capacity: first, a synthesis within a population of patients experiencing nonspecific chronic low back pain and, second, a synthesis within a population of healthy workers (Figure 1 and 2, Chapter 7). In healthy workers, the construct lifting capacity includes the constructs muscle power, aerobic capacity, sport participation, physical workloads, and the fear of injury of the examiner but not depressive symptoms or perception of work. In patients with chronic low back pain, the lifting capacity construct includes self-reported disability but not the duration of pain. Additionally, within the Delphi study, experts supplemented the factors of muscle power, aerobic capacity, and sport participation to affect the lifting capacity of patients with chronic low back pain.

The fear avoidance model provides a theoretical relationship between pain and the development of chronic pain with avoiding activities and the evidence of depressive symptoms. In this thesis, there is a high level of evidence that fear of pain, injury and/or movement is not a prognostic factor for the duration of chronic pain.

Recommendations for clinical practice

It is recommended for patients with nonspecific chronic low back pain with a decreased lifting capacity who request 'an increase of lifting capacity' to perform the following additional tests: Self-reported disability, depressive symptoms, irrational fear of injury, pain intensity, specific self-efficacy (the predicted number of kilograms lifting), and the fear of injury attitude of the examiner. It is recommended to patients with low back pain who request 'to avoid prolonged pain' to measure the following prognostic factors: Depressive symptoms but not fear of injury or work perception. If a healthy worker with a decreased lifting capacity inquires if 'his lifting capacity corresponds to his physical workloads', we recommend measuring the following factors: Muscle power, aerobic capacity, and the fear of injury of the examiner. Furthermore, it is generally recommended to observe the examiners of a Functional Capacity Evaluation by means of the observational guide described in Chapter 6.

Recommendations for education

Now that we are aware of the influence that a second year kinesiophobic student who followed a short repetition of a biomechanical lesson has on the activity level of a healthy person, it should influence future education. Offering biomechanical lessons to students with fear of injury attitude could possibly encourage, in the future, stimulating patients with low back pain to remain inactive. The latter is in conflict with the recommendations of guidelines. The ability of self reflection, in particular of students with fear of injury, on the consequences of the student's own behavior should be practiced during physical therapy study. It is recommended to teachers that act as role models during the teaching of biomechanical lessons to integrate bio-psychosocial models of low back pain during the lessons.

Recommendations for further research

In this thesis, evidence was ascertained that the examiner affects the activity level of a subject. Other beliefs, values, emotions, needs, and skills of physical therapists could possibly affect the activity level of another person. Moreover, agreement between the patient and the therapist regarding aims and tasks, as well as the quality of the personal patient therapeutic relationship might influence the activity level of a patient. The influence of this patient therapeutic working alliance requires further study.

Samenvatting

Musculoskeletale pijn, oftewel pijn aan het bewegingsapparaat, staat in de geïndustrialiseerde samenleving op de eerste plaats van oorzaken voor arbeidsverzuim. Risicofactoren verhogen de kans op het ontstaan van musculoskeletale pijn en prognostische factoren voor het langer aanhouden van de musculoskeletale pijn. Er is veel onderzoek gedaan naar risicofactoren en prognostische factoren voor het ontstaan en aanhouden van musculoskeletale pijn, maar het overzicht ontbreekt. Musculoskeletale pijn kan de aanleiding zijn voor een reductie van uitvoering van het werk. Om vast te stellen of iemand de werkgerelateerde functionele capaciteit heeft om een taak of handeling op het werk uit te voeren, worden gestandaardiseerde testen afgenomen. Een voorbeeld is het meten van tilcapaciteit. Functionele capaciteitstesten zijn testen waarmee de functionele capaciteit van werkgerelateerde activiteiten gemeten kunnen worden. De resultaten van deze testen worden gebruikt om aanbevelingen te doen voor arbeidsparticipatie, waarbij in de aanbeveling rekening wordt gehouden met andere componenten, zoals daar zijn: persoonlijke en externe factoren, functies en anatomische eigenschappen, en de gezondheidstoestand van de patiënt. Hoeveel er rekening moet worden gehouden met welke componenten, is nog onduidelijk. Daarom is er onderzoek nodig naar factoren die relaties hebben met de uitkomsten op functionele capaciteitstesten. De resultaten van dat onderzoek kunnen mensen die werken in de gezondheidszorg met patiënten op het gebied van arbeidsparticipatie, helpen bij het nemen van gefundeerde keuzes binnen het methodisch handelen.

Het eerste hoofdthema van deze studie is het identificeren van de mate van bewijskracht van zowel risicofactoren als prognostische factoren voor het ontstaan en aanhouden van musculoskeletale klachten. Het tweede hoofdthema van deze studie is het analyseren van factoren die gerelateerd zijn aan functionele capaciteit bij patiënten met musculoskeletale pijn.

De specifieke onderzoeksvragen zijn:

Musculoskeletale pijn

- Wat is de mate van bewijskracht van risicofactoren en prognostische factoren bij musculoskeletale pijn?

Functionele capaciteit

- Wat is bij patiënten met chronische lage rugpijn de mate van bewijskracht van factoren die gerelateerd zijn aan uitkomsten op functionele capaciteitstesten?
- Welke factoren beïnvloeden volgens onderzoekers, clinici, en patiënten, de functio nele capaciteit bij patiënten met chronische musculoskeletale pijn?
- Zijn biologische factoren of psychosociale factoren gerelateerd aan functionele capaciteitstesten in een gezonde populatie?

❖ Heeft de attitude van de fysiotherapeut invloed op tilcapaciteit en welk gedrag vertoont een fysiotherapeut met een hoge blessure vermijdende attitude tijdens het afnemen van een tilcapaciteitstest?

Er zijn vijf studies uitgevoerd om antwoord te geven op bovenstaande vragen. Hoofdstuk 2 tot en met 6 beschrijven deze studies. Hoofdstuk 7 beschrijft de belangrijkste bevindingen van dit proefschrift, bediscussiëert deze en geeft aanbevelingen voor de dagelijkse klinische praktijk en het onderwijs. Verder worden er aanbevelingen gedaan voor vervolgonderzoek.

Hoofdstuk 2 is een review waarin een overzicht wordt gegeven van literatuur over risicofactoren en prognostische factoren voor het ontstaan en het aanhouden van aspecifieke musculoskeletale pijn. Door middel van een uitgebreide zoekstrategie in elektronische medische databases, werden negen systematische reviews geïncludeerd. De geïncludeerde studies werden methodologisch beoordeeld en samengevoegd volgens de GRADE best-evidence synthese. Het resultaat was dat er in totaal 67 factoren werden onderzocht. Er is een hoge mate van bewijskracht dat verhoogde mobiliteit van de lumbale wervelkolom en lage tevredenheid over het werk risicofactoren zijn voor het ontstaan van lage rugpijn. Er is ook hoge mate van bewijskracht gevonden dat heftige pijn bij aanvang van schouderpijn enerzijds en middelbare leeftijd anderzijds, prognostische factoren zijn voor langer aanhoudende schouderpijn. Er werd ook hoge mate van bewijskracht gevonden dat bepaalde factoren niet prognostisch zijn. Voor whiplash zijn de niet-prognostische factoren: oudere leeftijd, vrouwelijke geslacht, angulaire deformiteiten van de nek, en het hebben van een acute psychologische reactie direct na het ongeval. Verder is er hoge mate van bewijskracht gevonden dat angst voor pijn, blessure, en/of beweging, geen prognostische factor is voor het aanhouden van lage rugpijn.

Hoofdstuk 3 is een review waarin een overzicht wordt gegeven van literatuur over factoren die een relatie hebben met functionele capaciteit bij patiënten met chronische lage rugpijn. De functionele capaciteitstesten werden ingedeeld in hoog tillen, laag tillen, dragen en statische tiltesten. De 22 geïncludeerde studies hadden een cross-sectioneel of Randomized Clinical Trial design en werden gepubliceerd tussen 1980 en 2010. De kwaliteit van de studies werd beoordeeld. Vervolgens werd de mate van bewijskracht van de factoren vastgesteld. Er werd hoge mate van bewijskracht gevonden voor verschillende factoren, maar ook conflicterend bewijs voor verschillende andere factoren. De conclusie van dit onderzoek is dat er heterogeniteit is tussen de studies.

Hoofdstuk 4 beschrijft een Delphi onderzoek waarin het doel was internationaal tot overeenstemming te komen tussen wetenschappers, clinici en patiënten, over factoren die mogelijk van invloed zijn op de functionele capaciteit bij patiënten met musculoskeletale pijn. De participanten waren 33 wetenschappers, 21 clinici en 21 patiënten. Er werd overeenstemming bereikt over 6 factoren die de uitkomsten op de functionele capaciteitstest Tillen aanzienlijk (50-95 %) beïnvloeden. Die factoren zijn: catastroferende gedachten en angst, de volgzaamheid van de patiënt aan de instructie van de arts, intrinsieke en extrinsieke motivatie, spierkracht, chronisch pijngedrag, en vermijdingsgedrag. Van de overige twee functionele capaciteitstesten, te weten langdurig werken in houdingen en herhaaldelijke bewegingen, zijn motivatie, chronisch pijngedrag en pijn de top 3 factoren die de functionele capaciteit beïnvloeden. Verder rapporteerden de participanten 28 factoren die van matige (25%-49%) invloed waren op functionele capaciteit.

Hoofdstuk 5 is een cross-sectionele studie naar de constructvaliditeit van functionele capaciteit bij gezonde werknemers. Opheldering over de constructvaliditeit van functionele capaciteit is belangrijk om het begrip functionele capaciteit verder te kunnen definiëren. Bovendien kunnen we, indien we de relaties van functionele capaciteitstesten met andere factoren kennen, met deze factoren rekening houden tijdens het klinisch redeneren binnen het methodisch handelen. De populatie bestond uit 403 gezonde werknemers die statische en dynamische functionele capaciteitstesten uitvoerden. De factoren waren: spierkrachttesten, aerobe capaciteitstest, persoonlijke factoren (leeftijd, geslacht, lichaamslengte, lichaamsgewicht en opleiding), psychologische factoren (mentale gezondheid, vitaliteit en algemene gezondheidsperceptie), en sociale factoren (perceptie van werk, fysieke werklast, sportparticipatie, vrije tijd participatie en de werk-index). Door middel van een regressieanalyse werden de vooraf geformuleerde hypotheses getoetst. Er werden matige correlaties gevonden tussen dynamische functionele capaciteitstesten enerzijds en spierkracht, geslacht, lichaamsgewicht en lichaamslengte anderzijds. Statisch bovenhands werken correleerde matig met aerobe capaciteit en handkracht, en laag met sportparticipatie en werkperceptie. De regressieanalyse liet zien dat 61% - 62% van de dynamische functionele capaciteit werd verklaard door fysieke factoren. Fysieke en sociale factoren tezamen verklaarde 5% - 15% van de statische functionele capaciteit. De conclusie luidt dat de dynamische functionele capaciteit in deze populatie met gezonde werknemers is gerelateerd aan fysieke factoren en niet aan psychosociale factoren. Het construct van statische functionele capaciteit blijft echter grotendeels onverklaard, met de factoren die gemeten zijn in deze studie.

Hoofdstuk 6 is een dubbel geblindeerde Randomized Clinical Trial (RCT). Uit resultaten van eerder onderzoek blijkt dat de attitude van fysiotherapeuten van invloed kan zijn op het advies dat therapeuten geven aan patiënten met aspecifieke lage rugpijn over het actief blijven bewegen. Het was nog niet bekend of de attitude van de fysiotherapeut overdraagbaar is naar de tilcapaciteit van proefpersonen. Om de overdraagbaarheid te onderzoeken, werd een RCT uitgevoerd. Alle studenten uit het eerste en tweede jaar van de opleiding fysiotherapie aan de

Hanzehogeschool Groningen, werden uitgenodigd om te participeren binnen deze studie. Voorafgaande aan deze studie werden alle tweedejaarsstudenten gevraagd een vragenlijst naar de relatie tussen bewegen en rugpijn (angst voor bewegen) in te vullen. De 12 studenten met de hoogste en de 12 studenten met de laagste scores op deze vragenlijst, werden in 2 uur tijd opgeleid tot testleider van een tiltest. De 12 studenten met de hoogste score (groep A) kregen binnen deze les naast het aanleren van het tiltestprotocol, een korte herhaling van de biomechanica van de lage rug. De 12 studenten met de laagste score (groep B) kregen binnen deze les naast het aanleren van het tiltestprotocol, een korte herhaling over de gezondheidsbevorderende effecten van sportactiviteiten, zoals tillen. Studenten in groep A (n = 124) werden getest in het bijzijn van een testleider met een blessurevermijdende attitude, studenten in groep B (n = 132) in het bijzijn van een testleider zonder een blessurevermijdende attitude. Omdat het observeerbare gedrag van een testleider met blessurevermijdende attitude niet bekend was, werd het gedrag van de testleiders vastgelegd op video. De gemiddelde tilcapaciteit in groep A bleek 32.1 kg. (SD 13.6); in groep B 39.6 kg. (SD 16.4). Het gemiddelde verschil was 7.4 kg. (95% CI= 3.7 - 11.2; $p < 0.01$). Het gedrag van de testleiders werd kwalitatief en kwantitatief geanalyseerd met behulp van een voor deze studie ontworpen gedragsobservatielijst. Testleiders met een blessurevermijdende attitude focusten meer op pijn en toonden vermijdend gedrag. Zij bewaakten meer de houding, controleerden meer het standaard protocol, vroegen vaker bevestiging, en toonden twijfelend gedrag. Uit de resultaten van deze studie blijkt dat een blessurevermijdende attitude van de testleider invloed heeft op de functionele tilcapaciteit van gezonde proefpersonen.

Hoofdstuk 7 geeft twee syntheses van de resultaten van onderzoek binnen deze thesis over de relaties tussen functionele tilcapaciteit en factoren die daarop van invloed zijn. Ten eerste een synthese bij een populatie van patiënten met aspecifieke chronische lage rugpijn en ten tweede een synthese bij een populatie van gezonde werknemers (Figuur 1 en 2, hoofdstuk 7). Bij gezonde werknemers bevat het construct tilcapaciteit de constructen: spierkracht, aerobe capaciteit, sportparticipatie, fysieke werkbelasting en de blessurevermijdende attitude van de fysiotherapeut. De factoren depressieve gevoelens en nervositeit, en perceptie van het werk, maken geen deel uit van het construct tilcapaciteit bij gezonde werknemers. Bij patiënten met chronische pijn bevat het construct tilcapaciteit de zelf gerapporteerde vermindering van functioneren, maar niet de pijnduur. Binnen het Delphi onderzoek gaven experts aan dat spierkracht, aerobe capaciteit en sportparticipatie ook van invloed kunnen zijn op de tilcapaciteit bij patiënten met chronische lage rugpijn. Het vrees-vermijdingsmodel geeft een theoretische relatie weer tussen pijn en het ontstaan van chronische pijn door middel van vermijding van activiteiten en depressieve gevoelens. In deze thesis is een hoge mate van bewijskracht gevonden dat angst voor pijn, blessure, en/of beweging geen prognostische factor is voor de duur van de chronische pijn.

Aanbevelingen voor de klinische praktijk

Het wordt aanbevolen om bij patiënten met aspecifieke chronische lage rugpijn én een verlaagde functionele tilcapaciteit, waarbij de hulpvraag 'verbeteren van tilcapaciteit' is, aanvullend de volgende metingen door te voeren: zelf gerapporteerde vermindering van functioneren, depressieve gevoelens, irrationele bewegingsangst, pijnintensiteit, specifieke zelfeffectiviteit (het door de patiënt voorspelde aantal kilogrammen tillen), en blessurevermijdende attitude van de fysiotherapeut. Het wordt geadviseerd om bij patiënten met lage rugpijn, waarbij de hulpvraag is 'langdurige pijn te vermijden', de prognostische factor depressieve gevoelens te meten. Het meten van bewegingsangst van de patiënt en/of de werkperceptie wordt niet geadviseerd. Bij gezonde werknemers met een verlaagde functionele tilcapaciteit, waarbij de hulpvraag is 'of de tilcapaciteit overeen komt met de fysieke belasting van het werk', adviseren wij de volgende factoren te onderzoeken: spierkracht, aerobe capaciteit en de bewegingsangst van de persoon die de test heeft uitgevoerd. Het wordt verder algemeen aanbevolen om personen die Functionele Capaciteits Evaluaties uitvoeren, te screenen met behulp van de gedragsobservatielijst zoals die beschreven staat in hoofdstuk 6.

Aanbevelingen voor onderwijs

Nu we de invloed kennen van de blessurevermijdende attitude van een tweedejaarsstudent die daarnaast ook nog een les biomechanica volgt, op het activiteitenniveau van een proefpersoon, zal dat gevolgen moeten hebben voor het aanbieden van kennis en vaardigheden binnen gezondheidszorgonderwijs. Het aanbieden van biomechanische lessen aan studenten met angst voor bewegen, zou mogelijk in de toekomst patiënten met aspecifieke lage rugpijn kunnen stimuleren om minder actief te blijven. Het advies om minder actief te blijven, is in tegenstelling met de aanbevelingen uit de richtlijn lage rugpijn. Het vermogen van kritische zelfreflectie van met name studenten met angst voor bewegen, zal moeten worden getraind tijdens de opleiding fysiotherapie. Het wordt aanbevolen aan docenten die als rolmodel fungeren en biomechanische lessen aanbieden, bio-psychosociale modellen van lage rugpijn te integreren in de les.

Aanbevelingen voor vervolg onderzoek

In dit proefschrift werd bewijs gevonden dat de testleider van invloed is op het activiteiten niveau van een proefpersoon. Er kunnen ook andere overtuigingen, waarden, emoties, behoeften en vaardigheden van fysiotherapeuten verbaal en non verbaal worden gecommuniceerd, die mogelijk van invloed zijn op activiteiten van een andere persoon. Verder kan mogelijk ook de overeenstemming tussen de therapeut en patiënt over doelen en taken, en de kwaliteit van de persoonlijke patiënt-therapeut relatie, van invloed zijn op activiteiten van de patiënt. Deze samenwerking tussen patiënt en therapeut, oftewel werkalliantie, behoeft nader onderzoek.

Dankwoord

*'In another moment down went Alice after it, never once considering how in the world she was to get out again.'**

Dit proefschrift is het resultaat van mijn reis door onderzoeksland. Met dit dankwoord wil ik een ieder bedanken die mij naar dit land toebracht, ondersteunde, en mij uiteindelijk heeft vergezeld naar de uitgang: dit proefschrift wat voor u ligt.

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*'Oh dear! Oh dear! I shall be late!' (when she thought it over afterwards, it occurred to her that she ought to have wondered at this, but at the time it all seemed quite natural)'**

Marianne, hartelijk dank voor je inspirerende aanzet tot verandering van praktijkmens tot onderzoeker. Ik verheug me op ons volgende gesprekje over de grens tussen onderzoek en praktijk. En je had gelijk; op onze grafsteen moet niet uitsluitend staan: "zie PubMed".

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'Lastly, she pictured to herself ....how she would gather about her other children, and make their eyes bright and eager with many a strange tale, perhaps even with the dream of Wonderland of long ago..........'

** Alice in Wonderland. Caroll L. 1865*

Curriculum vitae

Sandra Lakke werd op 28 augustus 1960 geboren te Meppel als vierde kind uit een gezin van vijf kinderen. In 1978 ronde zij haar VWO af en begon zij de opleiding Fysiotherapie te Groningen. Van 1982-1986 was zij werkzaam in het ziekenhuis te Meppel. Daarna is zij met haar partner vertrokken naar Duitsland alwaar zij werkte als fysiotherapeut in de eerste lijns fysiotherapiepraktijk te Detmold. In 1988 ronde zij de opleiding Manuele therapie van de Stichting Opleiding Manuele Therapie (SOMT) af. Een jaar erna startte zij een particuliere praktijk in hun woonplaats Lügde te Duitsland. Daarnaast was Sandra docent van de SOMT minikliniek cursussen. In 1999, inmiddels drie kinderen rijker, keerde het gezin terug naar Nederland en ging Sandra werken in een fysiotherapiepraktijk te Zuidlaren. In het jaar 2005 startte zij de studie Fysiotherapiewetenschap aan de Universiteit van Utrecht. Van 2007 tot 2009 was zij docent wetenschapslijn professional master manuele therapie aan de Hogeschool Utrecht en in het jaar dat zij haar bull mocht ontvangen (2008) werd zij docent fysiotherapie aan de Hanzehogeschool te Groningen. Vanaf september 2009 werd het promotietraject ingezet waarbij het Lectoraat Transparante Zorgverlening, de Hanzehogeschool en de afdeling Revalidatiegeneeskunde van het UMCG binnen de onderzoekslijn van EXPAND samenwerkten. Het promotie onderzoek werd vanuit het UMCG ondergebracht bij de Graduate School for Health Research (SHARE) en vanuit het Lectoraat Transparante Zorgverlening bij het kenniscentrum CaRES. Door deze samenwerking werd de kans geboden zich breed te kunnen ontwikkelen door aan te sluiten bij beide onderzoeksgroepen. Tijdens haar promotietraject heeft zij het Training and Supervision Plan van SHARE volbracht en de Basiscursus Regelgeving en Organisatie voor Klinisch onderzoekers (de BROK cursus) behaald. Haar huidige functie is Hogeschooldocent Fysiotherapie voor Specialisaties aan de Hanzehogeschool. Tevens geeft zij post-HBO cursussen. Sandra maakt op dit moment deel uit van de Kenniswerkplaats De Nieuwe Zorgprofessional binnen de Active Ageing Academy van de Hanzehogeschool, waar de toekomstige rol van professionals in de zorg en welzijn centraal staat.

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