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Active Therapy for Chronic Low Back Pain

Part 3. Factors Influencing Self-Rated Disability and Its Change Following Therapy

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Design. Cross-sectional analysis of the factors influencing self-rated disability associated with chronic low back pain and prospective study of the relationship between changes in each of these factors and in disability following active therapy.

Objectives. To examine the relative influences of pain, psychological factors, and physiological factors on self-rated disability.

Summary of Background Data. In chronic LBP, the interrelationship between physical impairment, pain, and disability is particularly complicated, due to the influence of various psychological factors and the lack of unequivocal methods for assessing impairment. Investigations using new ''belief'' questionnaires and ''sophisticated'' performance tests, which have shown promise as discriminating measures of impairment, may assist in clarifying the situation. Previous studies have rarely investigated all these factors simultaneously.

Methods. One hundred forty-eight patients with cLBP completed questionnaires and underwent tests of mobility, strength, muscle activation, and fatigability, and (in a subgroup) erector spinae size and fiber size/type distribution. All measures were repeated after 3 months active therapy. Relationships between each factor and self-rated disability (Roland and Morris questionnaire) at baseline, and between the changes in each factor and changes in disability following therapy, were examined.

Results. Stepwise linear regression showed that the most significant predictors of disability at baseline were, in decreasing order of importance: pain; psychological distress; fear-avoidance beliefs; muscle activation levels; lumbar range of motion; gender. Only changes in pain, psychological distress, and fear-avoidance beliefs significantly accounted for the changes in disability following therapy.

Conclusion. A combination of pain, psychological and physiological factors was best able to predict baseline disability, although its decrease following therapy was determined only by reductions in pain and psychological variables. The active therapy programm—in addition to improving physical function—appeared capable of modifying important psychological factors, possibly as a result of the positive experience of completing the prescribed exercises without undue harm. [Key words: chronic low back pain, muscle function, muscle structure, range of motion, coping strategies, fear-avoidance beliefs, psychological distress, active therapy] **Spine 2001; 26:920–929**

The important distinction between physical impairment, defined as objective structural/physiological limitation, and disability—the resulting loss of function—has been highlighted by a number of authors.[34,43,67] Disability is a good clinical assessment of severity in low back disorders[70] and is a strong determinant of return-to-work or ''work-readiness.''[48] One might expect that an individual's disability would be strongly determined by his/her level of physical impairment, but in the case of chronic low back pain (cLBP), the relationship between these two variables is exceedingly complicated. This is not only the result of the confounding influence of various cognitive and affective factors on self-ratings of disability, but also the consequence of insufficient unequivocal methods for assessing physical impairment. In contrast to the situation for the extremities, in which the quantification of impairment is assisted by comparison with an unaffected contralateral side, assessment of limitations in spinal function relies almost entirely on comparison with normative data. In doing so, the relative influences of the suspected spinal disorder, aging/degenerative processes, general disuse, motivation, and ''malingering'' can be extremely difficult to discern.

Official guidelines for assessing physical impairment in cLBP patients[2] are inadequate, and include only spinal range of motion (ROM) testing with goniometers/inclinometers, despite the fact that such measures not only show poor intrarater and interrater reliability,[47] but are also inexact[36] and discriminate poorly between patients and controls.[23,69] In an attempt to redress the situation, Waddell et al[69] developed a physical impairment scale based on a battery of simple clinical tests, which was reasonably capable of discriminating between cLBP patients and controls and could explain a significant proportion of the variance in self-rated disability in the patient group. Nonetheless, by the authors' own admission, the sensitivity of the physical impairment scale was not exceptionally high; each of the individual tests was related to some extent to behavioral signs and it was conceded that, by the very nature of the examination tech-

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Table 1. Sociodemographic and Baseline Characteristics of the Study Group (n = 148)

	Women (n = 84)	Men (n = 64)	Difference *P* value
Age (mean ± SD)	46.8 ± 9.5	42.8 ± 10.1	**0.013**
Highest education level (%)	%	%	0.24
Junior high school/comprehensive school	55	58	
High school/sixth-form college/day release college	38	28	
University	7	14	
Work status (%)	%	%	**0.0001**
Full time	20	83	
Part time	50	6	
Retired/unemployed/homemaker	30	11	
Heaviness of workload (%)	%	%	0.07
Office working/sedentary	43	53	
Light manual handling	56	41	
Heavy manual handling	1	6	
Involvement in disability claim (%)*	8.3	10.9	0.80
LBP duration (mean ± SD)	10.2 ± 9.9	10.2 ± 9.0	0.27
LBP intensity: highest (VAS) (mean ± SD)	6.7 ± 2.0	6.2 ± 2.0	0.09
LBP intensity: average (VAS) (mean ± SD)	4.4 ± 1.8	3.9 ± 1.9	0.11
LBP-frequency (%)	%	%	**0.01**
Permanent	60.7	35.9	
Often	32.2	51.6	
Sporadic	7.1	12.5	
Disability (RMQ) (mean ± SD)	9.3 ± 4.4	5.9 ± 4.0	**0.0001**

Bold—significant differences between men and women ($p < 0.05$).
* Regardless of whether claim being considered, or already submitted, granted, or turned down.

niques, the physical tests may be open to conscious deception.[68]

In recent years, a number of more sophisticated tests of "spinal function" have emerged, which have shown promise in the objective evaluation of physical impairment. A number of these—such as isokinetic strength measures,[45] the presence of flexion-relaxation during forward flexion,[63] and spinal motion[40]—although "quantitative," are still not totally objective, because they can only measure the effort that the patient is prepared to invest. Another method, which has proven to be more discriminating than either lumbar mobility or maximal strength in identifying cLBP patients,[23] is the quantification of back muscle fatigability by examination of changes in the surface electromyographic signal during sustained contraction.[4,21,37,55,57] Numerous studies employing this technique have shown that cLBP patients show significantly different values from controls,[4,37,55,57] some (but not all[37]) with an impressive sensitivity and specificity in carefully selected diagnostic groups,[55,57] and that these parameters are responsive to change following therapy.[20,21,37,56] Nonetheless, they have not been evaluated in relation to subjective indices of disability, and nor have their changes following therapy been examined in direct relation to corresponding changes in pain and disability.

A final factor, which deserves consideration in any discussion of determinants of disability, concerns the numerous "psychological" factors that are involved in mediating the relationship between physical impairment, pain, and disability. It has been shown that catastrophising,[52] fear-avoidance beliefs about work and physical activity[38,64,68] and the lack of belief in one's own ability to manage pain, cope, and function[3] are all significantly correlated with disability in chronic pain patients. How these factors interact with physical measures of impairment in explaining disability, and the relative extents to which psychological and physical factors account for improvements in outcome following therapy for cLBP, have rarely been examined.

The effects of an active intervention programm for cLBP on various muscle performance parameters (potential measures of physical impairment)[33] and on trunk muscle size and structure[22] were discussed in the accompanying papers in this series. The aim of the present study was to examine: 1) on a cross-sectional basis, the relative and combined potential of performance measures and psychological factors in explaining self-rated disability associated with cLBP, and 2) on a prospective basis, the relationship between changes in each of these parameters and disability following therapy.

Methods

Study Population. Details of the recruitment methods employed, and the inclusion and exclusion criteria for participation in the study have been described previously and in Part 1.[32,33] The sociodemographic and clinical characteristics of the 148 patients who took part are shown in Table 1.

Interventions. Patients were randomly assigned to one of the following three therapy groups:

(A) modern active physiotherapy;
(B) muscle reconditioning on training devices;
(C) low impact aerobics/stretching classes, which they attended two times per week for 3 months.

Sixteen patients dropped out of therapy leaving 132 to complete the post-therapy assessments.[32,33]

Assessments. Before and after therapy, a comprehensive questionnaire booklet was distributed and functional assessments were carried out. A subgroup of patients also underwent percutaneous muscle biopsy sampling and transverse magnetic resonance imaging (MRI) of the erector spinae muscles.

Questionnaires. Questionnaires inquired about the following factors:

- Socio-demographic characteristics: age, gender, education level, work status, heaviness of work, involvement (past, current, or intended) in a disability claim.
- Characteristics of low back pain: intensity of highest pain and of average pain over the last 6 weeks (Visual Analogue Scale (VAS)), duration, frequency (never, occasional, often, permanent).
- Physical disability (Roland and Morris questionnaire (RMQ)).[53] This is a 24-item questionnaire, previously recommended for the assessment of disability due to LBP in relation to various daily functions[8] (Score 0–24: higher score, increased physical disability).
- Psychological disturbance[11] determined using the combined scores from the modified somatic perception questionnaire (MSPQ)[30] (inquires about the frequency of somatic symptoms experienced in the last week) and the modified ZUNG Depression Questionnaire[28] (Score 0–99: higher score, increased psychological distress).
- Strategies for coping with pain (Coping Strategy Questionnaire (CSQ)[54]). This questionnaire contains 48 items assessing eight strategies: diverting attention, reinterpreting pain sensations, ignoring pain sensations, praying and hoping, coping self-statements, increasing behavioral activities, increasing pain behaviors, and catastrophizing (each strategy scores 0–6, higher score, increased use of coping strategy). Two additional items ask patients to rate their ability to control and decrease their pain through implementation of the strategies.
- Beliefs about physical/work activity being a cause of the patient's back trouble and fears about the dangers of such activities when experiencing an episode of LBP (Fear-Avoidance Beliefs Questionnaire (FABQ)[68]) (Score, physical activity 0–24, work 0–42: higher score, increased fear-avoidance beliefs).
- Beliefs about back-trouble (Back Beliefs Questionnaire (BBQ)[60]). This assesses beliefs about the "inevitability" of the future as a consequence of having back pain (Score 9–45: lower score, increased "negative" beliefs).

Functional Assessments. The functional assessments described below were carried out (for full details, see Part 1[33]).

Day 1

- Range of motion of the lumbar spine in flexion, extension, lateral bending, and axial rotation;
- Erector spinae flexion-relaxation during forward bending (*i.e.,* the absence of electrical activity in the lumbar musculature when in a position of full flexion);
- Modified Biering-Sørensen trunk endurance test[5] to fatigue.

Day 2

- Maximal isometric trunk strength in flexion, extension, rotation, and lateral bending;
- Back muscle fatigability during a 90 sec dynamic (flexion/extension) fatigue test.
- On both days, the fatigue tests were supported with bilateral recordings of erector spinae surface electromyographic (EMG) activity, to objectively quantify fatigability from frequency changes in the EMG power spectrum.

Muscle Size and Structure. In a volunteer subgroup of 59 patients, the following measurements were carried out (for details, see Part 2[22]):

- Cross-sectional area of the erector spinae muscles at L3/4 and L4/5 from MR images;
- Erector spinae muscle fiber type distribution, fiber size, and pathologic changes in the fibers from percutaneous biopsy samples

Statistics. Data reduction was carried out using principal components analysis with orthogonal rotation (varimax method), in an attempt to decrease the number of variables included to represent the attributes performance, psychology, and pain. The factor scores produced for each individual from the analysis were then used in the subsequent predictor analyses. Relationships between factors/variables were examined using Pearson product-moment correlations and simple linear regression. For categorical variables, associations were analyzed using contingency analyses. Stepwise linear regression was used to examine factors that significantly contributed to explaining the variance in self-rated disability.

Because muscle size and muscle structure variables were only available for a subgroup of 40% of the patients, these variables were neither subjected to principal components analyses nor included in any of the multivariate analyses, as their inclusion would have seriously reduced the number of data sets available for analysis.

Significance was accepted at the 5% level (see Part 1 for discussion of multiple comparisons).

Results

Principal Components Analysis to Design Variable Groups and/or Reduce Data

Principal components analysis of the 25 performance variables measured pretherapy identified seven factors. The factor name attributed to each and the variables that they represented were as follows:

1. muscle activation: surface EMG amplitude at the start of the dynamic fatigue test and during the maximal voluntary contraction;
2. range of motion: in flexion/extension, lateral bending, and axial rotation;
3. isometric strength: in extension, flexion, lateral bending, and axial rotation per kg body mass;
4. initial median frequency: at the start of the two fatigue tests;
5. isometric fatigue: (rate of decline in median frequency during Biering-Sørensen test and test endurance time);

6. dynamic fatigue: (rate of decline in median frequency and rate of increase in EMG amplitude during the 90's dynamic flexion/extension test);
7. flexion-relaxation: during forward bending.

These seven factors explained 78.4% of the variance in the whole data set for the performance variables.

From the 14 psychological scales, four factors were identified which described the following attributes:

1. use of coping strategies: represented by diverting attention, increasing behavioral activities, reinterpreting pain sensations, praying and hoping, ignoring pain, coping self-statements (all from the CSQ);
2. psychological distress: characterized by psychological disturbance (combination of MSPQ and ZUNG scores), catastrophizing (CSQ), increasing pain behavior (CSQ), and back beliefs (BBQ);
3. efficacy: concerning the ability to control or decrease pain (from the CSQ);
4. fear avoidance beliefs: about physical activity and work (FABQ).

These four factors explained 65.0% of the variance in the whole psychological data set.

The three variables— highest pain intensity, average pain intensity, and pain frequency— constituted one factor pain.

Principal components analysis of the same variables post-therapy produced identical grouping factors to those reported above for the pretherapy data for the performance, the psychological and the pain data.

Interrelationships Between Psychology, Performance, Muscle Structure, and Pain

None of the psychological factors was able to significantly account for the variance in the different performance factors, once the effects of gender had been eliminated. Of the performance factors, only strength showed a significant association with pain (R^2 =7.4%); the results were the same regardless of whether gender was entered into the analysis. Three of the psychological factors were together significantly associated with the factor "pain" (in decreasing order of importance: use of coping strategies, efficacy in controlling or decreasing pain, and psychological distress; R^2=26%). The addition of gender as a further factor did not influence this relationship.

None of the muscle structure variables showed a significant correlation with the factor "pain."

Multivariate Analyses to Explain Pain

When all the psychological and performance parameters were entered together, efficacy in controlling or decreasing pain, the use of coping strategies and strength accounted for 25.6% variance in pain.

Correlation of Performance, Muscle Structure, Psychology, and Pain With Disability

Table 2 shows the results of the correlation analyses for the 12 performance, psychological, and pain factors with self-rated disability. Table 3 shows similar data for the relationships between muscle structure and disability.

Of the performance factors, only muscle activation, ROM, and strength showed a significant correlation with pretherapy disability: more disabled patients had reduced values for each of these parameters (P<0.05 for each factor; Table 2).

Table 2. Correlation Coefficients (r) Showing the Strength of the Relationships Between Disability and (A) Performance, (B) Psychological, and (C) Pain Factors§ (Pretherapy Data)

	Men	Women	All Subjects
(A) Performance factors	r	r	r
Muscle activation	0.22	**0.23***	**0.31‡**
Strength	0.13	0.09	**0.34‡**
Initial median frequency of EMG	0.08	0.07	0.03
Isometric fatigue	0.02	0.04	0.05
Range of motion	0.17	0.22	**0.18***
Dynamic fatigue	0.06	0.10	0.09
Flexion-relaxation	0.002	0.09	0.01
(B) Psychological factors			
Use of coping strategies	0.15	0.16	**0.20†**
Psychological distress	**0.30†**	**0.37‡**	**0.40‡**
Efficacy in controlling/decreasing pain	0.02	**0.28†**	**0.23†**
Fear avoidance beliefs	**0.53‡**	**0.24***	**0.32‡**
(C) Pain factor			
Pain	**0.44‡**	**0.39‡**	**0.45‡**

Bold—significant correlation.
* $p < 0.05$.
† $p < 0.01$.
‡ $p < 0.001$.
§ As derived from factor analysis (see appendix for definition).

Table 3. Correlation Coefficients (r) Showing the Strength of the Relationships Between the Muscle Structure Variables and Disability (Pretherapy Data)

	Men	Women	All Subjects
	r	r	r
Muscle size (MRI)*			
Mean (right + left) Psoas size @ L3/4†	−0.24	−0.02	**−0.35§**
Mean (right + left) Psoas size @ L4/5†	**−0.38§**	0.07	**−0.38§**
Mean (right + left) ES size @ L3/4†	0.15	−0.10	−0.11
Mean (right + left) ES size @ L4/5†	−0.14	−0.15	−0.19
Muscle structure (biopsy)‡			
Pathological signs in muscle fibers	−0.04	0.29	0.05
% type I fibers	0.23	0.01	0.25
% type IIA fibers	**−0.38§**	0.11	0.18
% type IIX fibers	0.07	−0.18	0.17
Size type I fibers (μm^2)	−0.06	0.02	0.07
Size type IIA fibers (μm^2)	0.12	0.10	0.08
Size type IIX fibers (μm^2)	0.01	0.04	0.19
Fiber size ratio I:II	−0.12	0.03	0.14
% area occupied by type I fibers	0.22	0.01	**0.28§**
% area occupied by type IIA fibers	−0.34	0.10	0.21
% area occupied by type IIX fibers	0.05	−0.15	0.19

Bold = significant correlation.
* n = 26 women, 29 men.
† In relation to cross-sectional area of the intervertebral disc, to "normalize" the data for size ([58]).
‡ n = 30 women, 29 men.
§ $p < 0.05$.

There were no significant correlations between the muscle structure variables and disability for the women, and only few for the men (Table 3): lower disability was associated with larger psoas muscles at L5 and an increased proportion of type IIA fibers (at the expense of type I). However, the relationship for fiber type distribution was particularly influenced by the results of one patient with a very low proportion of type I fibers (higher IIA) and very low disability, and, as such, this rather weak relationship must be interpreted with caution.

Each of the psychological factors showed a significant correlation with disability ($P<0.03$; Table 2). More severely disabled patients showed an increased use of coping strategies, higher levels of psychological disturbance, reduced efficacy in controlling or decreasing pain, and increased fear-avoidance beliefs about physical activity and work.

Increased pain was also significantly associated with increased disability ($P=0.0001$;Table 2).

Multivariate Analyses to Explain Disability

For the multivariate analyses, the men and women were treated as one group and gender was included as an additional covariate in the analysis. Muscle structure data was not included in the multivariate analyses (see "Statistics" section in Methods).

When all the performance factors were entered together into a stepwise regression, the following three variables (in decreasing order of importance) were together able to significantly account for 24.5% variance in disability: strength, muscle activation, and ROM (the inclusion of gender had no effect on this result).

Stepwise regression analysis of the psychological factors revealed that each was significantly able to contribute to explaining the variance in disability, and did so in the following (decreasing) order of importance: psychological distress, fear-avoidance beliefs, efficacy in controlling or decreasing pain, and use of the coping strategies. Together these accounted for 35.7% of the variance in disability (40.6%, with the inclusion of gender).

Pain accounted for 20.2% variance in disability (increasing to 28.3% when gender was simultaneously added).

The interrelationships between disability and performance, psychological, and pain factors are summarized in Figure 1.

When all the performance, psychological, and pain factors (as well as gender) were entered simultaneously into a stepwise regression analysis, 51.4% of the variance in disability could be explained. The factors that made a significant contribution are listed in Table 4.

Relationship Between Changes in Pain, Psychological Attributes, Performance, Muscle Structure, and Changes in Disability After Therapy (Univariate Analyses)

At the end of the therapy a significant reduction in self-rated disability (from (mean ± SD) 7.9 ± 4.6 to 6.6 ± 5.0) was recorded, with no significant differences between men and women or between the three therapy groups. (The full results are reported in Mannion et al[32].)

Changes in pain ($r=0.39$; $P<.001$) and psychological distress ($r=0.27$; $P<.01$) were significantly related to changes in disability.

Changes in the performance factors were unrelated to changes in disability.

For the women, an increase in the size of the erector spinae muscles at L4/5 was significantly associated with a reduction in disability ($r=0.47$, $P=0.028$). In the men, a reduction in disability was significantly associated with an increase in the relative area of the muscle occupied by type IIX (fast-twitch glycolytic) fibers ($r=0.52$,

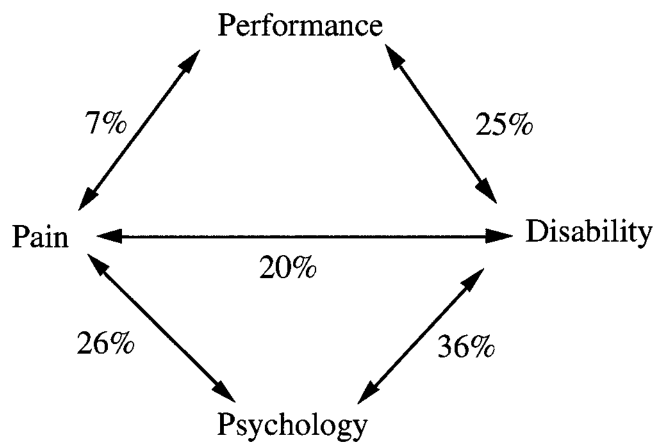

Figure 1. Interrelationship between performance, psychological, pain factors, and disability (explained proportion of variance using multiple regression analyses; see text for further details).

Table 4. Proportion of Variance in Disability Explained by the Three Attributes: Performance, Psychological Characteristics, and Pain. (A) Factors* Comprising Each Attribute Considered in Isolation; (B) All Factors* From All Attributes Considered Together

	Pretherapy	Post-therapy
(A)		
Physical performance	**24.5%**	**17.9%**
Strength		
Muscle activation		
Range of motion		
Psychological characteristics	**35.7%**	**46.8%**
Psychological distress		
Fear-avoidance beliefs		
Efficacy in controlling pain		
Use of coping strategies		
Pain characteristics	**20.2%**	**38.5%**
(B)		
All 12 factors and gender	**51.4%**	**62.8%**
Pain factor	19.1%	41.7%
Psychological distress	12.8%	9.2%
Fear-avoidance beliefs	10%	9.7%
Muscle activation	5.6%	—
Range of motion	2.3%	—
Gender	1.6%	2.2%

* As derived from factor analysis (see appendix for definition).

$P=0.009$) at the expense of type I (slow twitch oxidative) fibers (r=-0.43, $P=0.036$).

Multivariate Analyses to Explain Changes in Disability After Therapy

When the 12 performance and psychological factors were entered into a stepwise regression (again, without the muscle structural changes), changes in pain (16.0%), psychological distress (4.1%), and fear-avoidance-beliefs (3.7%) together accounted for 23.8% of the variance in the post-therapy reduction in disability. The addition of gender as a covariate did not influence the results.

Discussion

General

The aim of the present study was to identify factors that best explained self-rated disability in a group of chronic LBP patients, and to determine whether changes in these factors accounted for changes in disability post-therapy. Many individual variables were examined, including aspects of back "functional capacity," muscle anatomy, psychology, and pain. Most of these attributes have been examined in previous studies—in relation to their potential to identify LBP patients, predict outcome, or respond to therapy— but mostly in isolation. In this way, the sensitivity of the analysis to the chosen factor is naturally increased and its importance perhaps exaggerated. By combining all these factors within one comprehensive study, it is hoped that a valid conclusion as to which factors are of greatest importance is arrived at in determining an individual's perceived disability. This model was able to explain in total 51% of the variability in disability (discussed later). Another important part of the investigation was to examine changes in each parameter following active therapy in relation to changes in the clinical outcome measure of self-rated disability. Ultimately, it is the clinical aspects of pain and disability that drive the patient back into the healthcare system, which in turn gives rise to the enormous societal costs associated with the treatment of, and work-loss due to, LBP. As such, if specific therapy programs are to be advocated—especially those which aim to target "functional capacity"—it is important to be able to establish that the improvements in function are in some way associated with changes in the clinical complaint. It is often not clear whether changes in performance are responsible for improvements in clinical outcome or whether these two simply occur coincidentally and are actually contingent upon a common third factor. Unfortunately, even if a correlation between the changes in two variables (*e.g.*, muscle strength and disability) can be established, this still doesn't necessarily prove the existence of a causal relationship; the converse; however, a reduction in disability in the absence of any significant change in the performance dimension under investigation, or vice versa, would certainly imply that the two were unrelated.

In an attempt to reduce the current large data set to meaningful constructs by which the measured variables could be described, principal components analysis was first carried out. This statistical technique allows the identification of factors that can be used to represent interrelated variables. The 25 performance variables were reduced to seven factors, which were meaningful and simple to interpret and were formed consistently, from both the pre- and post-therapy data. Many attributes of "back function," such as mobility, strength, muscle activation, muscle fatigability, and flexion-relaxation during forward bending, were represented by the chosen factors.

For the psychological variables, the factors generated were also clear, meaningful, and consistent in both the pre- and post-therapy data, but the individual domains for a given questionnaire didn't always load on the same factor. Fourteen scales of five psychological questionnaires resulted in four dimensions: use of coping strategies, psychological distress, efficacy in controlling pain, and fear-avoidance beliefs. This factor structure supports the theoretical consideration that coping strategies and cognitions of LBP patients are independent[19] and that appraisal of self-efficacy in attempting to control pain is independent of other coping strategies.[24] Furthermore, it suggests that self-efficacy beliefs concerning control over pain and pain-related fear are different dimensions of pain-cognition. A third aspect of pain-cognition—catastrophizing—loaded on a factor, which was otherwise determined by psychological disturbance, increasing pain behavior (CSQ), and negative "back beliefs." Catastrophizing, the overestimation of possible negative consequences, or so-called "cognitive errors," is a frequent symptom of depression and can be interpreted as a sign of psychological distress. Turner et al[64] stated that there is empirical evidence that catastrophizing can be differentiated from coping strategies and is related to personality characteristics such as neuroticism and low disposal optimism. Associations between catastrophizing (CSQ) and psychological distress[29] and between catastrophizing and depression[52,64] have been shown before.

Summarizing the theoretical considerations and empirical findings, the four-factor structure—which distinguished between use of coping strategies, self-efficacy beliefs, fear-avoidance (appraisals), and psychological distress—seemed to accurately reflect the different psychological dimensions relevant in chronic LBP patients.

Physical Characteristics and Disability

For many other joint disorders, the level of physical impairment strongly determines the consequent disability.[36] However, in the case of cLBP, the relationship between these two attributes has proven to be, at best, only weak.[12,39,41,42,50,69] The present study employed a large number of objective and reliable tests of physical impairment, but the relationship between performance on these tests and disability remained relatively weak. Range of motion, muscle activation, and strength were the only factors that showed a significant correlation with pre-therapy disability, with more disabled patients having reduced values for each of these parameters. Together they accounted for 25% variance in disability, reducing to 10% when analyzed in conjunction with the psychological variables. The value of 25% is similar to that previously reported for other physical performance measures,[12,41,50,69] although no previous investigations have attempted to confirm the strength of the relationships in the face of other, perhaps more important, psychological determinants of disability.

Spinal ROM is currently the only measure that is included in official guidelines for assessing physical impairment in chronic LBP patients,[2] despite many suggestions that it does not warrant this status on account of its lack of reliability,[47] validity,[44] and inability to discriminate well between patients and controls.[23,69] That this was one of the few performance variables that correlated with disability, argues for its retention as a measurement of impairment, at least as one of the "best of a not so good lot," and with the proviso that reliable devices are used for its measurement. The relationship between strength and disability confirms previous results obtained using a variety of different clinical and machine-based tests,[41,50,12] although strength measures, too, have recently suffered a lot of criticism.[45] Many tests of strength and mobility must to a certain extent be susceptible to the influence of volition, and it is arguable that they reflect as much about an individual's motivation to perform as their anatomical/physiological capacity. Nonetheless, this appeared not to be the case in the present study, as evidenced by the lack of any significant correlations between the performance and the psychological measures. This may have been because great care was taken to habituate the patients to the performance tests and to allow enough repeated trials to obtain reliable measurements. Furthermore, the patients were generally well-motivated individuals who genuinely wanted to alleviate their back complaints, and there were probably few "malingers" among them. Not many were severely disabled in terms of their social and work environment.

The requirement for strictly objective measures of performance in relation to cLBP has led to the development of tests that rely on examination of the changing frequency components of the surface EMG signal during fatiguing efforts.[7] Investigations using these measures of EMG-determined muscular fatigability have proven to be more discriminating than ROM, or strength in cross-sectional analyses of patients and controls.[23] However, the results of the present study would tend to suggest that neither this physiological measure of fatigability, nor the structural characteristics of the muscle that determine it, bear much relationship to clinical measures of disability. Thus, the clinical significance of these measures remains obscure.

Only one study has investigated the relationship between disability and structural characteristics of the back muscles.[1] A significant correlation between the fat content of the lower erector spinae and disability (30% variance accounted for) was observed, in men only, although the patients investigated were considerably more disabled than those involved in the present study. For the latter, the only muscle structural parameter that correlated convincingly with disability was the psoas muscle size, again, in the men only.

Although a wide range of tests was employed, covering many aspects of "performance," it is conceivable that the particular attributes chosen for investigation do not reflect the most important physical dysfunctions associated with LBP. Recent studies have revealed interesting new avenues for assessing physical parameters related to cLBP. These abnormal parameters include impaired lumbar proprioception and awareness of position,[9,61] delayed trunk muscle responses to unexpected loading[71] and to voluntary upper limb,[15] and lower limb movements.[16] The sudden release of loading elicits different muscle activation patterns in patients and controls.[49] Reaction times (decision-making speed) to external visual stimuli are also lengthened in cLBP patients,[26,62] which is explained by disturbances in short-term memory due to pain and depression.[27] Impaired postural control[25,46] is another feature associated with cLBP, in which the greatest difference between healthy subjects and patients appears to be in the fast reflex responses at the spinal cord level.[25] Pain-induced changes in muscle activity have been observed in experimental[17] and clinical studies,[14] where reflex inhibition is suggested to play a role.[13] Lumbar muscle activity was a significant determinant of disability in the present study, and was one of the few physical factors that retained its importance when considered in combination with the psychological factors. Furthermore, increased lumbar muscle activation was considered one of the most substantial effects of the active therapy programs (see Part 1 of this series[33]).

Since, in the present study, one-half of the variability in disability at baseline and the majority of the change in disability after treatment remained unexplained, the authors suggest that these new aspects of physical function — which primarily assess the non-voluntary, reflex control of movement — may be worthy of investigation in future studies attempting to examine physical determinants of LBP-related disability.

Psychological characteristics and disability

In the present study, all psychological factors examined were significantly associated with disability. The highest correlation was for psychological distress, followed by fear-avoidance beliefs, efficacy in controlling pain, and the use of coping strategies. In a stepwise regression analysis, the order of importance of the factors was the same.

The most important variables represented by the psychological distress factor were the combination of depression and somatic symptom perception and the catastrophizing scale of the CSQ. An association with disability has previously been demonstrated for psychological distress (*e.g.*, depression, neuroticism)[3,35] and also for catastrophizing,[35,59] although not in all studies.[64]

In the last decade, an increasing number of both experimental and clinical studies have shown that fear and the avoidance of movement influence both the experience of pain and chronic pain disability.[66] Waddell et al[68] and Crombez et al[6] reported highly significant correlations (r>0.50) between fear-avoidance-beliefs and disability (Roland and Morris). These results were replicated in the present study. For women, the correlation was not as high as it was for men, possibly because of differences in work status (see Table 1). In multivariate analyses, pain-related fear has been shown to be one of the most important factors explaining disability.[18,38,68]

Self-efficacy beliefs (onto which ratings of "ability to control and decrease pain (CSQ)" loaded) have consistently demonstrated a relationship with physical disability.[19] In the present study, self-efficacy beliefs correlated significantly with disability in women only; in men, these variables had no relationship. In multivariate analysis, their influence on disability was overshadowed by other psychological factors and pain. The relationship between the use of coping strategies and disability appears to be inconclusive.[19] In the present study, coping strategies were only weakly associated with disability, and in multivariate analysis were no longer significant.

Characteristics of pain (especially pain intensity) have a great influence on disability. Previous studies that have used multivariate analysis to predict disability have shown (consistent with the present study) that pain normally explains the greatest or second greatest proportion of the variance.[18,38,64,68] The hypothesis that fear of pain and (re)injury may be more disabling than pain itself[6,66] was not supported by the data.

Multidimensional analysis of all 12 physical performance, psychological, and pain factors as well as gender, revealed that pretherapy 51% and post-therapy 63% of the variance in disability could be explained. The amount of variance explained by the two psychological factors (psychological distress and fear avoidance) was slightly lower post-therapy, and the two physical performance factors (muscle activation and ROM), which pretherapy accounted for 8% of the variance in disability, lost their significance in the post-therapy data. The proportion of variance explained by the pain factor was more than double in the post- compared with the pretherapy data. The interpretation of this phenomenon is unclear. In post-therapy, the patients generally showed an improvement in most of the characteristics investigated; possibly pain has a higher impact on disability in "healthier" patients than in those who are physically and psychologically more impaired. Alternatively, this may have been a statistical phenomenon, in which the increased variance around the group mean values of disability and pain, post-therapy, allowed for a higher percentage of the variance in disability to be statistically resolved. Regardless, it is clear that when all factors were considered together, the psychological factors and pain showed an overwhelming domination in accounting for the variance in self-rated disability.

Predictors of Reduction in Disability Post-Therapy

In predicting the post-therapy reduction in disability from changes in all the other dimensions, pain, psychological disturbance, and fear-avoidance beliefs were the only significant factors. This result is in concordance with Jensen et al,[18] who predicted pretreatment to 6-month follow-up changes in patients functioning from changes in average pain and pain-related beliefs.

In the subgroup of patients who underwent muscle structure analyses, it was shown that for the women only, an increase in erector spinae muscle size accounted for a significant proportion of the decrease in disability. Thus, although the patient group as a whole did not show dramatic changes in muscle size pre- to post-therapy,[22] on an individual basis there were patients who did show a positive response and this was associated with a reduction in disability. Although these measurements were made only on a subgroup of patients, the subgroup did not differ from the rest of the patient cohort either pretherapy, or in response to therapy, suggesting that the results can be safely extrapolated. Unfortunately, however, the groups were too small to analyze the importance of the muscle structure variables in multivariate analysis with the psychological factors. Nonetheless, it would seem that the role of muscle training and muscle hypertrophy in the rehabilitation process cannot be disregarded.

For the men, the fiber type characteristics were more important than muscle size: an increased proportion of type IIX (at the expense of type I) fibers was associated with greater reductions in disability. A specific training effect on the type II fiber has been observed before (also for men only), though this was in respect to its size, rather than its proportion within the muscle.[51] Increases in either the relative size or proportion of type II fibers would result in an increased relative area of the muscle being occupied by type II fibers. These findings are somewhat paradoxical, considering that an increase in type IIX fibers is usually observed with disuse/inactivity[10] and long term back pain.[31] There is currently no explanation for this phenomenon, which seems worthy of further investigation.

Interestingly, in the present study, none of the three therapies involved any psychological or cognitive-behavioral interventions, yet various psychological variables (*e.g.*, catastrophizing, fear-avoidance-beliefs, self-efficacy in controlling pain) showed positive changes. Perhaps these attributes are addressed inadvertently by active therapy programs, insofar as patients experience something quite different from their expectations (*i.e.*, their being able to complete the prescribed exercises without undue harm) and thereby correct their irrational cognitions and appraisals. It is also possible that patients readjust psychologically whenever pain is reduced—for any reason and regardless of the intervention method. Thus, active therapy programs appear to incorporate many of the positive benefits of cognitive-behavioral therapy, with the additional advantage of serving to improve the general physical condition of the patient. Whether changes in the psychological profile and clinical status of the patient are more effectively reduced by purely psychological interventions than by active therapy is not known; to date, no high quality randomized studies have been carried out to address this issue.[65]

In summary, active therapy has been shown to be effective in reducing disability in moderately disabled cLBP patients, although the precise mode of therapy and the extent of the subsequent muscular changes appear to be of limited importance. The reduction in disability recorded after therapy was mostly accounted for by reductions in pain and changes in psychological parameters. In this sense, the promotion of specific types of exercise programs for moderately disabled cLBP patients, targeting "physical weaknesses" typical of those examined in the current study, seems not to be justified.

■ Key Points

- The ability of pain, physical performance, back muscle structure, and psychological factors to account for individual differences in self-rated disability (Roland and Morris Score) was examined in a group of 148 patients with chronic low back pain.
- The most important factors that accounted for the variance in disability were (in decreasing order): pain, psychological distress, fear-avoidance beliefs, back muscle activation, lumbar range of motion, and gender. Individual differences in these factors together explained over half of the variance in the baseline disability scores.
- After 3 months active therapy, the patients' self-rated disability reduced significantly. Reductions in pain, psychological distress, and fear-avoidance beliefs were the only changes that were directly related to the reductions in disability scores (explaining approximately 24% variance). None of the changes in objectively-measured physical capacity could explain the reductions in self-rated disability.
- Many positive changes in the psychological status of the chronic low back pain patient accompany active therapy.
- The precise mode of active therapy employed and the extent of the resulting improvements in physical performance appear to be of no importance in determining the degree of reduction in self-rated disability post-therapy.

References

1. Alaranta H, Tallroth K, Soukka A, et al. Fat content of lumbar extensor muscles and low back disability: A radiographic and clinical comparison. J Spinal Disord 1993;6(2):137–40.
2. American Medical Association. Guides to the evaluation of permanent impairment. 4th ed. Chicago: American Medical Association, 1994.
3. Arnstein P, Caudill M, Mandle CL, et al. Self efficacy as mediator of the relationship between pain intensity, disability and depression in chronic pain patients. Pain 1999;80:483–91.
4. Biedermann HJ, Shanks GL, Forrest WJ, et al. Power spectrum analyses of electromyographic activity discriminators in the differential assessment of patients with chronic low back pain. Spine 1991;16(10):1179–84.
5. Biering-Sørensen, F. Physical measurements as risk indicators for low-back trouble over a one-year period. Spine 1984;9(2):106–19.
6. Crombez G, Vlaeyen JWS, Heuts PHTG, et al. Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability. Pain 1999;80:329–39.
7. De Luca CJ. Use of the surface EMG signal for performance evaluation of back muscles. Muscle Nerve 1993;16:210–6.
8. Deyo RA, Andersson G, Bombardier C, et al. Outcome measures for studying patients with low back pain. Spine 1994;19(18S):S2032–6.
9. Gill KP, Callaghan MJ. The measurement of lumbar proprioception in individuals with and without low back pain. Spine 1998;23(3):371–7.
10. Goldspink G, Scutt A, Loughna PT, et al. Gene expression in skeletal muscle in response to stretch and force generation. Am J Physiol 1992;262:R356–63.
11. Greenough CG, Fraser RD. Comparison of eight psychometric instruments in unselected patients with back pain. Spine 1991;16(9):1068–74.
12. Gronblad M, Hurri, Kouri JP. Relationships between spinal mobility, physical performance tests, pain intensity and disability assessments in chronic low back pain patients. Scand J Rehabil Med 1997;29:17–24.
13. Hides JA, Richardson CA, Jull GA. Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain. Spine 1996; 21(23):2763–9.
14. Hides JA, Stokes MJ, Saide M, et al. Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute/subacute low back. Spine 1994;19:165–72.
15. Hodges PW, Richardson CA. Altered trunk muscle recruitment in people with low back pain with upper limb movement at different speeds. Arch Phys Med Rehabil 1999;80(9):1005–12.
16. Hodges PW, Richardson CA. Delayed postural contraction of transversus abdominis in low back pain associated with movement of the lower limb. J Spinal Disord 1998;11(1):46–56.
17. Indahl A, Kaigle AM, Reikeras O, et al. Interaction between the porcine lumbar intervertebral disc, zygapophysial joints, and paraspinal muscles. Spine 1997;22(24):2834–40.
18. Jensen MP, Romano JM, Turner JA, et al. Patients beliefs predict patients functioning: further support for a cognitive-behavioural model of chronic pain. Pain 1999;81:95–104.
19. Jensen MP, Turner JA, Romano JM, et al. Coping with chronic pain: a critical review of the literature. Pain 1991;47:249–83.
20. Kankaanpää M, Taimela S, Airaksinen O. Reference change limits of the paraspinal spectral EMG in evaluation of low back rehabilitation. Pathophysiology 1998;5:217–24.
21. Kankaanpää M, Taimela S., Airaksinen O, et al. The efficacy of active rehabilitation in chronic low back pain. Effect on pain intensity, self-experienced disability, and lumbar fatigability. Spine 1999;24(10):1034–42.
22. Käser L, Mannion AF, Rhyner A, et al. Active therapy for chronic low back pain. Part 2: Effects on paraspinal muscle cross-sectional area, fiber type size and distribution. Spine 2001;26:909–19.
23. Klein AB, Snyder-Mackler L, Roy SH, et al. Comparison of spinal mobility and isometric trunk extensor forces with electromyographic spectral analysis in identifying low back pain. Phys Ther 1991;71(6):445–54.
24. Lawson K, Reesor KA, Keefe FJ, et al. Dimensions of pain-related cognitive coping: cross-validation of the factor structure of the Coping Strategy Questionnaire. Pain 1990:43:195–204.
25. Luoto S, Aalto H, Taimela S, et al. One-footed and externally disturbed two-footed postural control in chronic low-back pain patients and healthy controls: A controlled study with follow-up. Spine 1998;23:2081–90.
26. Luoto S, Taimela S, Hurri H, et al. Psychomotor speed and postural control in chronic low-back pain patients: A controlled follow-up study. Spine 1996; 21:2621–7.
27. Luoto S, Taimela S, Hurri H, et al. Mechanisms explaining the association between low back trouble and deficits in information processing. A controlled study with follow-up. Spine 1999;24(3):255–61.
28. Main CJ, Waddell G. The detection of psychological abnormality in chronic low back pain using four simple scales. Current Concepts in Pain 1984;2: 10–5.
29. Main CJ, Wood PL, Hollis S, et al. The Distress and Risk Assessment Method. A simple patient classification to identify distress and evaluate the risk of poor outcome. Spine 1992;17(1):42–52.
30. Main CJ. The modified somatic perception questionnaire (MSPQ). J Psychosom Res 1983; 27(6):503–14.
31. Mannion AF, Käser L, Weber E, et al. Influence of age and duration of symptoms on fiber type distribution and size of the back muscles in chronic low back pain patients. Eur Spine J 2000;9:273–81.

32. Mannion AF, Müntener M, Taimela S, et al. A randomised clinical trial of three active therapies for chronic low back pain. Spine 1999;24(23):2435–48.
33. Mannion AF, Taimela S, Müntener M, et al. Active therapy for chronic low back pain. Part 1: Effects on back muscle activation, fatigability and strength. Spine 2001;26:897–908.
34. Marras WS, Ferguson SA , Gupta P, et al. The quantification of low back disorder using motion measures. Methodology and validation. Spine 1999; 24(20):2091–100.
35. Martin MY, Bradley LA, Alexander RW et al. Coping strategies predict disability in patients with primary fibromyalgia. Pain 1996;68:45–63.
36. Mayer TG. Assessment of lumbar function. Clin Orthop Rel Res 1987;221: 99–109.
37. Mayer TG, Kondraske G, Mooney V, et al. Lumbar myoelectric spectral analysis for endurance assessment. A comparison of normals with deconditioned patients. Spine 1989;14(9):986–91.
38. McCracken LM, Gross RT, Aikens J, et al. The assessment of anxiety and fear in persons with chronic pain: A comparison of instruments. Behav Res Ther 1996;34(11/12):927–33.
39. McGregor AH, Dore CJ, McCarthy ID, et al. Are subjective clinical findings and objective clinical tests related to the motion characteristics of low back pain subjects? J Orthop Sports Phys Ther 1998;28:370–7.
40. McGregor AH, McCarthy ID, Dore CJ, et al. Quantitative assessment of the motion of the lumbar spine in the low back pain population and the effect of different spinal pathologies of this motion. Eur Spine J 1997;6(5):308–15
41. Mellin G. Chronic low back pain in men 54-63 years of age. Correlations of physical measurements with the degree of trouble and progress after treatment. Spine 1986;11(5):421–6.
42. Michel A, Kohlmann T, Raspe H. The association between clinical findings on physical examination and self-reported severity in back pain. Results of a population-based study. Spine 1997;22:296–303.
43. Mooney V. Impairment, disability and handicap. Clin Orthop Rel Res 1987; 221:14–25.
44. Nattrass CL, Nitschke JE, Disler PB, et al. Lumbar spine range of motion as a measure of physical and functional impairment: an investigation of validity. Clin Rehabil 1999;13(3):211–8.
45. Newton M, Thow M, Somerville D, et al. 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. Spine 1993;18(7):812–24.
46. Nies N, Sinnott PL. Variations in balance and body sway in middle-aged adults: Subjects with healthy backs compared with subjects with low-back dysfunction. Spine 1991;16:325–30.
47. Nitschke JE, Nattrass CL , Disler PB, et al. Reliability of the American Medical Association Guide's model for measuring spinal range of motion. Spine 1999;24(3):262–8.
48. Nordin M, Skovron ML, Hiebert R, et al. Early predictors of delayed return to work in patients with low back pain. J Musculoskel Pain 1997;5(2):5–27.
49. Radebold A, Cholewicki J, Panjabi MM, et al. Muscle response pattern to sudden trunk loading in healthy individuals and in patients with chronic low back pain. Spine 2000;25(8):947–54.
50. Rissanen A, Alaranta H, Sainio P, et al. Isokinetic and non-dynamometric tests in low back pain patients related to pain and disability index. Spine 1994;19(17):1963–7.
51. Rissanen A, Kalimo H, Alaranta H. Effect of intensive training on the isokinetic strength and structure of lumbar muscles in patients with chronic low back pain. Spine 1995;20(3):333-40.
52. Robinson ME, Riley JL, Myer SC et al. The Coping Strategies Questionnaire: A large sample, item level factor analysis. Clin J Pain 1997;13:43–9.
53. Roland M, Morris R. A study of the natural history of back pain. Part 1: Development of a reliable and sensitive measure of disability in low-back pain. Spine 1983;8(2):141–4.
54. Rosenstiel AK, Keefe FJ. The use of coping strategies in chronic low back pain patients: relationship to patient characteristics and current adjustments. Pain 1983;17:33–44.
55. Roy SH, De Luca CJ, Casavant DA. Lumbar muscle fatigue and chronic lower back pain. Spine 1989;14(9):992–1001.
56. Roy SH, De Luca CJ, Emley M, et al. Spectral electromyographic assessment of back muscles in patients with low back pain undergoing rehabilitation. Spine 1995;20(1):38–48.
57. Roy SH, De Luca CJ, Snyder-Mackler L, et al. Fatigue, recovery and low back pain in varsity rowers. Med Sci Sports Exerc 1990;22(4):463–9.
58. Savage RA, Millerchip R, Whitehouse GH, et al. Lumbar muscularity and its relationship with age, occupation and low back pain. Eur J Appl Physiol 1991;63:265–8.
59. Sullivan MJL, Stanish W, Waite H, et al. Catastrophizing, pain, and disability in patients with soft-tissue injuries. Pain 1998;77:253–60.
60. Symonds TL, Burton AK, Tillotson KM, et al. Do attitudes and beliefs influence work loss due to low back trouble? Occup Med 1996;46(1):25–32.
61. Taimela S, Kankaanpää M, Luoto S. The effect of lumbar fatigue on the ability to sense a change in lumbar position. A controlled study. Spine 1999; 24(13):1322–7.
62. Taimela S, Osterman K, Alaranta H, et al. Long psychomotor reaction time in patients with chronic low-back pain - preliminary report. Arch Phys Med Rehab 1993;74:1161–4.
63. Triano JJ, Schultz AB. Correlation of objective measure of trunk motion and muscle function with low-back disability ratings. Spine 1987;12(6):561–5.
64. Turner JA, Jensen MP, Romano JA. Do beliefs, coping and catastrophizing independently predict functioning in patients with chronic pain? Pain 2000; 85:115–25.
65. van Tulder MW, Koes BW, Bouter LM. Conservative treatment of acute and chronic nonspecific low back pain. A systematic review of randomized controlled trials of the most common interventions. Spine 1997;22(18):2128–56.
66. Vlaeyen JWS, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. Pain 2000;85:317–32.
67. Waddell G, Main CJ. Assessment of severity in low-back disorders. Spine 1984;9(2):204–8.
68. Waddell G, Newton M, Henderson I, et al. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. Pain 1993;52(2):157–68.
69. Waddell G, Somerville D, Henderson I, et al. Objective clinical evaluation of physical impairment in chronic low back pain. Spine 1992;17:617–28.
70. Waddell G. Clinical assessment of lumbar impairment. Clin Orthop 1987; 221:110–20.
71. Wilder D, Aleksiev A, Magnusson M, et al. Muscular response to sudden load - A tool to evaluate fatigue and rehabilitation. Spine 1996;21(22): 2628–39.

Appendix

Terminology and Abbreviations

Variable - derived from direct measurement of a certain aspect of performance, *e.g.*, strength in extension.

Factor - derived from factor analysis: represents an aspect of performance measured a number of ways, *e.g.*, strength (in all movement directions).

Attribute - represents a set of factors, *e.g*,. performance.

MSPQ - modified somatic perception questionnaire.

ZUNG - Zung modified self-rated depression questionnaire.

FABQ - fear-avoidance beliefs questionnaire.

CSQ - coping strategies questionnaire.

RMQ - Roland and Morris disability questionnaire.

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