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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 20–55 % 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.

Keywords Whiplash injuries · Neck pain · Chronic pain · Sick leave · Disability evaluation

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 20–40 % 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 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]. FCE's are applied in rehabilitation and insurance medicine [3]. The Neck Disability Index (NDI) measures

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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 was 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 to 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 (25e and 75e 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 (IBM Corporation, New York, USA, 2012). 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 70 % of the patients and 75 % had a pending compensation claim. Ranges in NDI and FCE tests varied widely (Table 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 2). At item level correlations ranged from $r = 0.03$ to $r = -0.72$. (Table 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. 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.

Table 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

KgF kilogram force

[#] Median and Inter Quartile Range

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.

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

Table 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	Headaches	Concentration	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*	-0.050*	-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

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, 5 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

Table 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 ^{2a}
NDI	Constant	10.5		0.43
	Pain intensity ^b	1.40	0.54 to 2.26	
	Claim pending ^c	7.35	3.05 to 11.6	
Overhead lifting test	Constant	26.6		0.44
	NDI	−0.39	−0.68 to −0.10	
	Gender ^d	−9.02	−13.2 to −4.83	
Front carry test	Constant	68.9		0.55
	NDI	−1.10	−1.68 to −0.51	
	Gender ^d	−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 ^b	−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 ^b	−6.54	−12.9 to −0.11	

NDI Neck Disability Index

^a r² is calculated for the full model

^b Pain intensity was measured with NRS scale (0–10), 0 = no pain, 10 = maximal pain

^c Not having a claim pending was the reference category

^d Male gender was the reference category

recommended in order to obtain a comprehensive picture of disability in patients with WAD.

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