Functional capacity and work ability

in patients with chronic musculoskeletal pain

Suzan van der Meer

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Paranimfen

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Contents

Chapter 1

General introduction

Chronic musculoskeletal pain (CMP) can be a disabling condition with potential negative effects on individuals' daily functioning. It is a common problem; one in five adults experience chronic pain across Europe[1]. Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage[2]. Pain is defined as chronic, when it has been present for longer than three months[1]. The pain can lead to significant disability and patients may experience limitations in all life domains like recreation, sleep and work[1]. Some patients do not recover and the reasons for this can be diverse and are not altogether clear. Obstacles for recovery can be biomedical, such as concurrent medical problems, psychological, such as psychopathology or distress, socioeconomic, such as social policy or litigation, or occupational, such as work status[1]. Pain can be located in one or more locations. In patients with chronic non-specific low back pain (CLBP) no well-defined etiology is found[1]. In patients with chronic whiplash associated disorders (WAD) the pain is primarily located in the neck and is related to an acceleration-deceleration trauma3. The problems in patients with WAD are known to be divers and may include dizziness or concentration problems in addition to pain[3]. However, research showed that patients with WAD with mild or moderate pain do not differ from patients with mild or moderate neck pain without neck trauma with respect to pain, functional limitations, and prognostic factors[4]. Pain is a common factor in patients with CLBP and WAD. Pain can be experienced in the absence of identifiable tissue damage; research shows that this is the case in patients with CLPB and WAD grade I-II[5,6].

The biopsychosocial model is applied worldwide to guide the assessment and treatment of patients with chronic pain[7,8]. Treatment options in patients with CMP are diverse. Analgesics, such as non-steroidal anti-inflammatory drugs or opioids, often have limited results on reducing pain in CMP[9]. Non-steroidal anti-inflammatory drugs are slightly effective for short term relief[10], and the effectiveness of opioids is low to moderate[11]. In patients with CLBP, multidisciplinary rehabilitation is more effective in reducing pain and disability in the long term than usual care[12]. Also, multidisciplinary rehabilitation has a positive effect on disability, work participation and quality of life[12-14]. Behavioural treatment and exercise therapy can decrease disability on the short term and long term functioning[15]. However, the level of evidence is low[15].

The evidence for the effectiveness of exercise programmes on disability and work related outcomes for patients with WAD is limited[16,17].

Many patients with CMP have limitations in work participation[1]. Work participation is in part dependent on work ability. The concepts and definitions of the ability to work have changed during the last decade. A concept closely related to the biopsychoscial model is

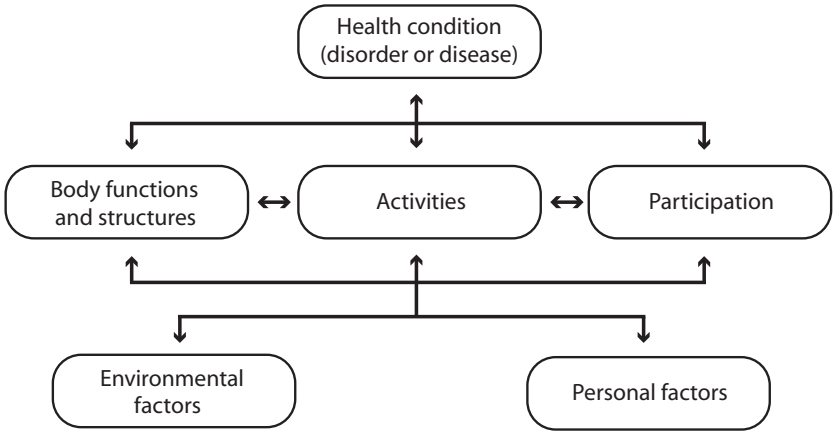

Figure 1.1 The International Classification of Functioning, Disability and Health model.

that work ability is primarily a question of a balance between work demands and personal resources[18]. This balance can change in the different phases of a working life, and work ability shows a declining trend with age[18]. To assess aspects of work capacity, functional capacity evaluations (FCE) have been developed. FCE is defined as an evaluation of capacity or activities, and 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[19]. The definition is based on the International Classification of Functioning, Disability and Health (ICF) (Figure 1.1). The ICF comprises the domains body functions and structures, activities, participation, environmental factors and personal factors.

FCEs are used by physicians and insurance companies to inform work disability claims and rehabilitation processes for people with or without disabilities[20]. The Workwell FCE is used in this thesis, and the complete test battery consists of 29 items[21]. Validity and reliability of the tests have been assessed[20]. The prognostic validity for return to work is modest[22], however a recent study in patients with WAD showed that FCE tests do not predict future work capacity[23]. The reliability for the parts "weight handling" and "strength" is acceptable[21].

Not all parts of FCEs have been investigated for their diagnostic or prognostic properties, nor have they been tested in all relevant patient groups[24]. For example, there are discussions regarding the prognostic value of the FCE tests and specifically regarding whether FCE tests are able to classify effort reliably and validly[24]. Also, psychometric properties of the FCE for patients with neck pain are scarse[25], and have not been studied in the Netherlands.

Rehabilitation can be aimed at (re)gaining work. Work ability of patients with CMP can be positively influenced by rehabilitation[26]. Thus far, the effects of rehabilitation on work ability have not been studied systematically in patients with WAD. Moreover, conflicting results are reported for patients with WAD with regard the effect of rehabilitation for disability reduction[17]. Additional, no strong evidence can be found regarding which biomedical, psychological, socioeconomic or occupational factors predict poor work ability in patients with CLBP and WAD[27,28].

The dose and content of rehabilitation interventions are heterogeneous and therefore difficult to compare between patients with CLBP and WAD[17,26]. The reason for the difference in treatment efficacy between CLBP and WAD is unknown and reason for debate. The so-called "splitters" side of the debate defends the necessity to discriminate between WAD and CLBP as separate diagnostic categories, and to group patients by symptom location, psychosocial or behavioural characteristics[29,30]. They also argue for different treatment approaches. "Lumpers", on the other hand, argue that all nonspecific pain syndromes represent one underlying common basic syndrome[29], and can thus be treated in similar ways. Concluding, the biopsychoscial factors that predict work ability can be different or similar for patients with CLBP and WAD.

Relevance

As mentioned above, not all parts of FCE have been investigated entirely. Firstly, the FCE is assumed to measure work-related activities, which are used to make recommendations for participation in work, vocational rehabilitation, and injury compensation. During testing, patients are asked to give their maximal capacity. However, there are patients that do not give a maximal capacity. It is therefore important to differentiate maximal capacity from submaximal capacity. An incorrect assessment of functional capacity can have far reaching implications for patients. Therefore, knowing whether the FCE can validly measure submaximal capacity is important. A systematic review might identify and synthesize all high quality evidence research on this subject. Secondly, self-reported abilities of a patient with CMP can differ from a performance based assessment of abilities. This is shown in the weak correlation between self-reported disability and functional capacity in patients with CLBP[31]. However, for WAD this is unknown. If the relation between self-reported disability and functional capacity is also weak in patients with WAD, this can influence the instruments physicians and insurance companies use to objectify disability. Thirdly, the reproducibility of the different tests of FCE has to be investigated. One of the FCE tests in patients with WAD is the neck muscles strength tests. The clinimetric properties of muscle strength testing with hand-

held dynamometers have not been studied extensively[32]. With regard to clinical assessment, knowing whether neck muscle strength can be tested in a reliable way is important.

As mentioned above, work ability of patients with CMP can be positively influenced by rehabilitation. FCEs cannot only be used to determine functional capacity, but also to guide a patient's return to work[33]. In a rehabilitation setting, a weak but significant relation between FCE information and improved return to work outcomes in patients with CMP was established[33]. However, this has not been tested in a 'light' setting: a short-form FCE and a brief cognitive behavourial intervention. It is arguable that a FCE together with a brief cognitive behavioural intervention can improve work ability in patients with CMP. If a FCE together with a brief cognitive behavioural intervention can improve work ability, this might relatively easily be implemented in daily practice.

It is unknown whether the biopsychosocial variables, such as high levels of pain, pain catastrophizing, self-reported disability and low quality of life, that are related to work ability, differ between patients with CLBP and WAD. Knowing whether these variables and relationships with work ability differ and whether this can influence the content of rehabilitation programs is important because it may improve and specify rehabilitation in patients with WAD and CLBP.

Finally, one of the environmental factors in the ICF is injury compensation, which is assumed to be a negative mediator on health status and disability in patients with WAD[34]. However, the reviews on this topic are contradictory to some extent[34] and more methodologically sound research is needed to study the possible influence of injury compensation on rehabilitation outcomes. If injury compensation influences rehabilitation according to professionals, advices can be given to rehabilitation professionals.

Aims and research questions

The main aim of this thesis is to obtain a better understanding of the role of FCE and work ability in patients with CMP both with regard to the validity and reproducibility of the FCE as well as for rehabilitation interventions that facilitate work ability (vocational rehabilitation). Six research questions were formulated:

1. What is the validity of instruments designed to detect submaximal physical or functional capacity when maximal capacity is requested in patients with nonspecific chronic musculoskeletal pain?
2. What is the strength of the relationship between self-reported disability and functional capacity, in patients with WAD?

3. What is the reproducibility of neck muscles strength testing with hand-held dynamometry in healthy young adults?
4. What is the feasibility of adding a short form FCE to a brief cognitive behavioural intervention with the aim to improve work ability in patients with CMP?
5. What are the differences and similarities in biopsychosocial factors that predict work ability between patients with CLBP or WAD who have been referred for multidisciplinary rehabilitation?
6. What are rehabilitation professionals' opinions about the influence and possible causal pathways of injury compensation on health and disability in patients with WAD?

Research question 1 is addressed in chapter 2. In this chapter, a systematic review is presented of the ability of instruments designed to detect submaximal physical or functional capacity when maximal capacity is requested in patients with CMP.

In chapter 3 research question 2 is addressed. The construct validity of the functional capacity of each of the neck FCE tests separately and self-reported disability measured with the Neck Disability Index in patients with WAD was investigated.

Chapter 4 addresses research question 3. Here the reproducibility of neck muscles strength testing with hand-held dynamometry in healthy adults was investigated.

Research question 4 is addressed in chapter 5, where a pilot RCT about whether adding a short form FCE to a brief cognitive behavioural intervention could improve work ability in patients with CMP is presented.

In chapter 6 research question 5 is addressed. In this chapter the relation between biopsychosocial factors and work ability of patients that have been referred to a rehabilitation physician for multidisciplinary rehabilitation because of CLPB or WAD was analysed.

Research question 6 is addressed in chapter 7. In this chapter rehabilitation experts-professionals' opinions about the influence and the possible causal pathways of injury compensation on health and disability in patients with WAD were explored.

In chapter 8 the results of the six studies are discussed.

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Chapter 2a

Which instruments can detect submaximal physical and functional capacity in patients with chronic nonspecific back pain? A systematic review.

Spine 2013;38(25):E1608-15.

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ABSTRACT

Study design: Systematic review.

Objective: To evaluate the validity of instruments that claim to detect submaximal capacity when maximal capacity is requested in patients with chronic nonspecific musculoskeletal pain.

Summary of background data: Several instruments have been developed to measure capacity in patients with chronic pain. The detection of submaximal capacity can have major implications for patients. The validity of these instruments has never been systematically reviewed.

Methods: A systematic literature search was performed including the following databases: Web of Knowledge (including PubMed and Cinahl), Scopus and Cochrane. Two reviewers independently selected the articles based on the title and abstract according to the study selection criteria. Studies were included when they contained original data and when they objectified submaximal physical or functional capacity when maximal physical or functional capacity was requested. Two authors independently extracted data and rated the quality of the articles. The included studies were scored according to the subscales "criterion validity" and "hypothesis testing" of the COSMIN checklist. A Best Evidence Synthesis was performed.

Results: Seven studies were included, five of which used a reference standard for submaximal capacity. Three studies were of good methodological quality and validly detected submaximal capacity with specificity rates between 75% and 100%.

Conclusions: There is strong evidence that submaximal capacity can be detected in patients with chronic low back pain with a lumbar motion monitor or visual observations accompanying a Functional Capacity Evaluation lifting test.

INTRODUCTION

Detecting submaximal capacity when a maximal capacity is requested is challenging in patients with chronic musculoskeletal pain. Detection rates between 1% and 20% are reported, especially in the medico-legal context[1,2]. Instruments used to detect submaximal capacity, guide decisions that may have far-reaching implications in medical management but also for injury compensation claims. Therefore, it is of great importance to validly diagnose submaximal effort. Studies have been published about instruments that claim ability to discriminate maximal from submaximal capacity in patients with chronic musculoskeletal pain, but to our knowledge, a methodologically rigorous review of these studies has not been published.

Capacity is defined as the highest probable level of functioning that a person may reach in a domain at a given moment in a standardized environment[3]. Submaximal capacity can be referred to as malingering, disability exaggeration, symptom magnification syndrome or insincerity of effort. The Diagnostic and Statistical Manual of Mental Disorders (DSM) defines malingering as intentional production of false or grossly exaggerated physical or psychological disability, motivated by external incentives such as avoiding military duty, avoiding work, obtaining financial benefits, evading criminal prosecution or obtaining medication[4]. Symptom magnification syndrome is a self-destructive, socially reinforced behavioral response pattern consisting of reports or displays of symptoms which function to control the life circumstances of the sufferer[5]. Submaximal effort is related to muscle strength tests but is physiologically different from maximal effort[6]. Sincerity of effort has been described as a person's conscious motivation to perform optimally during evaluation and treatment[7]. There may be several reasons for a patient to put forth submaximal capacity, one of which being an adaptive reaction to avoid (increase of) pain. In this review, however, no distinction is made between intentional and unintentional reasons for submaximal capacity. There is a lack of clear definitions as to what constitutes submaximal capacity. In the International Classification of Functioning, Disability and Health (ICF) physical capacity and functional capacity are described[8,9]. Our definition of submaximal capacity is inspired by ICF: less than a maximal level of functioning on the physical or activity level that a person may reach in a domain at a given moment in a standardized environment. In this paper, the term submaximal is intentionally used and not malingering, insincerity, etc., because the reasons for submaximal capacity are beyond the scope of this study.

Maximal capacity tests serve as a standard against which to compare other measures. They play a key role in the assessment of maximal aerobic capacity or functional work capacity[10]. Some people are limited by cardiopulmonary, musculoskeletal and neuromuscular

impairments and complaints such as dyspnea and pain. In those populations these instruments may be of limited use[10].

The aim of this systematic review was to identify the ability of instruments designed to detect submaximal physical or functional capacity when maximal capacity is requested in patients with nonspecific chronic musculoskeletal pain.

MATERIALS AND METHODS

Data sources and searches

Relevant studies were obtained through a computerized search of Web of Knowledge (including Medline and Cinahl), Scopus and Cochrane Library. The search included articles through October 10 2012 and used the following words: malingering, exaggeration, magnification, effort, discrepancies, submaximal, chronic pain (low back pain, whiplash injuries, fibromyalgia, neck pain) and is presented for the various databases in Appendix 2.1.

Studies in adults with nonspecific musculoskeletal chronic pain were included when they were: 1) written in English, German or Dutch; 2) contained original data; 3) objectified submaximal physical or functional capacity when maximal physical or functional capacity was requested. Studies describing mixed samples (e.g. subjects with pain and healthy subjects) or mixed methods (e.g. capacity test and self-report) were only included if the data of interest could be isolated.

Study selection

Two authors independently selected studies based on the title and abstract. Of potentially eligible studies a full copy was obtained. These articles were assessed for inclusion by two authors. Disagreements were resolved by discussion and if disagreement continued, a third person acted as an adjudicator. Additional reference tracking was performed. We hand-searched the reference lists of other relevant articles and eligible studies.

Data extraction and quality assessment

We used the COSMIN method to systematically evaluate the methodological quality of the studies[11]. The quality of the evidence for each study was assessed by using the COSMIN checklist Box H (criterion validity) or Box F (hypothesis testing)[11]. Two reviewers (SvdM

and MT) independently assessed the methodological quality of the included studies. The quality criteria of Box H were used to score studies with a reference standard, whereas Box F was used to evaluate studies without a reference standard[11].

Data synthesis and analysis

To determine the overall quality of the measurement properties of the instruments, we synthesized the different studies by combining their results. In light of the study question, we were interested in test specificity. With lower specificity patients performing at maximal capacity will be rated as negative, and consequently incorrectly diagnosed as submaximal performers (false negative). With a lower sensitivity, patients performing at submaximal capacity will be rated as positive, and consequently incorrectly diagnosed as maximal performers (false positive). The possible overall ratings for a measurement property were positive (+), indeterminate (+/-) or negative (-), accompanied by levels of evidence, as was proposed by the Cochrane Review Back Group[12,13] (Table 2.1). In the overall conclusion, because of their use of reference standards, criterion validity studies were preferred over hypothesis testing studies.

Table 2.1 Best evidence synthesis

Level	Rating	Criteria
Strong	+++	Consistent findings in multiple studies of good methodological quality OR in one study of excellent quality
Moderate	++	Consistent findings in multiple studies of fair methodological quality OR in one study of good methodological quality
Limited	+	One study of fair methodological quality
Conflicting	+/-	Conflicting findings
Unknown	?	Only studies of poor methodological quality

RESULTS

Study selection

The search strategy identified 2558 eligible studies. After screening the titles and abstracts, 29 potentially relevant studies were included. Of one study no full-text version could be obtained[14]. Twenty-one studies were excluded after reading the full text (Appendix 2.2). Seven studies were included (Figure 2.1).

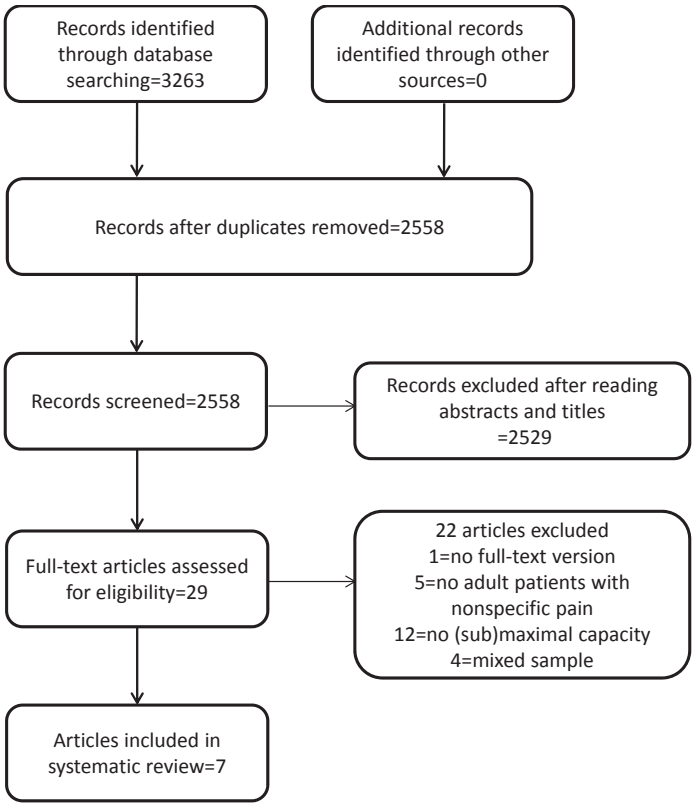

Figure 2.1 Flow diagram of study selection.

Study characteristics

Information about patient characteristics, setting, blinding and test instruments is presented in Table 2.2. Six out of the seven studies assessed patients with low back pain. From the studies by Reneman et al.[15] and Dvir et al.[16], we included only the data which fulfilled the inclusion criteria. One of the review authors (MR) was also an author of one of the included trials. According to the Cochrane Review Guidelines and to avoid conflict of interest this author was not involved in the data analysis that involved his trial[12].

Instruments

Lemstra et al.[17] randomized 90 patients with low back pain in a 100% effort group and a 60% effort group. The patients performed a Functional Lumbar Lifting Test (PILE) and hand grip tests from a Functional Capacity Evaluation (FCE), in which 45 patients were

Table 2.2 Study characteristics of the included studies

Study	Lemstra	Reneman	Marras	Dvir	Luoto	Robinson	Matheson
Diagnosis	Low back pain	Low back pain	Low back pain	Whiplash	Low back pain	Low back pain	Low back pain
Patients	90	16	100	25	23	98	165
Observations	1 measurements per patient	63 measurements in total	3 measurements in two ways per patient	6 measurements at two moments per patient	5 measurements in two ways per patient	7 measurement at two moments per patient	1 measurement per patient
Mean age ± SD	60% effort group 39.0 ± 10.4, 100% effort group 36.2 ± 12.7	39.6 ± 7.1	Men 38.4 ± 9.9 Women 37.4 ±11.2	37.1 ± 9.9	NR	40.3 ± 10.3	Males 38.3 ± 9.3 Females 41.9 ± 8.8
Male (%)	59	75	51	52	NR	74	66
Country	Canada	Netherlands	USA	Israel	Finland	USA	USA
Setting	Rehabilitation center	Rehabilitation center	Not stated	Not stated	Not stated	Rehabilitation center	Private rehabilitation center
Blinding therapists / researchers	Yes/No	Yes/NR	No/NR	NR/NR	NR/NR	NR/NR	NR/NR
Test	Lumbar lifting test and hand grip tests from FCE with observators	FCE lift test with observators	Lumbar motion monitor and statistic models	Cervical motion system and SAS software	Back isokinetic trunk dynamometer	Lumbar extension isometric strength testing, Waddell signs and MMPI	FCE and Symptom Rating Scale
Key results	Sensitivity: 65.2% Specificity: 84.1%	Sensitivity: 6.9% Specificity: 100%	Sensitivity: 75% Specificity: 75%	Sub maximal capacity is hard to diagnose	Effort with a coefficient of variation (CV) 11-20% is hard to diagnose maximal or submaximal.	No strong support for the use of test-retest torque variability as a mean of detecting sub maximal effort	Grip strength consistency is not a significant predictor of symptom magnification syndrome

NR = not reported, FCE = Functional Capacity Evaluation

asked to perform 60% effort on the tasks and 45 were asked to perform at 100% on the task. A blind tester gave an opinion as to whether the patient performed at 100% or 60% effort. This judgment was based on the analysis of all available data.

Reneman et al.[15] videotaped 16 patients with low back pain who performed a standardized lifting test as outlined in the Isernhagen Work System Functional Capacity (FCE). Sixty-three sets of lifting were edited on video and observed by nine trained observers who rated effort levels based on a rating scale.

Marras et al.[18] used a lumbar motion monitor to document the trunk motion characteristics of 100 patients with low back pain. The patients performed the test twice, one "sincere" trunk motion and one where they were asked to pretend that their pain was worse than it actually was. Judgment of submaximal effort was based on multivariate discriminant analyses and selected statistical models.

Dvir et al.[16] tested 25 patients with whiplash-related complaints using a cervical motion system for the rotation, lateral flexion, flexion and extension of the cervical column. The second time patients were asked to perform the tests whilst imagining that they were suffering from much more pain. Judgment of submaximal effort was done by the use of mixed effect models.

Luoto et al.[19] tested 23 patients with low back pain with a Lidoback isokinetic trunk dynamometer. The patients performed five trunk flexions at 100% effort, after three minutes rest they were asked to repeat the test at 50% of their maximal effort. The coefficient of variation was measured and differences between conditions tested with unpaired t-tests and Chi² tests.

Robinson et al.[20] performed an isometric lumbar extension task in 98 patients with chronic back pain and investigated the construct of symptom magnification with the results of Waddell signs, MMPI hysteria scale, MMPI hypochondriasis scale and the MMPI F-K index in a score. Judgment of submaximal capacity was done with the help of Pearson correlation coefficients.

In the study by Matheson et al.[21] 165 patients with low back pain underwent an FCE. An isometric grip strength measured with the JAMAR was performed and the examiner provided a score using the Symptom Magnification Rating.

Table 2.3 Results box H criterion validity

		Lemstra		Reneman		Marras		Dvir		Luoto	
1	Was the percentage of missing items given?	No missing items	E	No percentage, missing items were described	G	No missing items	E	Missing items not described	E	No missing items	E
2	Was there a description of how missing items were handled?	No missing items	E	They were not rated.	G	No missing items	E	No missing items mentioned	G	No missing items	E
3	Was the sample size included in the analysis adequate?	Good	G	Good	G	Adequate	E	Small	P	Poor	P
4	Can the criterion used or employed be considered as a reasonable "gold standard"?	Asked to give 60% effort compared to 100% effort within subjects	E	Sub maximal performance compared to better maximal performance of within subjects	E	Act that pain was worse than it actually was compared with maximum performance	G	Imagine that your pain is worse compared with maximum performance	G	Asked to give the second time 50% effort instead of 100%	E
5	Where there any important flaws in the design or methods of the study?	None	E	None	E	None	E	None	E	None	E
6	For continuous scores: Were correlations, or the area under the receiver operating curve calculated?	NA		NA		NA		NA		No	P
7	For dichotomous scores: Were sensitivity and specificity determined?	Yes	E	Yes	E	Yes	E	NA		NA	
	Quality score	**Good**	**G**	**Good**	**G**	**Good**	**G**	**Poor**	**P**	**Poor**	**P**

E = Excellent, G = Good, F = Fair, P = Poor, NA = not applicable

Table 2.4 Box F results hypotheses testing

		Robinson		Matheson	
1	Was the percentage of missing items given?	No missing items	G	No missing items	E
2	Was there a description of how missing items were handled?	No missing items mentioned	G	No missing items	E
3	Was the total sample size included in the analysis adequate	Good	G	Adequate	E
4	Were hypotheses regarding correlation or mean differences formulated a priori?	Hypotheses at end of introduction	G	Hypotheses at end of paragraph 2	E
5	Was the expected direction of correlations or mean differences included in the hypotheses?	Symptom magnification positive related to torque variability	E	Less than full effort is indication of symptom magnification	E
6	Was the expected absolute or relative magnitude of correlations or mean differences included in the hypotheses?	Not stated	G	Not stated	G
7	Was an adequate description provided of the comparator instrument?	The measure of torque variability is described, but the amount of torque variability is not described	P	Worse score compared to full-effort on performance level and repeatability	G
8	Were the measurement properties of the comparator instrument adequately described?	Adequate description in introduction and methods	E	References in introduction	G
9	Were there any important flaws in the design of method of the study?	None	E	None	E
10	Were design and statistical methods adequate for the hypotheses to be tested?	Appropriate	E	Appropriate	E
	Quality score	**Poor**	**P**	**Good**	**G**

E = Excellent, G = Good, F = Fair, P = Poor

Qualitative assessment

The results of the risk of bias assessment are presented in Tables 2.2 to 2.4. The blinding procedures were often not stated. In the studies by Lemstra et al.[17] and Reneman et al.[15], the observers were blinded. The studies with a reference standard were scored in box H (criterion validity) (Table 2.3). The studies of Robinson et al.[20] and Matheson et al.[21] were scored in Box F (hypothesis testing) because of their lack of a reference standard (Table 2.4). The reasons which led to the item scores are explained separately in the table. Lemstra et al.[17] asked their patients to perform maximal and also perform at 60% effort and Luoto et al.[19] asked their patients also to perform at 50% effort. Reneman et al.[15] used observations of submaximal performance followed by higher performance. The studies by Marras et al.[18] and Dvir et al.[16] asked their patients to imagine that their pain was worse than it actually was.

Based on the scoring system of the COSMIN checklist Marras et al.[18], Lemstra et al.[17] and Reneman et al.[15] scored GOOD and Dvir et al.[16] and Luoto et al.[19] scored POOR. Matheson et al.[21] scored GOOD and Robinson et al.[20] scored POOR. Cohen's kappa for overall agreement between the two reviewers was 0.77, which is considered to represent substantial agreement. Full agreement for all criteria (k=1.0) was reached during the consensus meeting.

Data synthesis and analysis

Three studies dichotomized their tests and used a sensitivity and specificity analysis. Lemstra et al.[17] reported a sensitivity of 65% and a specificity of 84%, which means that the test will identify 65% of all patients performing at a maximal level (sensitivity), and that the test will identify 84% of all patients performing at a submaximal level (specificity). Reneman et al.[15] reported a sensitivity of 7% and a specificity of 100%, and mentioned that they were uncertain whether their patients performed maximally (because of the absence of a reference standard for maximal performance). Marras et al.[18] reported both a sensitivity and specificity of 75%. Consented cutoff values for acceptable specificity and sensitivity are not available: however, with lower specificity patients performing at maximal capacity will be rated as false negative, and consequently incorrectly diagnosed as submaximal performers. With a lower sensitivity, patients performing at submaximal capacity will be rated as false positive, and consequently incorrectly diagnosed as maximal performers. These three studies were rated positive. The study by Dvir et al.[16] concluded that there was a relatively small and stable compression of cervical motion when patients simulated pain, so with their instrument, submaximal capacity was hard to diagnose. Luoto et al.[19] concluded that effort with a coefficient of variation between 11-20% is hard to diagnose maximal or submaximal.

Table 2.5 Data synthesis of the included studies

Study	Box	Rating test instrument	Rating methodological quality
Lemstra	H	+	Good
Reneman	H	+	Good
Marras	H	+	Poor
Dvir	H	-	Good
Luoto	H	-	Poor
Robinson	F	-	Poor
Matheson	F	-	Good

Robinson et al.[20] concluded that there is no strong support for the use of test-retest torque variability as a means of detecting submaximal effort. Matheson et al.[21] claimed that grip strength consistency is not a significant predictor of symptom magnification syndrome. The ratings based on the best evidence synthesis are stated in Table 2.5. Finally, there is in the criterion validity strong evidence that submaximal capacity can be detected in patients with chronic low back pain with a FCE lifting test or a lumbar motion monitor and there is moderate evidence in the case of hypothesis testing that submaximal capacity cannot be detected in patients with chronic low back pain.

DISCUSSION

Based on the results of three good quality studies there is strong evidence that submaximal capacity can be detected in patients with chronic low back pain with visual observations accompanying a FCE lifting test or a lumbar motion monitor.

In two studies with a reference standard and good methodological quality, visual observations accompanying FCE was used as the test instrument. The FCE is an instrument used to determine functional capacity[6,22]. FCEs are applied in rehabilitation, occupational and insurance medicine[23,24]. For further diagnostic studies on submaximal effort in patients with chronic musculoskeletal pain, the use of FCE including a physical effort determination by trained observers should be considered, over a method using statistical cut off values only. A reference standard could also be a lumbar motion monitor or another sophisticated testing device or procedure, for example superimposed electrical stimulation[25]. The instruments enquire training to use it in a correct way, but provide added clinical value. The specificity of the studies varied between 75% and 100%. False negative diagnoses can have major

implications and it is debatable if a specificity of 75% is sufficient to justify its use. Also, there are several extraneous variables that may influence muscle testing[26]. Several factors such as an unfamiliar testing environment or testing apparatus fear of pain and/or (re)injury, anxiety, depression, anger, work satisfaction, self-reported disability, motivation, medication consumption, and pain have been reported to influence the maximum capacity[26]. Those factors should be considered, when diagnosing submaximal capacity.

When comparing the results of the current systematic review with the findings of Fishbain et al.[2], they used a broader definition of submaximal capacity and therefore included more articles. They concluded that isometric strength testing and the use of the coefficient of variation did not reliably discriminate between full and submaximal effort, but isokinetic testing did, which is in contrast to our conclusion. In our review, however, the methodological quality of the study using isokinetic testing was rated as poor[19]. Because Fishbain et al.[2] did not perform a qualitative rating of the included studies, insufficiently designed and reported diagnostic studies may have influenced their results and conclusions. In healthy people, sincerity of effort was reviewed by Robinson et al.[26]. They stated that submaximal effort can be reliably discriminated from maximal effort in muscle testing with the help of statistical models. In general, submaximal effort conditions will reliably show greater variability than maximal effort conditions[26]. However, the clinical utility of variability cut-offs has still not been validated. Moreover, several studies have an inadequate sample size, unknown generalizability or other explanatory factors such as pain or fear of injury that should be considered in evaluating a person's sincerity of effort[26]. In neuropsychology, detection of submaximal effort has also received much attention[27,28]. However, it appears that an acceptable reference standard for methods that claim to detect submaximal capacity in neuropsychology has not yet been developed[29]. An example of a reference standard for submaximal functional capacity in our review is that if a person has lifted 10, 20, 30 and 40 kg within a five minutes session, then 10, 20 and 30 kg are submaximal efforts[15]. Hence, if patients are asked to perform submaximal and maximal, a reference standard for submaximal capacity is available.

This is the first systematic review about submaximal capacity in which definitions of submaximal physical and functional capacity were clearly described. This systematic review was performed following highly transparent procedures, using recommended checklists for the assessment of the methodological quality of health related outcome measures and by reporting a best evidence synthesis. In most of the included studies, there might have been some risk of bias, because procedures to "blind" researchers and testers were not described. Although we used clear definitions for submaximal physical and functional capacity, the

authors of the included articles used their own terminology with regard to malingering, symptom magnification and effort. There is not yet a clear general definition of these terms. It is unknown to what extent either better blinding strategies or clear definitions would have affected the conclusions of this systematic review.

In conclusion, this systematic review has identified few instruments that validly detect submaximal capacity in clinical samples with chronic pain. Knowing the relevance for the individual and society to accurately differentiate submaximal from maximal capacity, some major advances should be made to perform methodologically well-designed diagnostic studies with large clinical samples and practical instruments.

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Appendix 2.1 Search strategy

Database	Search terms	Include	Exclude
Web of Knowledge	chronic pain [MeSH] OR back pain [MeSH] OR neck pain [MeSH] OR whiplash injuries [MeSH] OR fibromyalgia [MeSH] (TOPIC) AND malingering [MeSH] OR exaggeration [tiab] OR magnification [tiab] OR effort [tiab] OR discrepancies [tiab] OR submaximal [tiab] (TOPIC)	1. articles 2. English, German, Dutch from languages	1. neuroscience and neurology
Scopus	(chronic pain OR back pain OR neck pain OR whiplash OR fibromyalgia) AND (malingering OR exaggeration OR magnification OR effort OR discrepancies OR submaximal) (TAK)	1. articles	
Cochrane	chronic pain OR back pain OR neck pain OR whiplash injuries OR fibromyalgia (TAK) AND malingering OR exaggeration OR magnification OR effort OR discrepancies OR submaximal (TAK)		

Appendix 2.2 Excluded studies

Author	Title	Country	Reason exclusion
Khalil[1]	Acceptable Maximum Effort (AME) - a psychophysical measure of strength in back pain patients.	U.S.A.	No adult patients with nonspecific musculoskeletal chronic pain
Duque[2]	Aerobic fitness and limiting factors of maximal performance in chronic low back pain patients.	Colombia	No adult patients with nonspecific musculoskeletal chronic pain
Ng[3]	Functional roles of abdominal and back muscles during isometric axial rotation of the trunk.	Australia	No adult patients with nonspecific musculoskeletal chronic pain
Robinson[4]	Lumbar iEMG during isotonic exercise: Chronic low back pain patients versus controls.	U.S.A.	No adult patients with nonspecific musculoskeletal chronic pain
Akebi[5]	Factors affecting the variability of the torque curves at isokinetic trunk strength testing.	Japan	No study that objectified submaximal capacity when maximal capacity was requested
Dvir[6]	Trunk extension effort in patients with chronic low back dysfunction.	Australia	No study that objectified submaximal capacity when maximal capacity was requested
Hazard[7]	Disability exaggeration as a predictor of functional restoration outcomes for patients with chronic low-back pain.	Denmark	No study that objectified submaximal capacity when maximal capacity was requested
Kaplan[8]	Maximal effort during Functional Capacity Evaluations: An examination of psychological factors.	U.S.A.	No study that objectified submaximal capacity when maximal capacity was requested
Oesch[9]	Comparison of two methods for interpreting lifting performance during functional capacity evaluation.	Switzerland	No study that objectified submaximal capacity when maximal capacity was requested
Reid[10]	Isokinetic trunk-strength deficits in people with and without low-back pain: A comparative study with consideration of effort.	U.S.A.	No study that objectified submaximal capacity when maximal capacity was requested
Ylinen[11]	Association of neck pain, disability and neck pain during maximal effort with neck muscle strength and range of movement in women with chronic non-specific neck pain.	Finland	No study that objectified submaximal capacity when maximal capacity was requested
Lindh[12]	Studies on maximal voluntary muscle-contraction in patients with fibromyalgia.	Sweden	No study that objectified submaximal capacity when maximal capacity was requested

Appendix 2.2 continues on next page

Appendix 2.2 ***Continued***

Author	Title	Country	Reason exclusion
Oddsson[13]	Activation imbalances in lumbar spine muscles in the presence of chronic low back pain.	U.S.A.	No study that objectified submaximal capacity when maximal capacity was requested
O'Leary[14]	A new method of isometric dynamometry for the craniocervical flexor muscles.	Australia	No study that objectified submaximal capacity when maximal capacity was requested
Roe[15]	Muscle activation during isometric contractions in workers with unilateral shoulder myalgia.	Norway	No study that objectified submaximal capacity when maximal capacity was requested
Newton[16]	Trunk strength testing with Iso-Machines: Part 2: Experimental evaluation of the Cybex II back testing system in normal subjects and patients with chronic low back pain.	Scotland	No study that objectified submaximal capacity when maximal capacity was requested
Da Silva[17]	Back muscle strength and fatigue in healthy and chronic low back pain subjects: A comparative study of 3 assessment protocols.	Canada	No study that objectified submaximal capacity when maximal capacity was requested
Schapmire[18]	Simultaneous bilateral hand strength testing in a client population, part I: Diagnostic, observational and subjective complaint correlates to consistency of effort.	U.S.A.	Contained mixed samples where data on the relevant subgroups could not be isolated
Ruan[19]	Functional Capacity Evaluations in persons with spinal disorders: Predicting poor outcomes on the Functional Assessment Screening Test (FAST).	U.S.A.	Contained mixed samples where data on the relevant subgroups could not be isolated
Hutten[20]	Differences in treatment outcome between subgroups of patients with chronic low back pain using lumbar dynamometry and psychological aspects.	Netherlands	Contained mixed samples where data on the relevant subgroups could not be isolated
Hutten[21]	Distribution of psychological aspects in subgroups of chronic low back pain patients divided on the score of physical performance.	Netherlands	Contained mixed samples where data on the relevant subgroups could not be isolated

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Chapter 2b

In response: Re: the letter by dr. Almosnino, regarding our published article "Which instruments can detect submaximal physical and functional capacity in patients with chronic nonspecific back pain? A systematic review".

Spine 2013;39(6):E259.

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Maurizio A. Trippolini
Job van der Palen
Jan D. Verhoeven
Michiel F. Reneman

We thank dr. Almosnino for critically reading and discussing our systematic review[1]. However, his arguments are based on the assumption that research concerning this topic should be based on two criteria: whether or not the patient is performing sincerely, and whether the effort is representative for the patient's maximal capacity. Dr. Almosnino does not, however, explain the (theoretical) basis for this distinction. We specifically stated in our introduction that we did not distinguish between reasons for submaximal capacity, because our study focused on the identification of submaximal capacity, regardless of its origin. Identification of the reason for submaximal capacity is a different issue that requires a different study methodology, as dr. Almosnino correctly points out. There are several factors that can influence the level of capacity[2] and these factors are difficult to objectify. Also, we worked with a definition of submaximal capacity, because effort and capacity can be interpreted in different ways. We found strong evidence that submaximal capacity can be detected in patients with chronic low back pain with a lumbar motion monitor or visual observations accompanying a Functional Capacity Evaluation lifting test. We did not find evidence for the detection of maximal capacity and for other instruments.

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Chapter 3

Relationship between self-reported disability and functional capacity in patients with Whiplash Associated Disorder

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ABSTRACT

Purpose: Patients with chronic Whiplash Associated Disorders (WAD) report symptoms and disability. Neither the relationship between self-reported disability and functional capacity, nor its predictors have been investigated in patients with WAD. This was the purpose of this study.

Method: This was a cross-sectional study. Participants were patients with WAD on sick leave. Self-reported disability was assessed with the Neck Disability Index (NDI). Functional capacity was assessed with a six-item neck Functional Capacity Evaluation (FCE). Correlation coefficients were used to express the relationship between NDI (total and items) and FCE. Multivariate linear regression analyses were performed to identify independent predictors of NDI and FCE.

Results: Forty patients were measured, of whom 18 (45%) were male. Mean age was 33 years, median duration of complaints was 12 months, and 75% had a pending insurance claim. Correlations between NDI and FCE tests varied from -0.39 to -0.70. Independent predictors of NDI were pain intensity and a pending claim, explaining 43% of the variance. Independent predictors of FCE were NDI, gender, and pain intensity, explaining 20% to 55% of the variance.

Conclusions: Self-reported disability and functional capacity are related but different. Both can part be predicted by pain intensity. A pending claim can predict higher self-reported disability. Both constructs are complementary and are recommended to determine disability in patients with WAD comprehensively.

INTRODUCTION

Patients with Whiplash Associated Disorder (WAD) experience a lot of symptoms like neck pain, headache, pain in shoulder and arm, paresthesia, dizziness, concentration problems, visual and auditory symptoms, depressive symptoms and insomnia[1]. Self-reported symptoms are indicators for the health status of patients with WAD. Research has shown that 20% to 40% of the patients with Whiplash Associated Disorder (WAD) still report symptoms and disability three months post injury[1,2]. Disability can be assessed via self-report and performance based tests such as the Functional Capacity Evaluation (FCE). The relation between functional capacity and self-reported performance in Whiplash Associated Disorder (WAD) is unclear.

Functional Capacity Evaluations (FCE) are batteries of tests that measure the capacity to perform activities and are used to make recommendations for participation in work while considering the person's body function and structures, environmental factors, personal factors and health status[3]. FCEs are applied in rehabilitation and insurance medicine[3]. The Neck Disability Index (NDI) measures self-reported disability in patients with neck pain[4]. In patients with chronic low back pain it is demonstrated that functional capacity and self-reported disability differ distinctly and correlate weakly to moderately with correlation coefficients from -0.27 to 0.40[5-7], similar weak correlations are reported in patients with osteoarthritis[8]. The relation between functional capacity and self-reported disability in Whiplash Associated Disorder (WAD) is unclear. It has also been demonstrated that pain intensity and social factors are related to self-reported disability and functional capacity[6,7]. In patients with WAD these relationships have not been examined and the construct validity of these tests has not been compared. Construct validity is the extent to which a test is convergent and/or divergent correlated with other tests that are presumed to measure a similar or different construct[9].

The primary objective of this study was to investigate the relationship between self-reported disability (NDI total score and on item level) and functional capacity, for each of the neck FCE tests separately. It was hypothesized that in patients with WAD the strength of the correlations (r) between NDI total score and each subtest of the neck FCE would vary between $r=\pm 0.3$ and ± 0.7, with the strongest correlation with the front carry test and weakest correlation with the repetitive side reaching test. A weak correlation ($r<0.3$) means that self-reported disability and functional capacity measure different constructs. A very strong correlation ($r>0.9$) can mean that they measure similar constructs. In that case the NDI could partially predict an FCE outcome, and potentially replace a cumbersome FCE test. Secondary objectives of this study were: to investigate whether functional capacity

(each of the FCE tests separately) is predicted by NDI, socio-demographic variables, and pain intensity, and to investigate whether self-reported disability, measured by the NDI, is predicted by social-demographic variables and pain intensity.

METHOD

Design and study sample

This is a cross-sectional observational study. Patients were included when they had a physician diagnosis WAD I-II[10]; had complaints for at least four months; were between 18 and 65 years old, and were on sick leave. They were excluded when they had co-morbidity with severe negative consequences for functioning; insufficient knowledge of the Dutch language, or had severe neck problems prior to the trauma, such as arthritis or hernias. The patients included in this study came from two sources. In both instances, data were gathered during the intake of a rehabilitation program. The first source was a commercial work assessment organisation. Potential participants received an information booklet and verbal explanation of the study. After signing and returning the informed consent, patients were invited for measurements. The study was approved by the Ethical Committee Twente at Enschede, the Netherlands (NL33508.044.10). The second source was a tertiary rehabilitation centre in Groningen, in the Netherlands. Data were derived from care as usual, for which ethical approval was not needed.

Measures

The 10 NDI items are pain intensity, personal care, lifting, reading, headaches, concentration, work, driving, sleeping, and recreation[4]. Each item can be scored from 0 (no disability) to 5 (most disability). The total score original ranges from 0-50 with higher scores indicating higher disability. Most studies suggest that the NDI has acceptable reliability and validity, including the Dutch language version[9].

The neck FCE consist of an overhead lifting test, front carry test, static overhead work test, repetitive overhead reaching test, repetitive side reaching test, and neck strength tests. Content validity and safety were established[11,12]. Test-retest reliability and agreement of a slightly modified neck FCE was acceptable[12]. Results are expressed in kilograms and seconds, with higher scores indicating higher capacity, except for the repetitive tests, where lower scores indicate higher capacity.

Pain intensity was assessed with a Numeric Rating Scale (NRS), with scores ranging from 0 (no pain) to 10 (worst pain). The NRS is considered to be valid and reliable[13].

Socio-demographic information on gender, age, marital status, duration of WAD, use of pain medication, education level, and claim status was collected before the start of the measurements.

Statistic analysis

Continuous variables were described as mean (SD) or median (25th and 75th percentile), as appropriate. The distribution of the data was visually inspected for normality. Categorical data were described by frequencies and percentages. Data were analyzed with SPSS 20.0. The two sample sources were checked for similarity with an independent t-test or Mann-Whitney U test. Depending on distribution of the data, Pearson's or Spearman's correlation coefficients were used to express the relationship between NDI and FCE. Correlations over 0.9 were considered very high positive, between 0.7 and 0.9 were high positive, between 0.5 and 0.7 were moderate, between 0.3 and 0.5 were low positive and between 0.0 and 0.3 negligible[14]. NDI was analyzed both as a total score and on item level. In case of missing values on the NDI, cases were excluded pairwise. Multivariate linear regression analyses were performed to identify independent predictors of NDI and FCE. Candidate predictors were those variables with a univariate association with NDI or FCE at a p-value <0.10. These candidate predictors were added to a full multivariate linear regression model. Subsequently, non-significant variables were removed, one by one, until either only significant variables remained or r^2 had decreased by 10%. Possible effect modification by gender was tested. A priori sample size calculation based on the primary objective (assessing correlations (r) between NDI total score and each subtest of the neck FCE) showed that a sample size of 37 would have 90% power to detect a correlation coefficient of -0.50 between NDI and FCE with a two-sided test with a significance level of p=0.05[15].

RESULTS

Sample characteristics

The study sample consists of 40 patients (18 males) with a mean age of 33 years (SD 9.6). The patients from the tertiary rehabilitation centre (n=22) had significantly lower self-reported disability, repetitive overhead reaching capacity and neck strength than the patients from the commercial work assessment organisation, but the duration of WAD was shorter (median 10.0 and 15.8 months). The duration of WAD from the total sample varied from 4 to 240 months (median=12; Inter Quartile range 7-19). Pain medication was used by

Table 3.1 Self-reported disability, functional capacity and pain intensity of patients with Whiplash Associated Disorder

	n	Unit	Range	Mean	Sd
Neck Disability Index	40	Points	5-39	23.6	7.4
Overhead lifting test	40	Kg.	0-37	12.4	8.4
Front carry test	40	Kg.	2-75	31.2	19.1
Static overhead work test	40	S.	0-365	133.2	88.9
Repetitive overhead reaching test#	37	S.	40-153	50	45-61
Repetitive side reaching test	39	S.	52-136	82.0	17.7
Neck strength flexion	37	KgF	11-224	75.4	44.3
Neck strength extension	37	KgF	16-270	90.2	63.3
Neck strength side bending right	37	KgF	13-202	80.7	49.3
Neck strength side bending left	37	KgF	9-188	77.9	46.4
Pain intensity	40	Points	0-9	5.43	2.19

#: median and Inter Quartile Range

70% of the patients and 75% had a pending compensation claim. Ranges in NDI and FCE tests varied widely (Table 3.1). Three patients performed a subset of the tests.

Correlations between FCE and NDI total score were all significant and varied from r= -0.39 (overhead lifting test) to r=-0.70 (neck strength flexion) (Table 3.2). At item level correlations ranged from r=0.03 to r=-0.72 (Table 3.2).

Candidate predictors added to the multivariate model were pain intensity, pending claim, gender, education level and NDI (added to FCE prediction model only). Results of the multivariate regression analyses are presented in Table 3.3. Independent predictors of NDI were pain intensity and a pending insurance claim; they explained 43% of the variance in NDI. NDI and gender explained 55% of the variance in the front carry test. NDI alone predicted 49% of the variance in the neck strength flexion test. For all regression analyses, there was no effect modification by gender observed, which means that the strength of the associations were not different for men and women.

DISCUSSION

The key finding of our study is that there is a moderate relationship between self-reported disability and functional capacity in patients with chronic WAD who are on sick leave. Independent predictors of self-reported disability are pain intensity and a pending claim. Independent predictors of functional capacity are pain intensity, NDI and gender.

Table 3.2 Pearson correlation coefficients between Functional Capacity Evaluation and Neck Disability Index (total and item level) in n=40 patients with Whiplash Associated Disorder

	NDI total	Pain intensity	Personal care	Lifting	Reading	Head-aches	Concen-tration	Work	Driving	Sleeping	Recreation
Overhead lifting test	-0.39*	-0.41*	-0.65*	-0.57*	-0.63	-0.26	0.03	-0.22	-0.27	-0.29	-0.16
Front carry test	-0.48*	-0.49*	-0.62*	-0.53*	-0.17	-0.29	-0.09	-0.34*	-0.31	-0.34*	-0.22
Static overhead work test	-0.47*	-0.59*	-0.41*	-0.41*	-0.28	-0.31	-0.15	-0.24	-0.29	-0.34*	-0.37*
Rep. overhead reaching test#	0.62*	0.54*	0.35*	0.33*	0.29	0.51*	0.39*	0.46*	0.54*	0.34*	0.35*
Rep. side reaching test	0.55*	0.57*	0.44*	0.42*	0.15	0.43*	0.23	0.51*	0.45*	0.37*	0.42*
Neck strength flexion	-0.70*	-0.72*	-0.54*	-0.52*	-0.26	-0.47*	-0.38*	-0.39*	-0.61*	-0.43*	-0.44*
Neck strength extension	-0.54*	-0.57*	-0.52*	-0.52*	-0.15	-0.33*	-0.22	-0.24	-0.45*	-0.37*	-0.34*
Neck strength side bending right	-0.61*	-0.66*	-.050*	-0.49*	-0.18	-0.40*	-0.32	-0.36*	-0.50*	-0.36*	-0.40*
Neck strength side bending left	-0.61*	-0.64*	-0.51*	-0.47*	-0.14	-0.43*	-0.29	-0.38*	-0.53*	-0.39*	-0.40*

NDI: Neck Disability Index; # = Spearman correlation coefficient; * = significant

Table 3.3 Multivariate linear regression analyses with dependent variables and predictors in patients with Whiplash Associated Disorder

Dependent variable	Predictor	Regression coefficient	95% confidence interval	r^2 [1]
NDI	constant	10.5		0.43
	Pain intensity[2]	1.40	0.54 to 2.26	
	Claim pending[3]	7.35	3.05 to 11.6	
Overhead lifting test	constant	26.6		0.44
	NDI	-0.39	-0.68 to -0.10	
	Gender[4]	-9.02	-13.2 to -4.83	
Front carry test	constant	68.9		0.55
	NDI	-1.10	-1.68 to -0.51	
	Gender[4]	-21.5	-30.0 to -12.9	
Static overhead work test	constant	267.5		0.22
	NDI	-5.68	-9.17 to -2.20	
Repetitive overhead reaching test	constant	27.9		0.20
	NDI	1.21	0.37 to 2.06	
Repetitive side reaching test	constant	52.1		0.31
	NDI	1.27	0.63 to 1.90	
Neck strength flexion	constant	177.4		0.49
	NDI	-4.25	-5.76 to -2.75	
Neck strength extension	constant	237.0		0.44
	NDI	-3.10	-5.63 to -0.57	
	Pain intensity[2]	-12.9	-21.8 to -4.09	
Neck strength side bending right	constant	179.3		0.37
	NDI	-4.12	-5.97 to -2.26	
Neck strength side bending left	constant	189.2		0.45
	NDI	-3.12	-4.96 to -1.28	
	Pain intensity[2]	-6.54	-12.9 to -0.11	

[1] r^2 is calculated for the full model; [2] Pain intensity was measured with NRS scale (0-10), 0 = no pain, 10 = maximal pain; [3] Not having a claim pending was the reference category; [4] Male gender was the reference category; NDI: Neck Disability Index.

This study shows that self-reported disability and functional capacity are two related but different constructs and should both be measured to assess disability in a comprehensive way. That self-reported performance and functional capacity are associated with higher pain intensity is important information in patients with WAD. The correlation between self-reported performance measured with the NDI and higher pain intensity can partly be explained by the fact that two items of the NDI measure pain intensity. The outcome that self-reported disability and functional capacity are different constructs, can help to make decisions in therapeutic options. The influence of a pending claim on self-reported disability does not necessarily constitute evidence that a compensation claim is a prognostic indicator

for non-recovery. This might also be attributed to selection bias, because patients with WAD with severe disability can be more likely to pursue a claim for compensation. Long-lasting work disability due to WAD is a relevant and substantial part of the economic burden of WAD. Return to work can be delayed due to self-reported disability[16], but this predictive relationship between work and functional capacity has not been tested in patients with WAD. Our study shows that evaluation of the functional capacity can be supplementary in the decision making if an employee is able to return to work[17].

In relation to previous literature, the moderate relationship between self-reported disability and functional capacity is consistent with reports of similar studies in other patient categories[5-8]. Also, in patients measured with the performance tests: sit-to-stand test, five minute walk test and loaded reach test, the relationships were low positive/negative[18,19]. Our study in patients with chronic neck pain adds to the robustness of these observations. Across patient groups, it is observed that self-reported disability and functional capacity are related and different. Predictors of disability and capacity investigated in this study were also reported in studies in other patient populations. That gender predicted the overhead lifting test was also concluded in patients with chronic low back pain (CLBP)[20], and is consistent with the overall strength difference between men and women. Conflicting evidence about the prediction of functional capacity by pain intensity has been reported in patients with CLBP[20], but this relationship has not previously been examined in patients with WAD. That pain intensity influences self-reported disability has been reported in patients with WAD[21]. In patients with WAD having a pending claim was associated with a higher disability level[22], which was also observed in our study. Concluding, our study adds value to robust relationship and difference in self-reported disability and capacity, the evidence that pain intensity and gender can predict functional capacity, (especially overhead lifting) and that pain intensity and a pending claim can predict self-reported disability.

This is the first study in patients with WAD where the relationship between self-reported disability and functional capacity was examined. Well-known clinical instruments were used. These results contribute to the existing knowledge of both instruments. However, all patients were seeking therapeutic help, absent from work and most had pending claims, and the results might not be generalizable to patients with other characteristics. This study was sufficiently powered for the primary research question, but had limited power for the second research questions. The final prediction models had limited numbers of prediction variables, and this study should be replicated with at least the addition of psychological variables, although their predictive ability was modest in other patient groups, such as CLBP[20]. These studies should be adequately powered for this purpose.

Self-reported disability and functional capacity measure different constructs. Both constructs can partly be predicted by the level of pain intensity. A pending claim can predict a higher level of self-reported disability. Based on the results of this study, the clinical relevance is that both self-reported disability and a performance based test are recommended in order to obtain a comprehensive picture of disability in patients with WAD.

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Chapter 4

Reproducibility of hand-held dynamometry for neck strength in healthy young adults

Submitted

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ABSTRACT

Background: The clinimetric properties of muscle strength testing with hand-held dynamometers have been studied extensively, but not for the neck muscles. Therefore, the objective of this study was to test the reproducibility of neck muscles strength testing with hand-held dynamometry.

Methods: Twenty healthy young adults were tested twice by two assessors according to a standardized test protocol, following the make method. Assessors and participants were blinded for the results. Mean differences between assessors for isometric neck strength (flexion, extension, side bending) were calculated. Intertester reliability and agreement were expressed as intraclass coefficient (ICC) and limits of agreement (LoA).

Results: The mean differences in measured neck muscle strength between the assessors varied between 1.6 and 7.6 Newton and were statistically non-significant. ICC values ranged from 0.75 to 0.87. LoA ranged from -40 to 56 Newton. The measurement error at assessor level was substantial.

Conclusions: Reproducibility of hand-held dynamometry to test neck strength in healthy young adults is satisfactory at group level. For measuring health changes, attention has to be paid to the substantial measurement error.

INTRODUCTION

Muscle strength is commonly measured for clinical purposes[1]. A frequently used easy and direct method is hand-held dynamometry. The clinimetric properties (eg, reproducibility) of muscle strength testing with hand-held dynamometers have been studied extensively but not for the neck muscles[2]. Reproducibility concerns the degree to which repeated measurements in stable study objects, often persons, provide similar results, and is usually an umbrella term for the concepts of reliability and agreement[3,4]. The reproducibility of muscle strength measurements depends on the muscle tested, standardization of procedures, patient and assessor[5,6]. Agreement parameters will be more stable over different population samples than reliability parameters; they are expressed on the actual scale of measurement, and not as reliability parameters as a dimensionless value between 0 and 1. This is an important advantage for clinical interpretation. Agreement parameters are preferable in all situations in which the instrument will be used for evaluation purposes, which is often the case in medical research[3] and have not been reported for the neck muscles[7,8]. Therefore, the objective of this study was to test the intertester reliability and agreement of neck muscles strength testing with hand-held dynamometry.

METHOD

Procedures

Participants were tested twice by two assessors according to a standardized test protocol9. There was at least five minute rest between the two tests. The tests assessed neck flexion, extension, and side bending strength. The Microfet hand-held dynamometer (Hoggan Microfet 2, Biometrics) was used to measure isometric strength in Newtons (N). Five repetitions were performed for every direction, by each assessor. The mean of the two highest scores was used in the analysis. Tests were performed following the make method[10]; subjects sat on a chair and were asked to exert maximal force during three seconds. Results were recorded by a test assistant. Assessors and participants were blinded for the results. The order of the tests was kept constant across participants and occasions. The order of assessors was random. The measurements were executed in October and November 2010.

Participants and assessors

Healthy physiotherapy students from Saxion University of Applied Science in Enschede, the Netherlands were asked to participate. Students could participate when they signed

informed consent. They were excluded if they had a medical condition with negative consequences for physical functioning or insufficient knowledge of the Dutch language. Two experienced assessors performed the tests. The study was performed conform the Helsinki Declaration. A clinical trial registration number was not obtained because this study was not a randomized controlled trial and did not meet the criteria for medical research with human subjects, because the impact on the research subjects was deemed negligible by the Medical Ethical Committee Twente.

Main analyses

The distribution of the data was visually inspected for normality. Continuous variables were described as mean (SD) or median (1QR), as appropriate. The mean differences between the assessors were calculated. Cross-over effects and period effects were calculated with paired and independent sample t-tests, respectively, as appropriate for cross-over trials. Intraclass coefficients (ICC; one way random, single measures) and 95% confidence intervals (95% CI) were calculated to analyze intertester reliability. ICC values were interpreted according to Landis et al.[11]. Agreement was analyzed using the Bland-Altman method[12]. Additionally, percentage (%) of cases where the difference between assessors was within 5% or 10% was calculated: ((difference between assessors (N) / mean strength (N)) x 100%). Analyses were considered significant when $p<0.05$. Data were analyzed with SPSS 20.0

RESULTS

Twenty participants (12 female, 8 male) with a mean age of 21.1 (SD 1.5) were included. One assessor was female (age 23) and the other male (age 24). Results of neck strength tests and reliability measures are presented in Table 4.1. The mean differences in neck muscle strength between the assessors were non-significant and varied between 1.6 and 7.6 Newton (N). There were no cross-over and period effects. The ICC varied between 0.75 and 0.87. The limits of agreement (LoA) were highest in the extension test and lowest in the flexion test. Differences between assessors were less than 5 N in 30-35% of the occasions, and less than 10 N in 55-75% of the occasions. Based on the magnitude of the LoA, and because differences between assessors often exceeded 10%, we interpret the measurement error at the assessor level to be substantial.

Table 4.1 Reproducibility of the measurements of neck strength (n=20)

Neck action	Strength (N) A1 Mean ± SD	Strength (N) A2 Mean ± SD	Mean difference A1-A2 ± SD	A1 versus A2: % within 5N	A1 versus A2: % within 10N	Agreement LoA (N)	Reliability ICC (95% CI)
Flexion	77.9 ± 24.0	72.9 ± 23.1	5.1 ± 11.1	30	55	-17.1-27.3	0.87 (0.71-0.95)
Extension	119.8 ± 40.2	112.2 ± 38.2	7.6 ± 24.0	30	55	-40.4-55.6	0.80 (0.58-0.92)
Side bending right	82.8 ± 23.9	77.4 ± 19.3	5.4 ± 14.8	35	75	-24.2-35.0	0.75 (0.48-0.89)
Side bending left	79.5 ± 20.1	77.9 ± 21.3	1.6 ± 11.7	30	55	-21.8-25.0	0.85 (0.66-0.94)

A1 = assessor 1; A2 = assessor 2; N = Newton; SD = standard deviation; LoA = limits of agreement; ICC = intraclass coefficient; CI=confidence interval

DISCUSSION

Because all ICC point estimates were 0.75 or higher, the intertester reliability of the hand-held dynamometry for neck muscle strength can be considered satisfactory at group level in healthy individuals. We interpret the measurement error at the assessor level to be substantial.

In this study the tests were performed using a standardized protocol and the assessors were trained. Because the order of assessors was random and there was no period effect, differences between Assessor 1 and 2 (between 1.6 and 7.6 N) should be attributed to the assessor, not the occasion (e.g. learning effect or fatigue). The results indicate that the procedures are reproducible at group level, and can now be extensively tested in relevant patient samples. Based on the magnitude of the LoA, and because differences between assessors often exceeded 10%, we interpret the measurement error at the assessor level to be substantial. Dynamometry can distinguish subjects with low neck muscle strength from those with high muscles strength, but may not be precise enough to evaluate clinical changes within individual patients.

ICC values ranged from 0.75 to 0.87, which is similar compared to other studies[2,8]. Shahidi reported in neck strength measurements substantial to almost perfect reliability for healthy persons (ICC = 0.67 to 0.85), and from fair to substantial reliability for patients with neck pain (ICC= 0.39 to 0.72) in patients tested with hand-held dynamometry[8]. In a systematic review on muscle function evaluation in patients with non-specific neck pain dynamometry studies testing reproducibility were included, but in the included articles agreement parameters were not described[7]. Without parameters of agreement the wrong conclusions can be made, especially in evaluative purposes[3]. We did not test the intratester reproducibility, but is assumed to be higher[7].

Concluding, in healthy young adults the reproducibility of the hand-held dynamometry in neck strength is satisfactory at group level. For measuring health changes, attention has to be given to the substantial measurement error.

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Chapter 5

Could the addition of a Short-Form Functional Capacity Evaluation to a brief cognitive behavioral intervention lead to better Work Ability in patients with musculoskeletal pain? A pilot RCT.

Submitted

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ABSTRACT

Purpose: Return to work interventions have demonstrated effectiveness with regard to improvement of work ability in patients with chronic nonspecific musculoskeletal pain. Addition of a Short-Form Functional Capacity Evaluation (SF FCE) might further improve work ability. Therefore, we conducted a pilot randomized controlled trial to assess whether adding a SF FCE to a brief cognitive behavioral intervention might relevantly improve work ability.

Methods: Patients with chronic musculoskeletal pain were included. They were randomized into a control or experimental group. The control group received a cognitive behavioural intervention, which consisted of 6 treatment sessions of 45 minutes in 16 weeks time. The experimental group received the same intervention, but it was extended with a 4-7 item SF FCE at baseline. The main outcome was self-reported work ability, assessed with the Work Ability Index (score 0-10). Clinical relevance was defined as >1.5 points improvement from baseline and a difference in effect of 1.5 points between intervention and control group.

Results: Eleven patients were included for analysis: 5 in the experimental group and 6 in the control group. Improvements of both interventions exceeded 1.5 points. The addition of SF FCE improved work ability with 0.7 points (95% CI -2.34; 3.74). No adverse effects were reported.

Conclusions: In both groups work ability improved relevantly. Addition of a SF FCE further enhanced work ability. Feasibility has been established. However, clinical relevance of the addition of a SF FCE is unconvincing. Recommendations for a full scale RCT are provided.

INTRODUCTION

Chronic nonspecific musculoskeletal pain (CMP) is very prevalent in most developed countries. It can lead to prolonged absence of work and thereby high costs related to treatment and work absenteeism[1]. There is a vast amount of interventions that facilitate return to work (RTW) during sickness absence. Early- and multidisciplinary rehabilitation interventions appear effective to support RTW[2], however, dose and content can differ significant among settings[3]. Short-Form Functional Capacity Evaluation (SF FCE) are used to determine functional capacity and to guide RTW[4]. The instrument contains standardized work related tests[4]. In an inpatient rehabilitation setting, a weak but significant relation between FCE information and improved RTW outcomes in patients with CMP was established[5]. However, this has not been tested in a 'light' setting: a SF FCE and a short intervention performed in a privately owned work assessment organisation. Additionally, the feasibility to perform a Randomized Controlled Trial (RCT) in a privately owned work assessment organisation is unknown.

If a short intervention and an additional SF FCE can improve work ability, this can be implemented in daily practice. The brief cognitive behavioral intervention is time-contingent and based on tackling illness and perpetuating factors, which makes return to work problematic[6]. The treatment goals are related to work ability. Work ability is built on the balance between a person's resources, such as functional capacity, professional knowledge and competence (skills) values, attitudes and motivation on the one hand and work demands on the other hand[7]. We performed a pilot RCT to assess feasibility, obtain an impression of effect size, to calculate sample size for a full scale trial, and to assess proof of concept of whether adding a SF FCE to a brief cognitive behavioral intervention could improve work ability. We hypothesized that the addition of a SF FCE to the intervention can lead to higher work ability, as assessed with the Work Ability Index (score 0-10). Clinical relevance was defined as 1.5 points improvement from baseline and a difference in effect of 1.5 points between intervention and control group.

METHODS

Study design

The study design was a pragmatic randomized controlled trial. The setting of the study was a privately owned work assessment organisation, specialized in treatment of patients with CMP with multiple locations in the Netherlands.

Procedures

All eligible patients were informed about the study during their intake session, and asked for their consent to participate in this study. They received a letter with all information and were asked to sign an informed consent form. If patients did not respond to the informed consent letter, telephone reminders were used. Subsequently randomization took place, with help of a randomization list prepared with the program Block Stratified Randomization[8]. Randomization occurred in blocks of four and was performed by an independent person. There was no blinding of patients, therapists, or the principal investigator. The measurements took place at baseline and at the end of the intervention period. The study has received ethical approval by the METC Twente, the Netherlands, number NL38523.044.11.

Participants

Patients were referred for treatment by insurance or occupational physician. They were eligible for inclusion when they met the following inclusion criteria: between 18 and 60 years; CMP for 3 months or longer; work absenteeism of 6 weeks or longer; sufficient knowledge of the Dutch language; no medical co-morbidity with significant influence on work ability, such as disc herniation or diagnosed psychiatric illness. Patients were included if they met these inclusion criteria and signed informed consent.

Treatment

As part of regular care a baseline assessment preceded the intervention. Based on the conceptual model that predisposing, precipitating and perpetuating factors, can explain persisting CMP and decrease work ability[6], these factors were identified with a structured interview. The level of pain self-efficacy, health-related quality of life, kinesiophobia, distress, anxiety and depression were measured with the pain self-efficacy scale[9], the RAND-36[10], Tampa Scale for Kinesiophobia[11] and the Four-Dimensional Symptom Questionnaire[12]. The intervention plan was coordinated by telephone with the patient's general practitioner and the main treatment goal with the representative of the workers insurance company. For each patient, individual treatment goals were chosen based on the factors that formed barriers to improve functioning and the guiding question of the patient. The control intervention consisted of maximal 6 treatment sessions of 45 minutes in 16 weeks' time. The treatment was based on cognitive behavioural principles and gave the patients insight in the principles of chronic pain and the factors that formed barriers for normal functioning. The patient

received instructions and assignments on how to handle the pain more adequately. Attention was paid to the principles of chronic pain, improvement of health behaviour, and graded activity to improve the activity level. The program was delivered by a physiotherapist or a psychologist. Motivational interviewing techniques and practical assignments were given and if necessary patient started physical training. In the experimental group the assessment was extended with a SF FCE[4]. The validity and reliability of the SF FCE is satisfactory[13]. The SF FCE consists of 4-7 tests that were selected from a comprehensive FCE based on work- and complaints relatedness[14]. The tests were lifting low, overhead lifting, carrying, overhead working, forward bending stand, dynamic bending, repetitive side reaching[4]. The dose and content of the experimental intervention was similar to the control intervention, however, in the experimental intervention specific attention was given to the results of the SF FCE, the influence of pain on the test results, and functional training activities derived from SF FCE.

Measurements

The Work Ability Index (WAI) is a well-accepted instrument to measure work ability and is available in 21 languages[15]. Self-reported work ability can be measured with one question[16]; the score ranges from 0 to 10, with higher scores indicating higher work ability. Clinical relevance was defined as 1.5 points improvement from baseline.

Feasibility

Feasibility was determined by reporting of barriers and adverse events by patients and therapists. Proof of concept was defined as an added effect of 1.5 points on work ability in favour of the experimental intervention.

Statistics

Continuous variables were described as mean (SD) or Median (Interquartile range) as appropriate. Categorical data are described by frequencies and percentages. Mann-Whitney U tests were performed to analyze the difference between the experimental and control group in continuous variables. A t-test was performed to assess changes over time. Changes within both groups and between groups are presented as percentages and effect sizes (ES) (Cohen's D) were calculated. Data were analyzed with SPSS 20.0 (IBM Corporation; United States).

RESULTS

Main results

Eleven patients were included for analysis. Five patients in the experimental group (2 men, 3 women) with a mean age of 34 ± 7.8, and six (3 men, 3 women) in the control group with a mean age of 35 ± 10.2, additional demographic information and clinical characteristics are presented in Table 5.1. Location of pain varied between individuals; patients with back pain, neck pain, knee pain and generalized pain were included. Work ability at baseline and change in work ability is presented in Table 5.2.

Table 5.1 Demographic information and clinical characteristics of patients with chronic musculoskeletal pain (n=11)

	Experimental group n=5	Control group n=6
Duration of pain (Months (median, IQR))	20 (7-186)	15 (11-95)
Body Mass Index (Kg/m^2; mean ± SD)	27.0 ± 4.12	27.8 ± 5.60
Unemployment benefits/disability benefits (median,IQR)	100% (100-100)	100% (80-100)
Use of pain medication (n yes)	4	4
Education level (n)		
Low	0	2
Moderate	5	2
Marital status (n)		
Single	0	1
Living together / married	5	5
Claim status (total) Yes	4	2
PSEQ (mean ± SD)	29.4 ± 3.21	22.2 ± 14.1
RAND-36 Physical functioning (mean ± SD)	58.0 ± 15.2	29.2 ± 15.3
RAND-36 Emotional functioning (mean ± SD)	51.2 ± 19.7	57.3 ± 25.9
RAND-36 Vitality (mean ± SD)	28.0 ± 22.0	26.7 ± 18.1
RAND-36 Bodily pain (mean ± SD)	33.6 ± 8.2	23.3 ± 19.1

PSEQ = pain self-efficacy questionnaire; RAND-36 = health- related Quality of life

Table 5.2 Results of work ability in patients with chronic musculoskeletal pain

	Experimental group (n=5)		Control group (n=6)		Between groups
	Baseline (mean ± sd)	Change* (mean ± sd; %; effect size)	Baseline (mean ± sd)	Change* (mean ± sd; %; effect size)	Difference in change (mean (95% CI); effect size)
WAI	1.80 ± 1.64	3.20 ± 2.05 177% 1.51	2.67 ± 1.37	2.50 ± 2.35 94% 1.29	0.70 (-2.34; 3.74) 0.46

WAI = work ability Index; sd = standard deviation; * = from baseline

Feasibility

Between Augustus 2012 and March 2013 13 patients were included, one patient did not receive the allocated intervention following randomization; her clinical status led to another intervention. Results of another patient were not analyzed, because the intervention period exceeded the 16 weeks. Fourteen patients refused to participate, based on different reasons. Fifteen patients were potentially eligible, however during the baseline assessment it became clear that they did not fulfill all inclusion criteria (e.g. psychiatric illness, medical comorbidity). A participant flow diagram is presented in Figure 5.1. No serious adverse events were reported. All patients were able to tolerate and complete both interventions. Both interventions were feasible for the therapists; they did not report any barriers.

Full scale trial

Based on available patient data a sample size analysis was performed to inform a full scale RCT. It was assumed that the between-group difference in change in work ability is 0.7

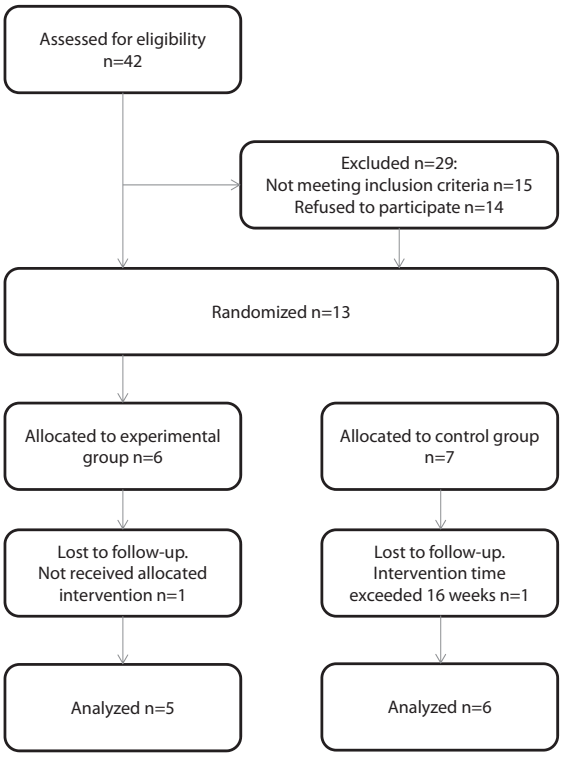

Figure 5.1 Participant flow diagram.

with an estimated pooled SD of WAI of 1.5. When using a two-sided two-sample t-test, a significance level (alpha) of 0.05, 80% power to detect a difference of 0.7 points with a SD of 1.5 sample sizes of n=73 for each arm will be needed. Assuming drop-out of 20% between admission and discharge, 91 patients in each group are needed (total sample n=182).

DISCUSSION

This pilot study shows that in both groups the improvement in work ability was clinically relevant. The addition of a SF FCE to a brief cognitive behavioral intervention further enhanced the effect on work ability. Feasibility has been established. However, clinical relevance of the addition of a SF FCE is unconvincing.

No minimal important differences (MID) are known for work ability. However, the results of a meta-analysis of RCTs reporting on RTW in patients with chronic pain showed a MID for overall improvement of 10 points, on a scale of 100[17]. In comparison with the average improvement of 3.2, on a scale of 10 points (ES 1.5) of our experimental group, these results look promising. The baseline self-reported work ability scores of our sample were low, probably based on the relative long duration of complaints (average 15 to 20 months), high level of unemployment and dependence on benefits. This brief cognitive behavioral intervention is feasible for physiotherapists and psychologists, after a training period. Physiotherapists have to be specially educated for performing the SF FCE. The intervention was performed in a setting were workers compensation companies ordered and payed the intervention, instead of a health insurance company. It is deemed positive that the workers compensation company is involved in the decision of the main treatment goal. It is deemed negative that patients did not take the initiative for the intervention. Additionally, there might have been financial incentives that might have influenced the results. For example, patients can lose their sick leave compensation benefits before they fully regained work.

The weak relation between FCE information and RTW was also found in an inpatient rehabilitation setting[5]. The patient groups were different in age and disability benefits. In our study the patients were average ten years younger and the disability benefits were higher. Work ability scores of average 5 at discharge are still considered poor compared to other workers with pain[18,19]. It is unknown to which extend work ability will improve, when patients entirely return to work. The challenging inclusion rate is an often reported problem; it is assumed that recruitment of patients is a problem in 50% of all RCTs[20]. The most promising reported strategies to optimize recruitment are telephone reminders to

non-responders and requiring potential participants to opt-out of being contacted by the trial team[20]. However, we used both methods and also did not blind the trial for patients[20] and still had a inclusion percentage of 31%. For a full scale trial, we recommend to take into account the challenging inclusion.

This proof of concept study is not designed to test the effectiveness of the brief RTW intervention, because the sample size was too small. However, this study showed that a brief RTW intervention with a SF FCE is feasible and can improve work ability. That is promising, because the intervention costs less than ten hours therapist time. To test the effectiveness a sufficiently powered full scale trial should be performed. Cost-effectiveness analyses should be included to analyze whether the small benefit of adding a SF FCE will be worth the extra costs (30-60 minutes). For the intervention the therapists were specifically trained. Because a combination of evidence-based methods was used, therapists should be specifically trained to replicate the intervention in another setting. Unfortunately, blinding of patients, therapists and principal investigator was not possible.

Concluding, the intervention improved work ability in both groups. Addition of a SF FCE enhanced work ability further. Thus feasibility has been established. However, clinical relevance for the addition of a SF FCE is unconvincing.

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Chapter 6

Associates of work ability: different for patients with Whiplash Associated Disorders compared to patients with chronic low back pain?

Submitted

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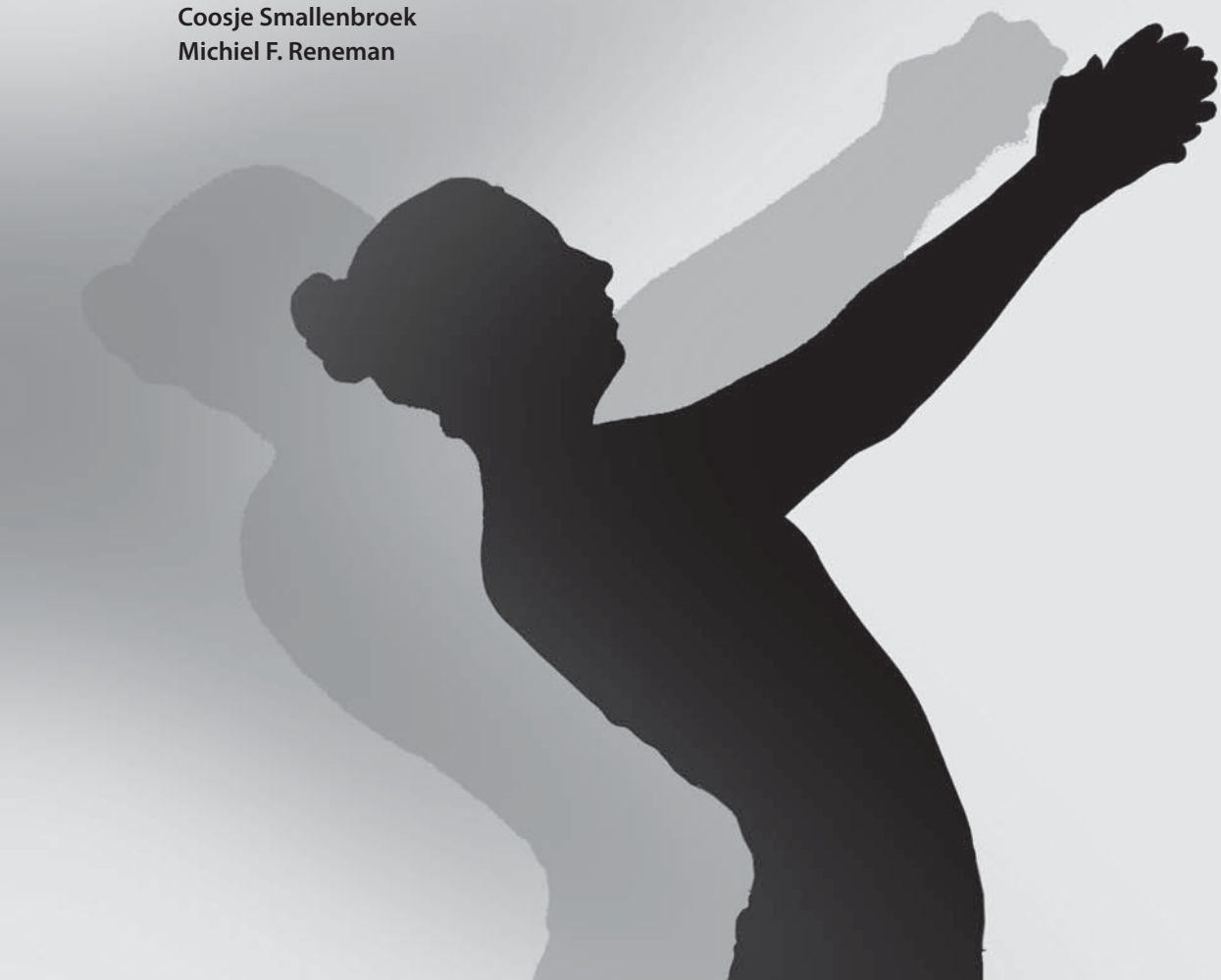

ABSTRACT

Background: Bio-, psycho-, and social variables are related to work ability of patients with chronic musculoskeletal pain. It is unknown whether associates of work ability differ between patients with chronic low back pain (CLBP) and Whiplash Associated Disorders (WAD).

Aim: To determine to what extend work ability is associated with pain, pain interference, pain catastrophizing, self-reported disability, quality of life and claim status in patients with WAD and CLBP.

Design: Cross-sectional study.

Setting: Three rehabilitation centers in the Netherlands.

Population: Patients aged 18 to 66 years, referred to a rehabilitation physician, were included when they had a diagnosis of CLBP or WAD and had pain for more than three months.

Methods: Self-reported work ability (WAS) was measured by the single-item of the Work Ability Index. Multivariate linear regression analyses were performed to identify independent associates of work ability.

Results: In total 438 patients were included. Independent associates for both CLBP and WAD were physical functioning and self-reported disability, which explained 22% of the variance in work ability for patients with CLBP and 30% of the variance in patients with WAD. All other variables did not contribute significantly to the regression models.

Conclusion: The associates of work ability in patients with CLBP and WAD are the same (physical functioning and self-reported disability), but the amount of explained variance is different (22% in CLBP and 30% in WAD).

BACKGROUND

Chronic pain affects 1 in 5 adults across Europe and leads to significant amounts of time off work[1]. In patients with chronic low back pain (CLBP), which does not have a well-defined etiology, the pain is located in the lower part of the back. In patients with chronic whiplash associated disorders (WAD) the pain is located in the neck and caused by an acceleration-deceleration trauma[2]. Patients with WAD experience pain, but can also experience other symptoms such as dizziness and concentration problems. Pain ca be seen as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage[3]. The experience of severe daily pain can has a substantial negative association with work participation[4]. Work ability is built on the balance between a person's resources, such as functional capacity, professional knowledge, competence (skills) values, attitudes and motivation on the one hand and demands of work itself on the other hand[5]. In general, bio-, psycho-, and social variables influence work ability of patients with chronic musculoskeletal pain. It is unknown, however, which of these variables affect functioning the most. In patients with chronic low back pain (CLPB), pain intensity, general health perceptions, fear avoidance, pain self-efficacy, work demands, working hours, control over work tasks and work satisfaction are reported to be correlated with self-reported workability[6,7]. In patients with WAD, correlations between work ability and other variables are unknown.

In patients with musculoskeletal disorders, multidisciplinary rehabilitation can help improve work ability[8]. However, the results for CLBP and WAD seem different. Work ability of patients with CLBP can be positively influenced by multidisciplinary rehabilitation (MR)[9]. Thus far, the effects of MR on work ability have not been studied systematically in patients with Whiplash Associated Disorders (WAD). Moreover, conflicting results are reported for patients with WAD with regard the effect of MR for disability reduction[10]. The dose and content of rehabilitation interventions are heterogeneous and therefore difficult to compare between patients with CLBP and WAD[9,10]. Why treatment efficacy differs between WAD and CLBP is also unknown and reason for debate: the "splitters" side of the debate defends the necessity to discriminate between syndromes such as WAD and CLBP as separate diagnostic categories and to group patients by example psychosocial or behavioral characteristics[11,12]. "Lumpers", on the other hand, argue that all pain syndromes represent one underlying common basic syndrome[11]. In relation to treatment, patients with WAD and CLBP can be given the same or different rehabilitation programs. Insight in the associates and their relative strength may improve and specify MR in patients with WAD and CLBP and may provide new insights into the debate between splitters and lumpers.

The objective was to analyze whether significant differences exist between a number of routinely assessed biopsychosocial factors and work ability between patients that have been referred to a rehabilitation physician for MR because of CLPB or WAD. Our hypotheses is that work ability for CLBP and WAD can be negatively influenced by high levels of pain, pain interference, pain catastrophizing, self-reported disability and low quality of life. Patients with WAD more often have a pending claim[13], than patients with CLBP. Therefore, our hypothesis is also that a pending claim is associated with work ability in patients with WAD, and not in patients with CLBP.

MATERIALS AND METHODS

Design

This is a cross-sectional study. All patients referred for any chronic pain condition that might be candidates for a MR are asked to fill is a standardized questionnaire (the "Dutch Dataset Pain Rehabilitation") before their first visit to the rehabilitation physician. Data were collected between 2010 and 2013. All patients aged 18 to 66 years, had a work relationship (either working or (partially) absent), were selected from the database when they had a diagnosis of CLBP or WAD. Data from three centers were used in the analyses. The following variables were selected for their possible association with work ability in patients with WAD and CLBP: gender, education level, duration of complaints, level of average pain, pain interference, pain catastrophizing, self-reported disability, health-related quality of life, and claim status.

Procedures

All patients filled out the standardized set of questionnaires as part of regular screening procedures. A research assistant screened the patients and checked if patients had answered the questions. After seeing the rehabilitation physician, patients who might benefit from MR, also filled in the additional questionnaires for pain interference and pain catastrophizing.

Measures

Work ability was measured with question 4 of the short version of the Work Ability Index (WAI)[14]. The question concerning self-reported work ability (WAS) is "current work ability in comparison with the lifetime best". The score ranges from 0 to 10, with higher scores indicating higher work ability[15]. The WAI is a validated and well-accepted instrument to measure work ability[14]. The convergent validity between WAI and WAS is acceptable[16].

Average pain intensity was measured with the Numeric Pain Score[17]. The score ranges from 0 to 10, with 0 = no pain and 10 = worst possible pain. The Numeric Pain Score is reliable and valid to measure pain intensity[17].

Pain interference was measured with the subscale Interference of the Multidimensional Pain Inventory (MPI), the Dutch Language Version[18,19]. The score range from 0-7 with 0=no control and 7 = total control. The reliability is acceptable[19].

Pain catastrophizing was measured with the 13-item Pain Catastrophizing Scale (PCS)[20]. Score range from 0-52, with higher scores indicating higher level of catastrophizing. The PCS has acceptable reliability[20].

Self-reported disability was measured with the7-item Pain Disability Index (PDI)[21]. It measures the magnitude of self-reported disability in different situations such as work, leisure time, activities of daily life and sports. The score ranges from 0-70, with 0 = no disability and 70 = maximally disabled. The validity and reliability are acceptable[21-23].

Three domains of health-related quality of life (physical functioning, emotional functioning, vitality) were measured with the validated RAND-36[24]. Score ranges from 0 to 100 with higher scores indicating better quality of life. The RAND has acceptable validity[25].

A pending claim status was asked by the question: "Do you have a pending claim, which has a relationship with your complaints?".

Other demographic and clinical variables were: gender, age, duration of complaints and education level. Education level was divided in low (primary school, lower vocational education), moderate (intermediate vocational education) and high (higher vocational or university education).

Statistical analysis

Continuous variables were described as mean (SD) or median (25th and 75th percentile), as appropriate. The distribution of the data was visually inspected for normality. Categorical data were described by frequencies and percentages. All variables of the groups, CLBP and WAD, were checked for differences with an independent samples t-test or Chi-Square, as appropriate. Multivariate linear regression analyses were performed to identify independent associates of work ability for both groups separately. Independent associates were defined as those variables with a univariate association with work ability $p<0.10$, tested with a Pearson correlation coefficient, independent t-test or ANOVA, as appropriate. These associates were added to a full multivariate linear regression model. Subsequently, non-significant variables

were removed, one by one, until either only significant variables remained or r^2 had decreased by 10%. To be able to compare the results of two groups, the significant associates in one group, were also included in the model of the other group. Multicollinearity was assessed[26]. In order to minimize the biased possibly introduced by missing data multiple imputations (N=5) were performed in case of missing data[27]. Subsequently the same analyses were repeated and the pooled analyses based on imputed data were compared to the non-imputed models. The associates of work ability for WAD and CLBP were compared which each other. Data were analyzed using the SPSS suite, version 20.0.

RESULTS

Data of 438 patients, who were referred to a rehabilitation physician were available (n=269 with CLBP and n=168 with WAD). Only patients who were possible candidates (after the screening phase) for participation in a MR rehabilitation program by the rehabilitation physician, filled also in the questionnaires for pain interference (n=116) and pain catastrophizing (n=135). The patients with CLBP were significantly older, had longer duration of complaints, were lower educated, had fewer pending claims, lower pain interference and lower physical functioning, than the patients with WAD. All data were normally distributed. Demographic and clinical information is presented in Table 6.1.

Factors univariately significantly associated with WAS and therefore added to the multivariate model for CLBP were: education level, level of average pain, pain interference, self-reported disability, physical functioning and emotional functioning. Factors univariately significantly associated with WAS and therefore added to the multivariate model for WAD were: education level, level of average pain, pain catastrophizing, self-reported disability, a pending claim, physical functioning and emotional functioning. Age, gender, duration of pain and RAND-36 vitality were not significantly related (all $p>0.10$) to WAS, neither for WAD nor for CLBP. Final results of the multivariate regression analyses are presented in Table 6.2. Independent associates for both CLBP and WAD were physical functioning (RAND physical) and self-reported disability (Pain Disability Index) which explained 22% of the variance in work ability for patients with CLBP and 30% of variance in patients with WAD. All other variables did not contribute significantly to the regression models. The results of the sensitivity analyses, based on multiple imputations because of missing data were essentially the same. Interpreting these results: a patient with CLBP with a RAND physical functioning score of 40 and a Pain Disability Index of 40 has an estimated WAS of 3.29 ((5.29 + (40 x 0.02) – (40 x 0.07)) and a similar patient with WAD has an estimated WAS of 3.06 ((1.86 + (40 x 0.05) – (40 x 0.02)).

Table 6.1 Demographic information and clinical characteristics of patients with Chronic Low Back Pain and Whiplash Associated Disorder

	CLBP		WAD		p-value*
	N	Mean ± SD or %	N	Mean ± SD or %	
Age (years ± SD)	269	44.7 ± 11.5	168	40.6 ± 11.7	<0.001
Gender Male (%)	268	38.4%	168	42.9%	0.32#
Duration of pain (%)	269		168		<0.001#
3 to 6 months	21	7.8%	33	19.6%	
6 to 12 months	32	11.9%	44	26.2%	
1 to 2 years	46	17.1%	42	25.0%	
2 to 5 years	63	23.4%	23	13.7%	
More than 5 years	107	39.8%	26	15.5%	
Education level (percentage)	261		159		0.02#
Low	120	46.%	48	30.1%	
Moderate	112	42.9%	80	50.4%	
High	29	11.1%	31	19.5%	
Claim status (% Yes)	260	8.5%	160	56.9%	<0.001#
Self-reported work ability (WAS)	264	3.53 ± 2.61	161	3.42 ± 2.33	0.65
Numeric Pain Score	215	6.02 ± 1.80	122	5.75 ± 2.02	0.22
Multidimensional Pain Inventory; Interference	72	3.90 ± 1.18	44	4.45 ± 1.13	0.01
Pain Catastrophizing Scale	70	28.0 ± 12.9	65	25.4 ± 12.5	0.23
Pain Disability Index	221	40.7 ± 13.4	127	38.9 ± 14.9	0.25
RAND-36; physical functioning	229	38.7 ± 20.4	134	53.3 ± 22.1	<0.001
RAND-36; emotional functioning	234	60.6 ± 13.4	138	59.9 ± 13.3	0.60
RAND-36; vitality	234	46.1 ± 13.6	136	44.3 ± 14.6	0.24

CLBP = Chronic Low Back Pain; WAD = Whiplash Associated Disorder; * p-value of differences between CLBP and WAD tested with an independent samples t-test; # p-value of differences between CLBP and WAD tested with a Chi-Square test

Table 6.2 Multivariate linear regression analyses with independent associates with work ability in patients with Chronic Low Back Pain and Whiplash Associated Disorder

Group	Dependent variable	Independent associate	B	95% CI	r^2 [1]
CLBP	Work ability	Constant	5.29		0.22
		RAND Physical Functioning	0.02	0.00 to 0.04	
		Pain Disability Index	-0.07	-0.10 to -0.04	
WAD	Work ability	Constant	1.86		0.30
		RAND Physical Functioning	0.05	0.03 to 0.06	
		Pain Disability Index	-0.02	-0.05 to 0.01	

[1] r^2 is calculated for the full model; WAD = Whiplash Associated Disorders; CLBP = Chronic Low Back Pain

DISCUSSION

The main result of this study is that independent associates for work ability in patients diagnosed with either CLBP or WAD were physical functioning and self-reported pain disability, which explained 22% of the variance in work ability for patients with CLBP

and 30% of variance in patients with WAD. The same two factors predict work ability, so the NULL-hypothesis that the same factors are associates of work ability in both groups, cannot be rejected.

The results of our study are in line with "The International Classification of Functioning, Disability and Health", where work ability, physical functioning and self-reported disability are related to activity and participation level[28], in contrast to pain related factors that are related to function level. The results of our study can indicate that interventions aimed at optimizing work ability for patients with WAD and CLBP do not have to be split in subgroups for pain related factors (high levels of pain, pain interference, pain catastrophizing), gender and a pending claim. This study identifies two factors that are associated with work ability in patients with CLBP and WAD: physical functioning and self-reported pain disability. Although cross sectional analyses can never demonstrate causality, one can speculate that improvement of physical function and self-reported disability, both 'areas' are typically targeted during MR, can improve work ability. In an intervention study with 800 Swedish newly sick-listed patients WAS of patients with musculoskeletal pain improved from average 3 to average 6 points[29]. Intervention studies that measure the improvement of WAS, sick leave, physical functioning and self-reported pain disability can help to improve the effects of multidisciplinary rehabilitation on work ability, especially for patients with WAD. Patients referred to a rehabilitation physician in this study report poor work ability[30], indicating that work ability has to be improved for labor force participation. In contrast to our hypothesis, pain-related factors like catastrophizing, interference and pain intensity were not significantly associated with WAS for both groups. Also a pending claim was not strongly associated with WAS in patients with WAD. The example that a patient with CLBP with a RAND physical functioning score of 40 and a Pain Disability Index of 40 has an estimated work ability score of 3.29 and a similar patient with WAD has an estimated work ability score of 3.06, indicates the small differences (0.26 points) between the two syndromes on WAS and supports the arguments of the lumpers in the debate between lumpers and splitters. In relation to work ability, CLBP and WAD can represent one underlying common pain syndrome without subgroups. The similarity in patients with CLBP and WAD is also shown in our study with the same distribution in gender, work ability scores, pain intensity scores, emotional functioning scores and vitality scores between the two groups. However, there are also differences between the groups like age and education level, and we did not measure all biopsychoscial variables that can explain the variance in work ability. Also, physical functioning and self-reported pain disability only explain a minor part of the work ability, with 70% or 78% that remained unexplained. This argues for individual patient assessment, to decide which additional factors contribute to

the individual WAS and should be addressed in MR. This may imply that patients with CLBP and WAD can be treated in a similar MR program (lumping) aimed at improving WAS. To address the currently unexplained areas, individual components may be added, assuming that these additional components differ between patients.

In our study pain intensity was not associated with WAS, in contrast to a study about prognostic factors for long-term sickness neck-shoulder and back pain6. However the WAS in our study was lower. This can indicate that the association between WAS and pain intensity is stronger in patients with higher WAS than in lower WAS. Also the statistical methods were different in the two studies. In a cross-sectional study of workers with chronic musculoskeletal pain self-reported disability was not associated with poor WAS, but pain intensity, pain self-efficacy and age were[7]. However, they used WAS on an ordinal scale (good / moderate / poor work ability). In a prospective cohort study with more than 800 newly Swedish sick-listed patients WAS at baseline of patients with musculoskeletal pain were also average between 3 and 4 points[29], this indicates that the WAS of Dutch patients with CLBP and WAD are similar with Swedish sick-listed patients with musculoskeletal pain.

We included a large group of patients from three different centers in the Netherlands, which can be seen as a representative group of patients. Unfortunately we had a relative small sample size for pain catastrophizing and pain interference. Multiple imputations did not change our results, indicating that also with a large sample pain catastrophizing and pain interference is not associated with work ability. We did not measure general health perceptions, fear avoidance, pain self-efficacy, work demands, working hours, control over work tasks and work satisfaction, which were associated with self-reported workability in other studies[6,7]. We have chosen to measure only the parameters that can be modified with therapy and that were part of the "Dutch Dataset Pain Rehabilitation", but we did not test all biopsychosocial factors possibly related to work ability. There are for example indications that a diagnosis of PTSS can influence work ability[31]. Therefore, we recommend further research on biopsychosocial factors. Furthermore, the effect of various treatment options in MR programs for patients with different characteristics should be explored.

CONCLUSIONS

The NULL-hypothesis that the same factors predict work ability in both the WAD and CLBP groups, cannot be rejected. The associates of work ability in patients with CLBP and WAD are the same (physical functioning and self-reported disability), but the amount of explained variance is different (22% in CLBP and 30% in WAD).

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Chapter 7

How does injury compensation affect health and disability in patients with complaints of whiplash: a qualitative study among rehabilitation experts-professionals

Submitted

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ABSTRACT

Purpose: Explore rehabilitation professionals' opinions about the influence and the pathways of injury compensation (IC) on health and disability in patients with whiplash associated disorder (WAD).

Methods: Semi-structured interviews were performed among a purposeful selected sample of Dutch expert-professionals in the field of rehabilitation of patients with WAD. Inclusion continued until saturation was reached. Inductive and deductive thematic analyses were performed.

Results: Ten rehabilitation expert-professionals (five females), working as physician, psychologist or physiotherapist, were interviewed. All expert-professionals acknowledged that IC can influence rehabilitation, health and disability. The expert-professionals provided three causal pathways; a psycho-somatic pathway through prolonged distress, a behavioral pathway, and patient characteristics that may either attenuate or worsen their response. They assess the influence of IC mainly with interview techniques. Most professionals discuss the potential influence of IC with their patients, because they want to give clear information to the patient. Some emphasise that their role is neutral in relation with the IC. Others mention that financial consequences can accompany functional improvement.

Conclusions: Rehabilitation expert-professionals believe that IC may affect rehabilitation, health and disability in patients with WAD. Three pathways are mentioned by the experts-professionals.

INTRODUCTION

Twenty to forty percent of the patients with whiplash associated disorder (WAD) demonstrate pain and other symptoms, as well as disability, four months after onset[1,2]. Several biological, psychological and social factors can predict delayed recovery[3,4]. Among the social factors is injury compensation (IC), which is defined as: the process to get payments for economic and non-economic losses for personal injury arising from an identifiable external cause[5,6]. Both the process for seeking compensation and the outcome of this process can differ substantially between patients[5]. In the Netherlands 90% to 95% of the claims are completed without a law court[7]. Claimants are required to prove liability and causality between accident and injury and accident and damages[8]. After liability and causality are established, the insurance company pays for (additional) loss of income (to a certain level, employees receive social security benefits), travel and household services, additional medical services (to a certain level claimants' health insurance pays for health services), rehabilitation and disability services, lawyer services, and pain and suffering[8]. Damages are paid lump sum, but claimants normally receive advance payments[8]. According to a code of conduct the majority of the claims have to be completed within two years[7]. In this time frame the legal responsibility, the medically stable condition, and the damage costs have to be determined[7]. However, this is not always possible.

Compensation related factors are deemed to have a negative influence on health status and disability in patients with both verifiable and non-verifiable injuries[5]. However, reviews on this topic are to some extent contradictory[5]. In patients with WAD there is preliminary evidence that a prevailing compensation system is prognostic for delayed recovery[4]. A review reported detrimental associations between compensation related factors (compensation claim, litigation status, previous claim, lawyer involvement) and pain and self-reported improvement[6]. There is still uncertainty how IC affects health and disability, because causal pathways are not yet adequately addressed and therefore remain ambiguous[6]. Leading scientists agree that IC is a complex construct and that the moderators of an effect of compensation factors in patient with WAD on health outcome should be further clarified[9]. Strong methodologically sound studies are needed. However, it is not feasible to randomize patients with WAD to having a claim or not, or to receive compensation or not[9].

Rehabilitation professionals play an important role in the treatment of patients with WAD and may have insight in the phenomenon of IC. They can help the patient to obtain a better understanding of the role of IC in health and disability. However, little is known about the opinions of rehabilitation professionals on this subject. The primary aim of this qualitative study was to explore rehabilitation experts-professionals' opinions and practices

regarding the influence and the possible causal pathways of IC on health and disability in patients with WAD.

The main questions investigated were:

1. Do rehabilitation experts-professionals acknowledge an influence of IC on health, disability, and on rehabilitation treatment, and which pathways may explain this influence?
2. How do rehabilitation experts-professionals address IC clinically, both in assessment (diagnosis) and treatment?

METHODS

Design

Semi-structured interviews were conducted with rehabilitation experts-professionals. The interviews consisted of topics and semi-structured questions related to the research questions. The interviews were held between April and November 2013. Ethical approval was not needed, because there were no patients involved in this study.

Participants

The participants were purposefully selected Dutch expert-professionals in rehabilitation of patients with WAD. They were included because of their influential opinions on rehabilitation in patients with WAD, as demonstrated by scientific publications or professional leadership. The first eight on the list were asked to participate before the start of the study. Subsequent expert-professionals on the list were asked to participate until saturation was reached (no new topics were identified).

Procedures

The semi-structured interviews were conducted by the first author, who is an experienced physiotherapist, specialized in treating patients with WAD. This experience made communication with the expert-professionals easier. To ensure high quality interviewing, the interviewer received a prior training in conducting qualitative interviews. Also, the first two interviews were critically reviewed by the second author (MP) who provided feedback to the interviewer. Prior to the interview participants were verbally informed about the procedure:

duration (60 minutes), themes, permission for recording the interview, and anonymity of their responses. The date and place of the interview was confirmed by telephone, and the semi-structured question form was sent via email prior to the interview.

Interviews

Six major topics were derived from the two research questions, each introduced with an open format question to elicit as much spontaneous responses as possible. The following questions were investigated:

1. Do rehabilitation expert-professionals acknowledge an influence of IC on health and disability?
2. What could be the causal pathway of IC on health and disability?
3. How can IC influence rehabilitation?
4. How do rehabilitation expert-professionals assess the influence of IC on health and disability in an individual patient? What are the pro's and con's of this assessment?
5. Do rehabilitation expert-professionals discuss the possible IC effects with their patients and what are their (ethical) considerations?
6. How do rehabilitation expert-professionals view their role and responsibility towards patients, insurance companies and others involved in the treatment of the patient?

Each of the six major topics was then further explored by introducing a set of predefined subtopics. The interview scheme was pre-tested in an interview with one of the co-authors (JV), who fulfilled our inclusion criteria. These data were not included in the analysis. If new relevant topics emerged during an interview, these were then added to the interview scheme for the next interview.

Analysis

Inductive and deductive thematic analyses were used to analyse the data with the help of Atlas- ti, version 7[10]. First, the recordings of the interviews were transcribed verbatim. Second, the salient themes were identified by coding the fragments, in order to develop the coding scheme. Both theory-driven codes, which were based on earlier studies and also included in the interview scheme, as well as data-driven codes were defined. Two interviews were coded

by two researchers independently (SvdM and MP), and differences in coding were discussed until consensus was reached. This open coding was done until no new codes were necessary and there was a final code scheme. The coded transcripts were tested for inter-rater reliability between two researchers. Direct quotes from the respondents were used to illustrate outcomes.

RESULTS

Participants

Ten expert-professionals (5 females) were interviewed until topic saturation was reached. Five are rehabilitation physicians, three psychologists, and two physiotherapists. Eight participants have a PhD in the rehabilitation field. They work in rehabilitation centers or private practices in different parts of and settings in the Netherlands. Their mean age was 55.3 years (s.d. 8.1, range 42-68).

Do rehabilitation expert-professionals acknowledge an influence of IC on health and disability?

All expert-professionals acknowledge that IC can influence health and disability, although the prevalence of this phenomenon is estimated considerably differently by the experts-professionals. For example: "*I think only 1% of the patients with a neck trauma*" and "*I think that in almost everyone it plays a role, in greater or lesser degree*". This variation in estimated prevalence does not seem to be dependent of the work setting (primary of tertiary care) of the experts-professionals. In general, the participants indicate three life domains that all may be affected by an IC. They report impairments on functional aspects (decreased concentration), on activities (washing windows), and on participatory aspects (decreasing social activities). Regarding participatory aspects, the financial consequences when patients stop working are also mentioned. Although the expert-professionals agree that in general IC can affect outcomes unfavourably, this is not necessarily so in all situations. Patients can also benefit psychologically from an IC as this serves as a recognition for their suffering, and enables patients to put the blame elsewhere. Experts-professionals also indicate a more instrumental benefit, in cases where the insurance company pro-actively helps a patient (financially) to obtain adequate treatment to recover. In contrast, when the insurance company approaches the patient less benevolent the procedure may become particularly stressful. As an expert-professional mentioned: "*that they also are suspected of a personality disorder, which can be really traumatic and insulting*".

What could be the causal pathway of IC on health and disability?

The expert-professionals provided three pathways; a psycho-somatic pathway through prolonged distress, a behavioral pathway, and patient characteristics that may either attenuate or worsen their response. These pathways are elaborated below.

1. All expert-professionals agree that the compensation process can lead to prolonged distress, which affects health and disability directly. Consistent with the "International Classification of Function, Disability and Health" (ICF), the IC is regarded as an environmental factor that influences function, activity and participation level of the patient. One of the expert-professionals mentioned the role of myofascial trigger points; stress gives a disturbance of the "internal environment", and that will aggravate their symptoms. Additionally, as already mentioned in the previous section, the interaction that patients have with their own insurance company and the liable company can be stressful and even harmful, with "*extraordinary little respect for the patients*". Also, continuing disagreement about a medical stable situation can be stressful: "*the patients are always anxious about decisions relating to their medical situation. So, the complaints do not go away, if there is no calmness, security and safety.*" It can take years till the claim has come to a conclusion, and some expert-professionals therefore argue to reduce the time between start and end of the IC to limit the impact on health and disability.

2. Within the behavioural pathway, IC serves as a reinforcing factor, rewarding behaviors that are conducive to receiving compensation. At the same time, behaviors promoting recovery are abated. The compensation the patient might receive from the IC can influence their behaviour. In general, the professionals underscore the potential inherent conflict of interests between striving for compensation on the one hand and recovery on the other: "*You have to recover, also you want to recover, however, you also have to show that you are disabled*". The expert-professionals believe that malingering by patients is rare, as patients usually appear to be unaware of this conflict of interests. This suggests that effects of IC on patients' behaviour would primarily occur unconsciously.

3. The characteristics of patients most susceptible to IC effects seem to be rather heterogeneous, according to the experts-professionals. Patients can, for example, have a strong feeling of injustice, with an external locus of control: "*So it may happen that patient A, although going through a much more difficult IC case than patient B, still experiences less perceived injustice than B. Persons vary*". They can be socially deprived and/or have a history of anxiety, depression and/or pain catastrophizing. But there are also expert-professionals who contradict this view and who think that "*it can happen to anyone*".

How does IC influence rehabilitation?

All expert-professionals believe that IC can influence rehabilitation. One example that IC influences rehabilitation in a positive way is that rehabilitation can be facilitated and paid by insurance companies and that advice about rehabilitation options were given by representatives of the insurance companies. One expert-professional reported a case in which a patient fully recovered after the IC was ended, another reported a better rehabilitation outcome after the struggle with the IC ended, or patients do not progress in a week that patients also have an appointment about the compensation. Sometimes rehabilitation programs will not be started or postponed, because of the way patients struggle with the IC: "*the patients are fighting with the IC, cannot stop the fight and cannot recover*". Some expert-professionals report that they sometimes do not start or postpone a rehabilitation program, because of the lack of motivation and realistic goal setting of the patient. Also, patients can exaggerate their impairments in neuropsychological tests. Such cases also illustrate behavioural pathways involved in IC, as mentioned above. Another experts-professional stated that the lack of motivation of the patient can negatively influence the motivation of the professional during treatment. The expert-professionals report difficulties in objectifying the struggle of the patient with the IC. One expert-professional specifically states: "*Basically, you deny a patient a healthcare intervention, based on the fact that the IC procedure is still ongoing. You cannot do that*". Sometimes a rehabilitation program is postponed until the IC is ended or has progressed to a more advanced stage: "*When the IC is very important for the patient, then you can decide together to first finish the IC and then start the rehabilitation program*". Also, self-management interventions are given in rehabilitation to teach patients to change their behaviour, specifically in relation to the IC.

How do rehabilitation expert-professionals assess the influence of IC on health and disability in an individual patient?

Several techniques were reported by the professionals to assess the influence of IC. They ask whether there is a compensation claim and most also ask how patients cope with it. One expert-professional stated that the influence of the IC on health and disability is a multidimensional assessment made in a multidisciplinary team. The team develops an opinion and judgement, based on discussion of information from the interviews, questionnaires (Tampa scale for Kinesiophobia[11] and the Hospital Anxiety and Depression Scale (HADS)[12], physical (Ästrand test)[13] and functional tests (stair climbing). Most expert-professionals use interviews because it can be easily applied and produces valuable information, one expert-professional mentions specific "open questions" and motivational interview techniques. At

the same time caution is needed, according to some experts-professionals, as interviews may not be valid, and patients may easily become defensive. A professional said: "*Sometimes patients are annoyed during the treatment; they ask one of the therapists why we ask so many questions about the compensation claim*".

Do rehabilitation expert-professionals discuss the possible IC effects with their patients and what are their (ethical) considerations?

The majority of expert-professionals discuss the possible effects of compensation claims with their patients. One expert-professional explained it like this to his patients: "*You have a dilemma. You have to see me, and maybe you want to tell me that you are doing better. That is also the goal of our contacts. When you go to the physician of the IC, you want to emphasize that you are disabled and that you need compensation. Your accident is maybe three months or three years ago. Your compensation claim is about that period and for your claim you have to look to that period. Now we are going to look if you can recover. I don't know if that will happen, and if that is not the case, this period can also be included in the compensation claim. Therefore, my advice is that you separate these periods. The compensation claim is about the moment until you get better, and now you are getting better.*" Not all expert-professionals believe that this information directly improves the health of the patients, but it helps patients to clarify their current situation. The information can improve the relationship between professional and patient. However, sometimes the relationship ends, when patient decide to stop the rehabilitation program. The expert-professionals consider ethically that they want to give clear information to the patient, but the ultimate decision how to cope with a compensation claim is the responsibility of the patient. Some patients stop the IC on account of the discussion. A reason to not discuss the situation, is that the expert-professional will not be involved in the IC.

How do rehabilitation expert-professionals view their role and responsibility towards patients, insurance companies and others involved in the treatment of the patient?

The expert-professionals highlight that it is important to help the patient in a professional manner and to obtain a good treatment result. Some expert-professionals emphasise that their role is neutral regarding the IC: "*it does not matter to me if the IC pays the patient or not*". However, some other expert-professionals mention that there can be financial consequences for the professional, because professionals get paid for their work. One expert-professional working in a private practice state that "no" isn't easily said by therapists: "*When already three or four neuropsychological tests have been performed, and a therapists is asked to do one*

more, he will do it, otherwise someone else will do it. So, this situation continues". Also negative consequences are mentioned; the medical reports they have to write for the IC are time consuming and limit the time they have for the patients. Expert-professionals mention that a collective interest of all stakeholders can be the good functioning and coping of the patient, the acknowledgement for the disability of the patient and a quick resolution of the compensation claim. According to the expert-professionals the patient associations play an ambivalent role. On the one hand they can be supportive in helping patients with receiving acknowledgement of their disabilities. On the other hand, this can exacerbate the patients' condition due to a one-sided position: "*what you have is really serious, miserable and difficult and we do not get any acknowledgment*". Other expert-professionals said that this has changed over the past years and that currently patient associations are more aware of their own responsibility in this process.

DISCUSSION

To our knowledge, this qualitative study is the first to provide insight in the opinions of a selected group of rehabilitation expert-professionals about the influence of IC on health and disability in patients with WAD. All rehabilitation expert-professionals stated that IC can (usually negatively) influence health and disability, and recovery. Differences exist on the extent to which IC-interference may occur. The severe IC-related distress, rehabilitation impeding behaviour, and patient characteristics were identified as pathways through which IC interference occurs. Finally, this study provided an initial understanding of how rehabilitation professionals in the Netherlands tend to address the issue in their clinic and how they perceive their own role and responsibility.

Expert-professionals generally believe that IC can have negative side effects. However, positive effects may also occur. For example, the observation that IC can help patients to put the blame elsewhere can also be regarded as a positive factor, because they can externally attribute their current poor health and disability to the accident in the past[14]. That IC can lead to distress, was also found in a meta-analysis on mental health of patients with or without an IC[15]. However, these results should be interpreted with caution, due to the limited quality of evidence[15]. A remarkable outcome in this study on this topic were the differences in the estimated prevalence of IC interference occurring in whiplash patients, which varied from an estimated 1% to almost 100% of cases. This variation in estimated prevalence does not seem to be dependent of the work setting (primary of tertiary care) of the experts-professionals. An English longitudinal study showed that occurrence can be biased by reverse causality[16]. The relation between IC and health can be ambiguous, by

example IC can lead to slower recovery, but is also possible that slower recovery can lead to IC[16]. This can partly explain the broad range of opinions regarding the occurrence that IC influences health and disability.

Another outcome of this study were the mentioned pathways through which IC may influence health and disability. The most important pathway, as mentioned by the expert-professionals, appears to be that the IC itself may be a source of distress, which affects health and disability more or less directly. There is evidence that stress can affect the brain, cognition, and recovery[17,18]. The specific effects of stress emerge as a function of the timing and the duration of the exposure to stress[17]. That claimants may experience high levels of stress from IC schemes and that this experience is positively correlated with poor long-term recovery, was demonstrated in a recent Australian cohort study[18]. Also, central sensitization can play a role in this pathway, where distress can lead to more sensitisation and pain. However, underlying mechanisms are still unclear[19]. Similarly, biological markers to reliably and validly diagnose the structural effects of stress and sensitisation on an individual level are still lacking[19]. Secondly, IC may indirectly interfere with rehabilitation through reinforcing adverse patient behaviour impeding effective treatment. Apparently, the expected financial consequences from the IC can influence patients' behaviour. Patients who are striving for compensation may need to communicate poor health and disability, while at the same time they have to work on their recovery. This inherent conflict was also mentioned by Hadler in 1996. He wrote "the litigant is likely to lose the prerequisite skills for well-being… Inexorably, the litigant is drawn into the vulnerable state, too often never to return"[20]. The expert-professionals views were consistent with, but more nuanced than Hadler's[20]. Thirdly, patient characteristics can play a moderating role, determining patients' vulnerability for IC effects. This can also be related to the Communications model of Pain[21]. This model states that the experience of pain causes an internal reaction in the patient, which is influenced by intrapersonal and contextual factors[21]. This leads to verbal, non-verbal and behavioural expressions, which are influenced by the cognitions and emotions of the patients. It may be challenging for rehabilitation professionals and insurance workers to interpret these communications correctly. The internal reactions of patients are based on personal characteristics of the patient and his experiences with pain. Patients with a strong feeling of injustice and an external locus of control behave different from patients with an internal locus of control[22]. A questionnaire has been recently developed to measure perceive injustice, the Injustice Experience Questionnaire[23].

Further, this study explored how rehabilitation professionals tend to address IC in clinical practice, both with regard to diagnosis and treatment. It appeared that expert-professionals

assess whether, how and to what extent IC may influence the rehabilitation process and outcomes, primarily through interviews. However, whether interviews are a valid method is debatable, because they are not always structured and standardized[24]. The experts, nor the authors of this manuscript, are aware of a validated means of assessing the influence of IC on health and disability. Therefore, it is recommended that valid instruments to measure the influence of the IC in rehabilitation are developed.

If IC is deemed to relevantly influence the rehabilitation process and outcomes, the expert-professionals will discuss the possible effects of IC with their patients. However, this will not directly influence outcomes, because this does not solve any of the pathways identified. Furthermore, the IC can influence the professional views of the professional and can lead to self-fulfilling prophecies, in relation to the patient prognosis of health and disability[25]. The attitude of the patient can also lead to a self-fulfilling prophecy, if a patient does not change his behaviour in relation to the therapy goals, the therapy does not work[25]. Pessimistic expectancies of the patient can therefore be particularly self-fulfilling[25]. Professionals and patients can be made aware of this process through education. A recent quantitative study shows that procedural fairness of the compensation process is positively correlated with quality of life[8]. This study implicated that patients' quality of life can be improved by increasing the fairness of the compensation process and communicating more directly towards the patients[8].

A strength of this study is that we purposefully selected Dutch experts-professionals. All selected participants agreed to participate, and we created a balanced mix in field of occupation. Most participants had earned a Doctorate Degree, which in general involves extensive training in communication and argumentation[26]. Also, we used quotes to show that our results hold true and improve internal credibility. There are also some limitations. The tendency of people to favour information that confirms their beliefs (confirmation bias) could influence both researchers and experts-professionals in their opinions and can lead to biased results. Also, as this was a qualitative study, the outcomes should be interpreted as expert-opinions and arguments, but not as facts. We reached saturation on the main research questions. However, on some subthemes, such as the causal pathways and the influence of IC on rehabilitation, opinions differed widely. The underlying reasons for these differences are unknown and may be subject of further study. We only interviewed rehabilitation experts-professionals, so the results of this study cannot be (directly) generalized to patients and insurers. Also, we interviewed Dutch experts-professionals; the Dutch system differs from other countries in relation to rehabilitation and claim settings, which may also influence generalizability. The first author could be influenced by her own experience as a professional

in the field of physiotherapy. However, the other authors have different backgrounds and therefore improve the generalizability of the interpretations.

Recovery in WAD is multifactorial and not only the IC, but multiple environmental and personal factors can affect the health and disability[4,27]. Attention for the influence of the IC is one of the interests for rehabilitation professionals. In further research, attention should be paid to the empirical support of the pathways and validated means of assessing it, as well as recommendations for rehabilitation professionals to validly assess the influence of IC on health and disability.

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Chapter 8

General discussion

Six studies were conducted to gain better understanding of the role of functional capacity evaluation (FCE) and work ability in patients with chronic musculoskeletal pain (CMP). In this chapter the main findings of these studies are discussed. In addition, overarching methodological issues concerning these studies are considered, and implications and recommendations for future research are formulated.

Main findings

The systematic review (chapter 2) identified three instruments that could detect submaximal capacity in patients with CMP. The three instruments had a specificity, the ability of the instruments to correctly identify individuals who perform at submaximal effort, of 75% to 100%. One of the three instruments, was a FCE with was used with an observer trained to identify submaximal capacity.

In the second study (chapter 3), it was demonstrated that in patients with Whiplash Associated Disorder (WAD), correlations between NDI and FCE tests varied from Spearman rho = -0.39 to -0.70. Multivariate regression analysis showed that level of pain intensity was an important predictor of self-reported disability and functional capacity. Also, a pending insurance claim predicted higher levels of self-reported disability.

Testing reproducibility of hand-held dynamometry to test neck strength (flexion, extension, side bending) in healthy young adults, led to intraclass correlation coefficient values for intertester reliability from 0.75 to 0.87 (chapter 4). The results also showed that the mean differences of results between the assessors were not statistically significant.

The other three studies described in this thesis (chapters 5, 6 and 7) focused on work ability and vocational rehabilitation. The pilot randomized controlled trial (chapter 5) showed that in patients with CMP a brief cognitive intervention improved work ability in both the intervention (with the addition of short form FCE as intervention strategy) and control groups (without the short form FCE). The use of the short form FCE in addition to the cognitive intervention resulted in a slight, but non-significant increase in self-reported work ability. A cross-sectional study (chapter 6) aimed to analyze the relation between biopsychosocial factors and work ability in patients with CLBP or WAD. Associates of self-reported work ability (physical functioning and self-reported disability) were the same in patients with CLBP and WAD, but the amount of explained variance differed slightly (22% in CLBP and 30% in WAD).

Rehabilitation experts-professionals (chapter 7) acknowledged that injury compensation may affect rehabilitation, health, and disability in patients with WAD. They provided three possible causal pathways. Most professionals discuss the potential influence of injury

compensation with their patients. Some emphasise that their role is neutral in relation with the injury compensation. Others mention that financial consequences can accompany functional improvement.

Discussion

The studies in chapter 2 and 3 focused on the validity of the FCE in patients with CMP. As defined in terms of ICF, FCE aims to measure the capacity of an individual to execute activities in order to inform about work participation, while considering body functions and structures, environmental factors and personal factors[1,2]. Physical activity can be affected by pain, which can lead to a physiological response as explained in the pain adaption model[3]: the patient can perceive his pain as harmful and adjust his behavior[3,4]. It may, therefore, be important to detect submaximal capacity using a FCE, keeping in mind that the results of the FCE might be limited to a physiological pain response and/or that the behavior of the patient can play a role in the outcome of the tests. It has been suggested that illness behavior can be measured with Waddell signs, and that Waddell signs can be helpful to interpret FCE tests results[5]. Positive Waddell might be indicative for illness behavior[5]. However, the Waddell signs cannot be seen as a straightforward screening instruments for illness behavior[6]. Also, by example, central sensitization can be an explanation for pain behavior[7]. In chapters 3, 5 and 6 questionnaires were used to assess self-reported disability, work ability and health conditions. Self-report measures are the main way to gather this information, since certain health conditions cannot easily be observed directly[8]. One study (chapter 3) showed that patients report differently on self-reported disability (using the NDI) compared to their results during their FCE. Therefore, in order to capture a comprehensive picture of disability, it is necessary for clinicians and insurance companies to use both self-reported and capacity-based instruments[9]. In chapter 5 and 6 self-report work ability was used as main outcome. Other self-reported disability questionnaires were also used in study 5 and 6. This means that only a part of the patient's functioning was measured.

When patients are asked to report their symptoms, patients with the same symptoms can have different perceptions of these symptoms and might therefore complete questionnaire differently. This can in part be explained with the illness perceptions model[10,11]. A patient's illness perceptions can be regarded as a "personal factor" (ICF). That is why assessment and consideration of personal factors is also important, when interpreting individual self-report questionnaires.

Personal factors, and also environmental factors, are important when comparing the FCE test results with reference values, which was the case in the pilot RCT (chapter 4). Here,

the reference values helped to set personal rehabilitation goals. However, caution is advised, because reference values can also be used to give advice about return to work[12]. This can result in a loss of sick leave compensation benefits (an environmental factor) before patients are completely returned to work.

That injury compensation can influence health and disability, in both a negative as positive manner, was acknowledged by rehabilitation experts-professionals in chapter 7. Additionally, a systematic review showed that the relation between injury compensation and health can be ambiguous[13]. For example, compensation can lead to slower recovery, but is also possible that slower recovery can lead to compensation[13].

Within the field of rehabilitation, the concepts of functioning, (dis)ability and health are used[14]. The outcome measures used in our studies can be categorized within the domains of the (ICF) framework[14] (Figure 8.1). Submaximal capacity (as observed within the short form FCE) can be categorized within the "activities" domain (chapter 2). Neck strength (neck FCE) can be classified as "body functions and structures" (chapter 4). The FCE has a moderate correlation with self-reported ability (body functions and structures, activities and participation) as measured with the NDI (chapter 3).

In relation to vocational rehabilitation, work ability can be classified in the domain of "participation". The associates for work ability in patients with CLBP and WAD are physical functioning (measured with the subscale of the RAND-36) and self-reported disability (measured with the Pain Disability Index) (chapter 6), which can be classified within the domains of "activities" and "participation". Finally, a pending injury claim, which can be classified under the ICF domain "environmental factors", might influence self-reported

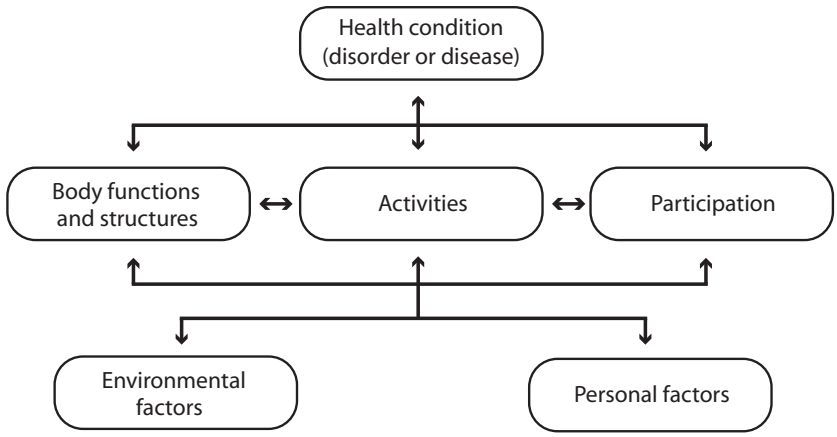

Figure 8.1 The International Classification of Functioning, Disability and Health model.

disability, health and rehabilitation (chapter 7). In conclusion, self-reported functioning, measured with NDI and Pain Disability Index cannot be classified in a single domain of the ICF. The other main measures in this thesis can each be categorized in a single domain of the ICF.

Methodological considerations

The studies in this thesis have several methodological strengths that warrant discussion. In a high quality systematic review (chapter 2) instruments to detect submaximal capacity, including the FCE, were critically assessed on their methods and psychometric properties. Another strong point is that well known and widely used instruments were used to measure (self-reported) (dis)ability in the clinical studies. The results of chapter 3 and 6 are generizable to different rehabilitation settings, because patients with CMP were included from a commercial work assessment organisation and various rehabilitation settings throughout the Netherlands. Also, not only patients were measured, but also opinions of experts-professionals in rehabilitation of patients with WAD were systematically gathered. Further, the possible causal pathways described in chapter 7 can help start new lines of research.

A few weaknesses in this thesis should also be considered. Two cross-sectional designs were used (chapters 3 and 6), which prohibit the investigation of causal relationships. With longitudinal designs, stronger evidence can be found for the relation between functional capacity and self-reported disability and the relation between work ability and biopsychosocial factors than with cross-sectional designs. In chapter 4, only healthy persons were involved, which limits generalizability to patients with CMP. In the pilot randomized controlled trial (chapter 5), the sample size was too small to test the added benefit of the FCE to a brief cognitive behavioral intervention. Finally, Dutch patients were assessed. Among others, the Dutch health care and social compensation system differs from other countries with regard to rehabilitation and claim settings (environmental factors), and it is unclear whether all our results are generalizable to other countries. For example, the mean capacity results of FCE were found to be higher in Dutch samples, than in Swiss and Canadian samples, and it is suggested that this difference may in part be explained by difference in environmental factors[15]. Dutch study samples were used in chapter 3-7.

Theoretical considerations

To measure functional capacity correctly, validity is one of the important measurement properties. Validity concerns the ability to measure what one intends to measure. In chapters

2 and 3, the *criterion* validity and *concurrent* validity of the FCE were measured, while in chapter 4, the reproducibility of one part of the FCE was measured. In relation to *criterion* validity, submaximal capacity can be detected with a FCE by means of an observer (chapter 2). However, in studies of good methodological quality, the specificity of the FCE to detect submaximal performance compared to a reference standard, varied between 75% and 100%, meaning that some patients can receive a false positive conclusion of performing submaximally. There is no consensus regarding the level of acceptable cutoff values for specificity. For this reason, among others, the interpretation that a patient performed at submaximal capacity should be made carefully.

Concurrent validity is the extent to which a test is associated with other tests that are presumed to measure the same construct[16,17]. In chapter 3, functional capacity was associated with self-reported disability. Based on the results of this study, both self-reported disability and a performance based test are recommended in order to obtain a complete assessment of patients with WAD. This is also in line with the ICF, where disability and activity are two terms defined in different ways[1,14].

Reproducibility concerns the degree to which repeated measurements in stable study subjects provide similar results, and is usually an umbrella term for the concepts of reliability and agreement. In chapter 4, the inter-tester reliability and agreement of testing the strength of neck muscles by means of hand-held dynamometry in healthy young adults was tested. The intraclass coefficients were all above 0.75, showing satisfactory inter-tester reliability[18]. However, the measurement error at assessor level often exceeded 10%, so clinical changes in patients cannot be observed accurately if the patient is measured by different assessors[19]. In patients with neck pain, lower reliability measures were shown than in persons without pain[20]; the explanation for this can be that persons without pain show less variability in their test results. The results can indicate that a person's capacity can change over time and it is recommended that it is to be tested by a single assessor rather than multiple assessors.

Clinical implications

The results of this thesis can be helpful for the practice of rehabilitation. Based on the results of the studies five clinical implications are described, three regarding the assessment of patients with CMP and two regarding treatment options.

1. Because self-reported disability and functional capacity are related, but different constructs, rehabilitation professionals are advised to measure both self-reported disability and functional capacity to assess a patient's disability more comprehensively.

2. During clinical examinations or examinations for injury compensation claims, patients can perform submaximally. Trained observers can rate effort levels based on a rating scale. Another study showed that unfamiliar testing environment, fear of pain and/or (re)injury, depression, work satisfaction, self-reported disability, motivation, and pain intensity might influence maximum capacity[21] and thus might affect the tests results.
3. Professionals assess, whether injury compensation may affect rehabilitation, health and disability in patients with WAD. However, caution is needed because of the unknown reliability and validity of the assessment. It is important for professionals to realise that currently there is no validated means to assess the influence of injury compensation on rehabilitation, health and disability. Professionals should be aware that their assessment can be subject to (a currently unknown amount of) measurement error.
4. Chapter 6 showed that the associates of work ability in patients with CLBP and WAD are physical functioning and self-reported disability and not pain-related factors. These results imply that patients with CLBP and WAD can be treated in a similar multidisciplinary rehabilitation program aimed at improving work ability. However, 70 to 78% of the variance of work ability is still unexplained. Besides improving physical functioning and decreasing self-reported disability, other components, for example personal components, should be added to the rehabilitation program to improve work ability.
5. The use of a short FCE as an intervention strategy might have added value in addition to a brief cognitive intervention to improve work ability in rehabilitation. If the results of this pilot RCT are confirmed in a full scale trial, then comparing the performance of the short form FCE with reference values[22] and the influence of pain can be discussed with the patient. Further, depending on the magnitude of the added effects, functional training activities might be added based on the results of the FCE.

Societal implications

Patients with CMP who seek compensation for economic and non-economic losses can be tested to determine whether they are eligible for injury compensation and their ability to return to work. During testing, the detection of submaximal capacity can be difficult and decisions can have implications with regard to welfare benefits. There are several external variables that may influence capacity and/or performance[21] as mentioned above. Therefore, the FCE tests have to be performed by trained observers, who are capable of assessing physical capacity and are trained in taking external variables into account. However, the FCE does not aim to reflect a comprehensive assessment of all related factors that comprise

work-related (dis)ability. Therefore, in FCE assessments which might have an impact on a patient's welfare benefits, observers have to carefully write down their conclusions.

As the cross-sectional study in chapter 3 showed, functional capacity and self-reported disability are related but different constructs. Rehabilitation expert-professionals opinions stated that patients seeking injury compensation can influence rehabilitation (chapter 7). However, two cross-sectional studies (chapter 3 and 6) demonstrated that a pending claim is not associated with work ability and functional capacity, but is associated with self-reported disability. Although, there is no strong evidence for the influence of injury compensation on health-related outcomes, it might be valuable for third parties, such as personal injury specialists, to discuss the potential negative effects of injury compensation claims with individual patients.

The pilot RCT (chapter 5) showed that a brief intervention can improve patient's work ability. That is promising for societal, because the intervention costs less than ten hours therapist time and can therefore be seen as a low cost intervention in comparison to multidisciplinary rehabilitation.

Recommendations for further research

The clinimetric properties of neck muscle strength testing have not been studied extensively[23], and also reliability and agreement parameters are often not adequately reported[24]. So, to test and interpret neck strength in patients with CMP accurately, more well-designed studies have to be performed.

The pilot RCT showed a small effect of adding a FCE to the standard brief cognitive behavioral intervention. Therefore a sufficiently powered full-scale trial is recommended. A cost-effectiveness analysis should be included to analyze whether the small benefit of adding a short-form FCE will be worth the extra costs.

Vocational rehabilitation can differ for patients with CLBP and WAD. The results of chapter 6 imply that interventions do not specifically have to be targeted at subgroups of patients according to the pain- related factors measured. Future longitudinal studies which include subgroups of patients with CLBP and WAD can provide more insight into the long term effects of rehabilitation for work ability. Potential differences in improved work ability for subgroups should be identified.

In chapter 7 three pathways were identified through which injury compensation may influence health and disability: injury compensation related distress, rehabilitation impeding behavior, and patient characteristics. These pathways were mentioned by expert-professionals

and are partly supported by scientific literature. Injury compensation related distress can influence recovery negatively[25,26], however the evidence is not strong and the magnitude of the influence is deemed modest. The evidence for the influence of an injury compensation claim on behavior[27] and the influence of patient characteristics is low to moderate[28,29]. Further research into these pathways is warranted. For example, measurements to objectify injury compensation related distress could be developed. Clinicians could use new clinimetrically sound assessments to objectify the influence of a pending claim on health and rehabilitation.

Final conclusions

The main objective of this thesis was to gain a better understanding of the role of functional capacity evaluation and work ability in patients with CMP. The first focus was on the validity and reproducibility of components of the FCE. This thesis showed that self-reported disability differs from functional capacity in patients with WAD and that the detection of submaximal capacity can be made with the help of a FCE and an observer. These findings add to the developments of FCE, and provided added insights into the construct of disability. The second focus was on vocational rehabilitation. For the assessment of patients with CMP, professionals have to assess both self-reported disability and functional capacity to obtain a complete understanding of the functioning of their patient. If a patient has a pending injury compensation claim, professionals need to carefully consider the possible effect of injury compensation on rehabilitation and health. With regard to interventions, it seems that in relation to work ability, patients with CLBP and WAD can partly be given the same rehabilitation program to improve work ability. Added insights were developed indicating that a brief intervention may yield beneficial effects, but this should be tested in a full-scale trial.

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SUMMARY

Chronic musculoskeletal pain can be a disabling condition. It is a common problem; across Europe one in five adults experiences chronic pain. Some patients do not recover and may experience problems in many life domains. The reasons for this can be diverse and not clear. Obstacles for recovery can be biomedical, psychological, socioeconomic or occupational. In patients with chronic low back pain (CLBP) no well-defined aetiology is found. In patients with chronic whiplash associated disorders (WAD) the pain is primarily located in the neck and caused by an acceleration-deceleration trauma. Symptoms in patients with WAD, besides pain, can include dizziness and concentration problems. The pain is a common factor in both patients with CLBP and WAD, both referred to as chronic non-specific musculoskeletal pain (CMP). Typically, these patients can have limitations in work participation. In a biopsychosocial context, functional capacity and work ability tests are used to measure a person's ability to work. Functional Capacity Evaluation (FCE) is defined as an evaluation of capacity or activities, and 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. Work ability is primarily a question of a balance between work demands and personal resources. There are multiple scientific gaps with regard to functional capacity and work ability in patients with CMP. Therefore, the main aim of this thesis was to obtain a better understanding of the role of functional capacity and workability in patients with CMP both with regard to the validity and reproducibility of the FCE as well as for rehabilitation interventions that facilitate work ability (vocational rehabilitation). We performed six studies; the first three studies (chapter 2-4) were related to validity and reproducibility of the FCE and the second three (chapter 5-7) about vocational rehabilitation.

In **chapter 1** the theoretical framework for this thesis is provided. Also, six research questions are introduced and formulated.

In **chapter 2** a systematic review is described that evaluates the validity of instruments that claim to be able to detect submaximal capacity when maximal capacity is requested in patients with chronic nonspecific back pain. Included studies were rated according to the subscales "criterion validity" and "hypothesis testing" of the COSMIN checklist. A Best Evidence Synthesis was performed. Seven studies were included, five of which used a reference standard for submaximal capacity. Results showed that three studies were of good methodological quality and validly detected submaximal capacity with specificity rates between 75% and 100%. To conclude, there is strong evidence that submaximal capacity can be detected in patients with chronic low back pain with a lumbar motion monitor or visual observations accompanying a FCE lifting test.

In **chapter 3** a cross-sectional study is presented where the relationship between self-reported disability and functional capacity and its predictors in patients with WAD have been investigated. Self-reported disability was assessed with the Neck Disability Index (NDI), while functional capacity was assessed with a six-item neck FCE. Forty patients on sick leave were measured. Their mean age was 33 years and median duration of complaints was 12 months. Correlations between NDI and FCE tests varied from -0.39 to -0.70. Independent predictors of NDI were pain intensity and a pending claim. Independent predictors of FCE were NDI, gender, and pain intensity. The conclusion is that self-reported disability and functional capacity are related but different. Both can partly be predicted by pain intensity. A pending claim is associated with higher self-reported disability. Both constructs are complementary and are recommended to comprehensively determine disability in patients with WAD.

The study described in **chapter 4** investigates the reproducibility of neck muscles strength testing with hand-held dynamometry. Twenty healthy young adults were tested twice by two assessors. Assessors and participants were blinded for the results. Mean differences between assessors for isometric neck strength (flexion, extension, side bending) were calculated. Intertester reliability and agreement were expressed as intraclass coefficient (ICC) and limits of agreement (LoA). The results showed that the mean differences in measured neck muscle strength between the assessors varied between 1.6 and 7.6 Newton and were statistically non-significant. ICC values ranged from 0.75 to 0.87. LoA ranged from -40 to 56 Newton. The measurement error at assessor level was substantial. The conclusion is that reproducibility of hand-held dynamometry to test neck strength in healthy young adults is satisfactory at group level.

In **chapter 5** a pilot randomized controlled trial is described that aimed to assess whether adding a Short-Form FCE to a brief cognitive behavioral intervention could improve work ability. Eleven patients with chronic musculoskeletal pain were included, five in the experimental group and six in the control group. The control group received a cognitive behavioural intervention, which consisted of six treatment sessions in 16 weeks' time. The experimental group received the same intervention, but it was extended with a Short-Form FCE at baseline. The main outcome was self-reported work ability (score 0-10). Clinical relevance was defined as >1.5 points improvement from baseline and a difference in effect of 1.5 points between groups. The intervention group improved on average 3.2 points (SD 2.05) and the control group improved on average 2.5 points (SD 2.35). So, the addition of Short-Form FCE improved work ability with 0.7 points (95%CI -2.34; 3.74). Concluding, in both groups work ability improved relevantly. Feasibility has been established. However, clinical relevance of the addition of a Short-Form FCE is unconvincing.

In **chapter 6** a cross-sectional study is presented that aimed to determine to what extend work ability is associated with pain, pain interference, pain catastrophizing, self-reported disability, quality of life and claim status in patients with WAD and CLBP. The study was performed in three rehabilitation centers in the Netherlands. Patients aged 18 to 66 years, referred to a rehabilitation physician, were included when they had a diagnosis of CLBP or WAD and had pain for more than three months. Self-reported work ability was measured by the single-item of the Work Ability Index: "current work ability in comparison with the lifetime best". The score ranges from 0 to 10, with higher scores indicating higher work ability. Multivariate linear regression analyses were performed to identify independent associates of work ability. In total 438 patients were included. Results showed that independent associates for both CLBP and WAD were physical functioning and self-reported disability, which explained 22% of the variance in work ability for patients with CLBP and 30% of the variance in patients with WAD. All other variables did not contribute significantly to the regression models. Concluding, the associates of work ability in patients with CLBP and WAD are the same (physical functioning and self-reported disability), but the amount of explained variance is different.

In **chapter 7** a qualitative study is described to explore rehabilitation professionals' opinions about the influence and pathways of injury compensation (IC) on health and disability in patients with WAD. Therefore, semi-structured interviews were performed among a purposeful selected sample of Dutch expert-professionals in the field of rehabilitation of patients with WAD. Inclusion continued until saturation was reached. Inductive and deductive thematic analyses were performed. Ten rehabilitation expert-professionals (five females), working as physician, psychologist or physiotherapist, were interviewed. All expert-professionals acknowledged that IC can influence rehabilitation, health and disability. The expert-professionals provided three causal pathways; a pathway through prolonged distress, a behavioral pathway, and patient characteristics that may either attenuate or worsen their response. They assess the influence of IC mainly with interview techniques. Most professionals discuss the potential influence of IC with their patients, because they want to give clear information to the patient. Some emphasise that their role is neutral in relation with the IC. Others mention that financial consequences can influence functional improvement. To conclude, rehabilitation expert-professionals believe that IC may affect rehabilitation, health and disability in patients with WAD. Three pathways are mentioned by the experts-professionals.

In **chapter 8** the main results of this thesis are summarized, overarching methodological issues concerning these studies are considered, and implications and recommendations for future research are formulated.

The first focus was on the validity and reproducibility of the FCE. This thesis showed that self-reported disability differs from functional capacity in patients with WAD and that the detection of submaximal capacity can be made with the help of a FCE and an observer. These findings add to the developments of FCE, and provided added insights into the construct of disability.

The second focus was on vocational rehabilitation. For the assessment of patients with CMP, professionals have to assess both self-reported disability and functional capacity to obtain a complete understanding of the functioning of their patient. If a patient has a pending injury compensation claim, professionals need to carefully consider the possible effect of injury compensation on rehabilitation, disability and health. With regard to interventions, it seems that in relation to work ability, patients with CLBP and WAD can partly be given the same rehabilitation program to improve work ability. Two strong points of this thesis are that well known and widely used instruments were used to measure (self-reported) (dis)ability in the clinical studies. The results of chapter 3 and 6 are generizable to different rehabilitation settings, because patients with CMP were included from a commercial work assessment organisation and various rehabilitation settings throughout the Netherlands. A few weaknesses of this thesis are that two cross-sectional designs were used, which prohibit the investigation of causal relationships. Also, Dutch patients were assessed and the Dutch health care and social compensation system differs from other countries with regard to rehabilitation and claim settings (environmental factors), it is unclear whether these results are generalizable to other countries.

Future longitudinal studies which include subgroups of patients with CLBP and WAD can provide more insight into the long term effects of rehabilitation for work ability. Further, the pathways in chapter 7 should be investigated and could lead to the development of reliable and valid assessments of the influence of a pending injury claim on health and rehabilitation.

SAMENVATTING

Chronische musculoskeletale pijn kan tot grote beperkingen leiden. Het komt veel voor; één op de vijf volwassenen in Europa ervaart chronische pijn. Een deel van de patiënten herstelt niet en kan problemen ervaren in vele levensdomeinen. De redenen hiervoor zijn divers en vaak onduidelijk. Belemmeringen voor functieherstel kunnen biomedisch, psychologisch, socio-economisch en werkgerelateerd zijn. Bij patiënten met chronische lage rugpijn (CLBP) is er meestal geen duidelijke oorzaak bekend. Bij patiënten met whiplashgerelateerde klachten (WAD) zit de pijn voornamelijk in de nek en wordt deze in eerste instantie in verband gebracht met een acceleratie-deceleratie ongeluk. Patiënten met whiplash kunnen naast pijn ook last hebben van duizeligheid en concentratieproblemen. CLBP en WAD worden beide geclassificeerd als chronische aspecifieke musculoskeletale pijn (CMP) en deze patiënten kunnen beperkingen ervaren in hun werkparticipatie. In een biopsychosociale context worden testen voor het bepalen van fysieke capaciteit en werkvermogen gebruikt om het vermogen van een persoon om te werken te meten. Functionele Capaciteit Evaluatie (FCE) is gedefinieerd als een evaluatie van capaciteiten en wordt gebruikt om aanbevelingen te doen voor participatie in werk, waarbij factoren op functieniveau, omgevingsniveau, persoonlijk niveau en gezondheidsstatus worden meegenomen. Werkvermogen is een balans tussen werkeisen en persoonlijke hulpbronnen. Er zijn kennishiaten omtrent (het meten van) fysieke capaciteit en werkvermogen bij patiënten met CMP. Daarom is het hoofddoel van dit proefschrift om een beter inzicht te krijgen in de rol van fysieke capaciteit en werkvermogen bij patiënten met CMP. Dit hoofddoel is zowel gerelateerd aan validiteit en reproduceerbaarheid van de FCE, alsmede aan revalidatiebehandelingen die werkvermogen beïnvloeden. In dit proefschrift worden 6 studies beschreven; de eerste drie studies (hoofdstuk 2-4) over de validiteit en reproduceerbaarheid van de FCE, en de volgende drie studies (hoofdstuk 5-7) over arbeidsgerelateerde revalidatie.

In **hoofdstuk 1** wordt het theoretische raamwerk van dit proefschrift gegeven en worden de zes onderzoeksvragen geïntroduceerd en geformuleerd.

In **hoofdstuk 2** is een systematische review beschreven over de validiteit van instrumenten die claimen dat ze bij patiënten met chronische aspecifieke rugpijn submaximale capaciteit kunnen vaststellen wanneer een maximale capaciteit wordt gevraagd. De geïncludeerde studies werden gescoord met de subschalen "criterion validity" en "hypothesis testing" van de COSMIN checklist. Een Best Evidence Synthese werd uitgevoerd. Zeven studies werden geïncludeerd, waarvan vijf een referentiestandaard hadden om submaximale capaciteit vast te stellen. Resultaten lieten zien dat drie studies van goede methodologische kwaliteit submaximale capaciteit valide kunnen vaststellen met specificiteitwaardes tussen de 75 en

100%. Concluderend, er is sterk bewijs dat submaximale capaciteit kan worden vastgesteld in patiënten met chronische lage rugpijn met een lumbale bewegingsmonitor of met een fysieke capaciteit tiltest, samen met visuele observaties.

Hoofdstuk 3 beschrijft een cross-sectionele studie waarbij bij patiënten met WAD de relatie tussen zelfgerapporteerde beperkingen en fysieke capaciteit en de voorspellers daarvan wordt onderzocht. Zelfgerapporteerde beperkingen werden gemeten met de Neck Disability Index (NDI) en fysieke capaciteit met de uit zes onderdelen bestaande nekgerelateerde FCE. Veertig patiënten die zich arbeidsongeschikt hadden gemeld werden gemeten. De gemiddelde leeftijd was 33 jaar en de mediane duur van de klachten was 12 maanden. Correlatiecoëfficiënten tussen NDI en FCE varieerden van -0,39 tot -0,70. Onafhankelijke voorspellers van de NDI waren pijnintensiteit en een letselschadezaak. Onafhankelijke voorspellers van de FCE waren NDI, geslacht en pijnintensiteit. De conclusie is dat zelfgerapporteerde beperkingen en fysieke capaciteit zijn gerelateerd, maar verschillend zijn. Beide worden gedeeltelijk door de pijnintensiteit voorspeld. Een letselschadezaak voorspelt een hogere mate van zelfgerapporteerde beperkingen. Beide constructen en instrumenten zijn aanvullend en worden aangeraden om bij patiënten met WAD toe te passen om de activiteiten en beperkingen zo uitgebreid mogelijk te onderzoeken.

In **hoofdstuk 4** was het doel om de reproduceerbaarheid van het meten van nekspierkracht met een dynamometer vast te stellen. Twintig jong-volwassenen werden twee keer onderzocht door twee testers. Testers en proefpersonen waren de tweede sessie geblindeerd voor de resultaten van de eerste sessie. Het gemiddelde verschil tussen de testers voor isometrische nekkracht (flexie, extensie, zijwaarts buigen) werd uitgerekend. Intertesterbetrouwbaarheid en -overeenstemming werden uitgedrukt in een intraclasscoëfficiënt (ICC) en de limits of agreement (LoA). De resultaten lieten zien dat het gemiddelde verschil in gemeten nekkracht tussen de testers varieerde tussen de 1,6 en 7,6 Newton; dit was statistisch niet significant. ICC-waardes varieerden van 0,75 tot 0,87. LoA varieerde tussen -40 en 56 Newton. De meetfout bij de testers was substantieel. De conclusie is dat de reproduceerbaarheid van de dynamometer om nekkracht te testen bij gezonde jong-volwassenen voldoende is op groepsniveau.

In **hoofdstuk 5** wordt een pilot gerandomiseerd onderzoek beschreven waarbij onderzocht werd of de toevoeging van een korte FCE werkvermogen verbetert bij patiënten die een korte cognitief-gedragsmatige behandeling ondergaan. Elf patiënten met chronische musculoskeletale pijn werden geïncludeerd, vijf in de interventiegroep en zes in de controlegroep. De controlegroep ontving een cognitief-gedragsmatige behandeling, die bestond uit zes behandelingen in 16 weken tijd. De interventiegroep ontving dezelfde behandeling, maar dit werd uitgebreid met een korte FCE tijdens de beginmeting. De

hoofduitkomst was zelfgerapporteerd werkvermogen (score 0-10). Klinische relevantie werd gedefinieerd als >1,5 punt vooruitgang vanaf de beginmeting en een verschil in effect van minimaal 1,5 punt tussen de groepen. Resultaten lieten zien dat beide groepen vooruit zijn gegaan. De interventiegroep ging gemiddeld 3,2 punten (SD 2,05) vooruit en de controlegroep 2,5 punten (SD 2,35). Door de toevoeging van een korte FCE verbeterde het werkvermogen extra met 0,7 punten (95% BI -2,34; 3,74). Concluderend, in beide groepen nam het werkvermogen relevant toe. Haalbaarheid is aangetoond, echter de klinische relevantie van de toevoeging van de FCE is niet overtuigend.

Hoofdstuk 6 beschrijft een cross-sectionele studie die als doel had om te bepalen in welke mate werkvermogen is gerelateerd aan pijn, pijninterferentie, pijn catastroferen, zelfgerapporteerde beperkingen, kwaliteit van leven en het hebben van een schadeclaim. De studie werd uitgevoerd in drie revalidatiecentra in Nederland. Patiënten tussen de 18 en 66 jaar, verwezen naar een revalidatiearts, werden geïncludeerd wanneer ze een diagnose van CLBP of WAD hadden en langer dan drie maanden pijn hadden. Zelfgerapporteerd werkvermogen werd gemeten met één vraag uit de Work Ability Index: "Veronderstel dat uw werkvermogen in de beste periode van uw leven een waarde van 10 punten bedroeg. Hoeveel punten zou u dan aan het huidige werkvermogen toekennen?" De score loopt van 0-10, waarbij een hogere score een beter werkvermogen betekent. Multivariate lineaire regressie werd uitgevoerd om associaties met werkvermogen te identificeren. In totaal werden 438 patiënten geïncludeerd. Resultaten lieten zien dat fysiek functioneren en zelfgerapporteerde beperkingen geassocieerd zijn met zowel CLBP als WAD; ze verklaarden 22% van de variantie in werkvermogen bij patiënten met CLBP en 30% bij patiënten met WAD. Concluderend, de associaties van werkvermogen bij patiënten met CLBP en werkvermogen zijn hetzelfde (fysiek functioneren en zelfgerapporteerde beperkingen), maar de hoeveelheid verklaarde variantie is verschillend.

Hoofdstuk 7 beschrijft een kwalitatief onderzoek met als doel de mening van revalidatie-professionals te exploreren over de invloed en mogelijke verklaringsmodellen van een letselschadezaak op gezondheid en beperkingen bij patiënten met WAD. Daarvoor zijn semigestructureerde interviews uitgevoerd bij doelgericht geselecteerde Nederlandse expert-professionals op het gebied van revalidatie bij patiënten met WAD. Er werd geïncludeerd tot saturatie bereikt was. Er werd een inductieve en deductieve thematische analyse uitgevoerd. Tien revalidatie-expert-professionals (vijf vrouwen), werkend als revalidatiearts, psycholoog of fysiotherapeut, werden geïnterviewd. Alle expert-professionals erkenden dat een letselschadezaak revalidatie, gezondheid en beperkingen kan beïnvloeden. De expert-professionals kwamen met drie verklaringsmodellen: een verklaringsmodel

waarin distress de onderhoudende factor is, een gedragsmatig verklaringsmodel en de overtuiging dat patiëntkarakteristieken het gedrag van patiënten zowel positief als negatief kunnen beïnvloeden. Ze onderzoeken de invloed van letselschadezaken voornamelijk met interviewtechnieken. De meeste expert-professionals bediscussiëren de mogelijke invloed van de letselschadezaak met hun patiënten, omdat ze hun patiënten heldere informatie willen geven. Sommige expert-professionals geven aan dat ze een neutrale rol innemen in relatie tot de letselschadezaak. Anderen geven aan dat functionele vooruitgang financiële consequenties kan hebben. Concluderend, revalidatie-expert-professionals zijn van mening dat letselschadezaken revalidatie, gezondheid en beperkingen kunnen beïnvloeden bij patiënten met WAD. De expert-professionals noemen drie verklaringsmodellen.

In **hoofdstuk 8** worden de belangrijkste resultaten van dit proefschrift samengevat. Verder worden overkoepelende methodologische zaken rondom de studies besproken en implicaties en adviezen voor verder onderzoek geformuleerd. De eerste focus was op de validiteit en reproduceerbaarheid van de FCE. Dit proefschrift toont aan dat zelfgerapporteerde beperkingen verschillen van fysieke capaciteit bij patiënten met WAD en dat de detectie van submaximale capaciteit gedaan kan worden met hulp van een FCE en een observant. Deze bevindingen zijn een toevoeging op de ontwikkeling van de FCE en geven een toegevoegd inzicht in het (meten van het) construct van beperkingen.

De tweede focus was op arbeidsgerelateerde revalidatie. Voor inschatten van de mogelijkheden en beperkingen van patiënten met CMP is het belangrijk dat clinici zowel zelfgerapporteerde beperkingen als fysieke capaciteit onderzoeken om een compleet beeld te krijgen van het functioneren van deze patiënten. Als een patiënt een letselschadezaak heeft, is het van belang dat de clinicus het mogelijke effect van een letselschadezaak schat met betrekking tot de revalidatie en gezondheid van de patiënt. Bij behandelingen, gerelateerd aan werkvermogen, kunnen patiënten met CLBP en WAD gedeeltelijk hetzelfde behandelprogramma krijgen.

Twee sterke punten van dit proefschrift zijn dat bekende en wereldwijd gebruikte meetinstrumenten gebruikt werden om zelfgerapporteerde beperkingen te meten in de klinische studies. De resultaten van hoofdstuk 3 en 6 zijn generaliseerbaar naar verschillende revalidatiesettingen, omdat patiënten met CMP zijn geïncludeerd uit zowel een commerciële arbeidsrevalidatiesetting als van verschillende revalidatiecentra in Nederland. Een zwak punt is dat twee cross-sectionele studies zijn gebruikt, waardoor er geen oorzakelijke relaties vastgesteld kunnen worden. Ook zijn Nederlandse patiënten onderzocht en de Nederlandse zorg en het sociale systeem verschillen van andere landen in relatie tot revalidatie en claimsituaties (omgevingsfactor). Het is daarom onduidelijk in hoeverre deze resultaten generaliseerbaar zijn naar andere landen.

Toekomstige longitudinale studies, waarbij subgroepen van patiënten met CLBP en whiplash worden geïncludeerd, kunnen meer inzicht geven in het langetermijneffect van revalidatie op werkvermogen. Verder kunnen de genoemde verklaringsmodellen uit hoofdstuk 7 de basis vormen voor verder wetenschappelijk onderzoek. Dit zou moeten leiden tot nieuwe betrouwbare en valide meetinstrumenten om de invloed van letselschadezaken op revalidatie en gezondheid te meten.

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Sinds augustus 2013 werk ik bij Hogeschool Saxion. André Bieleman, als student fysiotherapie heb ik patiënten gemeten voor jouw promotieonderzoek. Fijn dat we nu als collega's samenwerken op het vlak van Arbeid & Gezondheid. Ik heb bij Saxion de kans gekregen om onderwijs te ontwikkelen op het gebied van pijneducatie en zelfmanagement. Govert Verhoog, bedankt dat je me deze kans gegeven hebt en alle collega's bedankt met wie ik dit onderwijs heb mogen ontwikkelen. Remko Soer en Sander van der Water, bedankt voor het kritisch meekijken bij de laatste hoofdstukken van mijn proefschrift. En Jeanette en Irene, als carpoolcollega's kunnen we heerlijk over werk en andere zaken praten. Irene, veel succes met jouw laatste loodjes van je proefschrift.

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CURRICULUM VITAE

Suzan van der Meer werd op 4 januari 1983 geboren in Doetinchem. Na het afronden van het Atheneum ging ze fysiotherapie studeren in Enschede. Nadat ze haar diploma hiervan ontving in 2005, ging ze als fysiotherapeut werken bij Fysiotherapie de Eekmaat in Glanerbrug. Hier kreeg ze de kans om de Master Fysiotherapiewetenschap te volgen te Utrecht, waar zij in 2009 cum laude afstudeerde. Ze ging daarna als fysiotherapeut en fysiotherapiewetenschapper werken bij Condite, een organisatie gespecialiseerd in advies bij ziekteverzuim. Hier kreeg ze de mogelijkheid om wetenschappelijk onderzoek uit te voeren, wat in april 2011 officieel werd omgezet in een promotieonderzoek. In 2013 heeft ze kort als fysiotherapeut gewerkt in revalidatiecentrum de Tolbrug. Vanaf augustus dat jaar kwam ze in dienst als docent/onderzoeker fysiotherapie bij Saxion Hogeschool. Hier geeft ze les aan alle leerjaren fysiotherapie en de Master Arbeid & Gezondheid. Voor het derde leerjaar heeft ze onderwijs ontwikkeld op het gebied van pijneducatie en zelfmanagement. Ze woont met haar vriend in Arnhem. In haar vrije tijd speelt ze hockey.