Are Functional Capacity Evaluations Affected by the Patient's Pain?

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Current Pain and Headache Reports 2006, **10:**107–113
Current Science Inc. ISSN 1531-3433
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Functional capacity evaluations (FCE) are comprehensive batteries of performance-based tests used commonly to inform return-to-work decisions for injured workers. As many people undergoing FCE have painful musculoskeletal conditions limiting their work ability, pain becomes a critical factor in the assessment of function. This paper considers the available literature related to the influence of pain on FCE, which clearly indicates FCEs are behavioral assessments influenced by pain intensity and other pain-related constructs. Increasing pain levels are consistently associated with reduced FCE performance levels. As such, for purposes of claims adjudication, FCE should not be considered a purely "objective" indicator of functional impairment independent of subject or evaluator perceptions. FCE may have some value for facilitating return-to-work or re-integrating chronically disabled workers into the workforce, although pain factors must be taken into consideration when making predictions about future work status. Shorter FCEs could potentially be as effective as more lengthy protocols.

Introduction

Functional capacity evaluations (FCEs) are comprehensive batteries of performance-based tests used commonly to determine ability for work or activities of daily living [1,2]. FCEs are commonly used in the area of occupational rehabilitation to inform decisions of return-to-work readiness for injured workers [3]. As such, FCE results have momentous implications in the lives of individual workers, including whether they will re-enter the workforce or continue receiving disability benefits. The nature and quality of decisions made with FCE are closely linked to the tests' measurement properties and ability to quantify the construct (work ability) they are purported to measure. As many people undergoing FCE have painful musculoskeletal conditions limiting their work ability, pain becomes a critical factor in the assessment of function [4]. The purpose of this paper is to review the available literature related to the effect of pain on FCE and on return-to-work decisions informed by FCE results.

Does Pain Affect Function?

The question of whether pain affects function has been debated in the literature and clinical community for decades [5]. Anecdotally, numerous examples exist of sports figures, firewalkers, or others who perform dramatic physical feats despite exposure to noxious stimuli causing extreme pain [6]. Whether such performance capability is the result of pain adaptation, high motivation levels, stoicism, or other factors is unknown. Partially due to observations of people who are capable of maintaining high performance or activity levels despite high pain intensity, pain and function have been considered separate and independent constructs [7,8]. This division has had implications on the clinical assessment and measurement of pain and function (ie, one may be measured without considering the other) and on the goals of treatment and rehabilitation. Pain-based treatments often are contrasted with function-based care [9].

Various tools and questionnaires have been described in the literature and are widely accepted as reliable and valid indicators of the pain and function constructs [10]. Self-report functional measures inquire directly about the cognitions, perceptions, beliefs, and attitudes of the individual completing the questionnaire and have been found to correlate moderately to highly with self-ratings of pain, especially in more chronic conditions [11,12•,13]. Performance-based functional measures, including formal FCEs, have been promoted as alternative methods of identifying functional levels, which may be more "objective" or, in other words, less dependent on patient self-ratings [7,14]. Numerous FCE batteries have been described and are currently marketed [1].

Performance-based functional testing has become of tremendous interest to insurers adhering to injury models of disability, such as most workers' compensation systems, in which pain developing in the workplace needs to be linked to identifiable tissue injury or physical pathology [15]. Non-specific pain conditions, including regional back, neck, or shoulder pain, are of special concern because these conditions represent leading causes of work disability, but do not fit traditional injury models [16]. No signs of injury or tissue damage are typically seen in these conditions; however, they often result in severe and prolonged work disability. This has led to strong support for assessment procedures, such as FCEs, capable of identifying work ability and limitations independent of worker self-ratings. Most FCEs are undertaken on people with such conditions, and most FCE research has been done on workers with non-specific back pain.

Many insurance and workers' compensation jurisdictions rely on FCE results to inform claim and benefit adjudication processes and to document levels of functional impairment [15]. Subsequently, some workers unwilling or unable to perform to physical maximum levels during FCE (ie, those judged as demonstrating submaximal, inconsistent, or insincere effort) have been withheld indemnity benefits or had claims closed. The validity and "objectivity" of judgments made with FCE rely directly on the assumption of independence between function and pain (or other self-ratings), which implies that these constructs can be measured separately. However, new research findings have shed light on this fundamental underlying relationship as investigators have examined what factors influence subject performance during FCE.

Functional Capacity Evaluation Assessment Models

A variety of FCE assessment models or approaches have been described in the literature and used clinically, and typically vary according to acceptable test-termination points [17]. The two most common approaches are the psychophysical (also termed cognitive-behavioral or assessment of maximum acceptable load) and kinesiophysical (including biomechanical or physiologic) approaches. These two methods are described in this article and the literature is reviewed in consideration of the question regarding whether pain affects performance in these separate FCE approaches.

Testing of acceptable load

Psychophysical testing ensures that the individual undergoing testing is in control of the weight or force handled and ability is assessed within self-rated tolerable levels [18]. Intolerable increases in pain intensity with increased load are accepted as valid reasons for test termination and, therefore, pain is by definition a critical factor influencing psychophysical FCE results. Empirical observations have confirmed the close association between pain and maximal performance during this form of FCE (Table 1).

Consistently, higher pain levels have been found to be associated with lower psychophysical FCE performance. In a sample of 85 subjects with chronic low back pain, Lackner et al. [19] found that ratings of pain intensity on a visual analogue scale entered final regression models predicting psychophysical waist-to-eye level lifting and bilateral carrying. Higher pain was associated with lower lift performance. The authors confirmed these findings in a separate cohort of 100 non-working subjects with chronic back pain and found a significant association between average pain intensity and floor-to-waist lift performance [20••]. The association was maintained even after controlling for other factors thought to influence lift performance, such as gender and anxiety levels. The authors also observed a close association between functional self-efficacy beliefs and FCE performance, and hypothesized that functional self-efficacy may mediate the influence of pain intensity on psychophysical lift performance in some circumstances. Higher pain intensity may diminish functional self-efficacy beliefs, which subsequently reduces actual lifting ability.

In another study of 65 subjects with chronic pain who completed interdisciplinary functional restoration programs, Vowles and Gross [21•] observed a modest but statistically significant association ($r = \sim 0.25$; $P < 0.05$) between pain intensity, as measured with the McGill Pain Questionnaire, and psychophysical lift performance. Again, higher pain intensity was associated with lower lift performance. In a study of 98 men with persistent pain referred for treatment at an industrial rehabilitation center, Burns et al. [22] found a small but significant correlation ($r = 0.27$; $P < 0.01$) between the Pain Severity Scale of the Multidimensional Pain Inventory and a psychophysical carry test modeled after the Progressive Isoinertial Lifting Evaluation (PILE). However, these authors were able to predict performance on the PILE and carrying activity more effectively using the Pain Anxiety Symptoms Scale.

For making return-to-work decisions, FCE performance most commonly is compared with occupational demand levels. The matching relationship between psychophysical FCE and job demands also appears associated with pain factors. Fishbain et al. [23] compared psychophysical FCE results with occupational demands in 67 patients with chronic low back pain and observed moderate, statistically significant correlations ($r = 0.36$–0.60; $P < 0.01$) between the total number of FCE items failed and three separate tests of pain intensity. This finding was confirmed in a separate study of 188 patients with chronic pain being admitted for multidisciplinary pain treatment [24••]. Cutler et al. [24••] found pain to be a primary predictor of whether patient performance met job requirements on lifting, stooping, and crouching tests from an FCE based on Dictionary of Occupation Titles work activities.

Research findings from Wallbom et al. [25] have important implications on the interpretation of psycho-

Table 1. Summary of articles examining the relationship between pain and functional capacity evaluation

Study	Study design	Subjects	Results
Psychophysical testing			
Lackner et al. [19]	Cross-sectional	85 people with chronic back pain	Pain VAS entered a final regression model predicting dynamic waist-to-eye ($P < 0.001$) and bilateral carrying ($P < 0.01$); functional self-efficacy was the most robust predictor of life performance
Lackner et al. [20••]	Cross-sectional	100 people off work with chronic back pain	Average pain intensity on VAS entered final model ($P < 0.01$) predicting dynamic floor-to-waist lift; functional self-efficacy was the most robust predictor
Vowles and Gross [21•]	Longitudinal	65 people with chronic pain who completed functional restoration programs	Higher pain ratings on the McGill Pain Questionnaire were associated with lower floor-to-waist lifting ($r = 0.25$; $P < 0.05$), and carrying ($r = 0.26$; $P < 0.05$) at the beginning and end of rehabilitation programs
Fishbain et al. [23]	Cross-sectional	67 people with chronic pain	Total number of failed FCE items correlated with the UAB pain behavior scale ($r = 0.60$; $P < 0.001$), a VAS ($r = 0.36$; $P < 0.01$), and a low back pain VAS ($r = 0.38$; $P < 0.001$)
Cutler et al. [24••]	Longitudinal	188 people with chronic low back pain undergoing multidisciplinary pain treatment	At program admission, a pain VAS significantly predicted FCE stooping ($\beta = 0.79$), crouching ($\beta = 0.77$), and lifting ($\beta = 0.76$); pain also significantly predicted future work status
Burns et al. [22]	Cross-sectional	98 men with persistent pain being treated at a work rehabilitation program	A small, but significant correlation ($r = 0.27$; $P < 0.01$) was observed between the Pain Severity Scale of the Multidimensional Pain Inventory and a psychophysical carry test modeled after the PILE; performance on the PILE and carrying activity was predicted more effectively using the Pain Anxiety Symptoms Scale
Kinesiophysical testing			
Gross and Battie [12•]	Cross-sectional	321 workers with chronic pain	Pain VAS correlated with maximum FCE manual handling (average floor-to-waste, waist-to-overhead, and horizontal lift; $r = 0.45$; $P < 0.05$) and number of failed FCE items ($r = 0.34$; $P < 0.05$)
Gross and Battie [28••]	Cross-sectional	170 workers with chronic back pain	Pain VAS significantly predicted FCE floor-to-waist performance and number of failed FCE items (R2 ~ 0.10)
Unknown testing approach			
Hart [30]	Cross-sectional	42 workers with chronic pain syndromes	Higher SF-36 Bodily Pain Scale correlated with FCE floor-to-waist lift ($r = 0.56$), waist-to-shoulder lift ($r = 0.42$), and dynamic 10-foot carrying (0.25)

FCE—functional capacity evaluations; PILE—Progressive Isoinertial Lifting Evaluation; UAB—University of Alabama at Birmingham; VAS—visual analog scale.

physical FCE and on the relationship between pain and FCE performance. In a study of 50 subjects undergoing multidisciplinary assessment for chronic pain conditions, higher ratings of perceived exertion (BORG scale) were associated with and apparently influenced by higher pain levels. Patients with higher pain levels rate their exertion levels as higher than those with lower pain levels, and thus may be prone to terminate psychophysical FCE testing more rapidly. It is clear by definition and through review of the literature that testing of acceptable performance levels during FCE is influenced by pain perceptions of the individual being tested.

Reliance on Rater Observation

In contrast to psychophysical testing, which places control of test termination with the individual being tested, kinesiophysical testing places control of test termination with administering clinicians who are trained to observe biomechanical and physiologic signs of effort and exertion [26]. When performance of the individual being tested reaches or exceeds pre-defined safety thresholds (eg, heart rate maximums, biomechanical instability), assessment is stopped and maximum levels determined [27]. Because kinesiophysical endpoints are of a purely physical nature, this approach to testing has been reported as

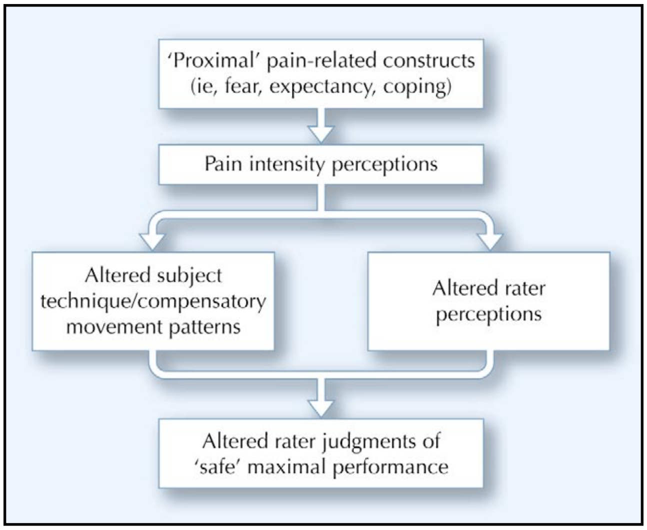

Figure 1. Possible model of pain's influence on functional capacity evaluation.

independent of the subject's perceptual or cognitive influence and, therefore, independent of the influence of pain. Traditionally, testing of this nature has been marketed as more "objective" and independent of worker "subjective" perceptions. However, some recent investigations have examined the influence of worker self-ratings on kinesiophysical FCE performance and brought this underlying assumption into question.

The construct validity of kinesiophysical FCE and the purported independence of pain and function was examined in a cross-sectional study by Gross and Battié [12•] in a sample of 321 workers' compensation claimants with low back pain conditions. Pain intensity and perceived disability due to pain were moderately and significantly associated ($r = 0.34–0.52$; $P < 0.05$) with maximum kinesiophysical lift levels and the number of failed FCE items when demonstrated performance was compared with required job demands. As in the case of psychophysical testing, higher pain ratings were associated with lower FCE performance. These results were confirmed in a separate sample of 170 workers' compensation claimants with back pain conditions, for whom pain intensity and pain-related disability ratings explained the largest amount of variance ($r^2 \sim 10\%–20\%$) in regression models predicting indicators of kinesiophysical FCE performance [28••]. Kinesiophysical FCE does not appear completely independent of the "subjective" pain ratings of the individual being tested.

Two proposed pathways as to how pain influences rater judgments during kinesiophysical FCE include an influence on demonstrated performance and an influence on rater observations (Fig. 1). Higher pain levels potentially alter the biomechanical techniques of the individual being tested (eg, greater limping, more asymmetrical trunk positions to avoid painful positions) and these compensatory patterns lead raters to judge lower performance as maximum ability. Alternatively, pain complaints or demonstrated behaviors may consciously or subconsciously alter the perceptions of the therapist administering the FCE, leading them to terminate testing at lower performance levels. In the latter case, evaluator beliefs and attitudes regarding pain and function will have important consequences. Therapists who hold more fear-avoidant attitudes toward pain may be more likely to terminate testing at lower performance levels. Of note, it appears that kinesiophysical testing may not be influenced by subject fear-avoidance beliefs, although this observation requires confirmation [29].

In a study by Hart [30], the method used for identifying maximal endpoints during FCE was not specified. In this study of 42 patients referred to one industrial rehabilitation clinic for chronic work-related symptoms, the author observed a moderate association between pain intensity and FCE lifting, with the highest association ($r = 0.56$) observed between pain intensity and floor-to-waist lifting.

Sincerity of Effort Testing

In addition to determining maximal functional performance capabilities, FCEs also are used frequently to make judgments related to sincerity of effort. When adjudication decisions are made based on such findings, claimants judged to be insincere, inconsistent, or providing less than full effort may have benefits suspended or claims closed. Various techniques and strategies are used to inform such judgments; however, none have been thoroughly examined and shown to be valid for this important purpose [31]. In addition, the techniques used for making such judgments appear to be influenced by pain, pain-related disability ratings, depression, and anxiety (with both of the latter also closely associated with and affected by pain) [32].

Other Forms of Functional Performance Testing

In studies examining other forms of functional capacity testing, such as isokinetic or isometric strength testing, pain remains an important factor. In a group of 148 subjects with back pain for more than 3 months, Mannion et al. [33] examined the correlation between isometric back strength and a wide variety of psychologic factors. The only significant association observed was between pain and maximal isometric back strength ($r^2 = 7.4\%$). The authors also reported that none of their measures of back muscle structure, including magnetic resonance imaging of muscle dimensions, correlated significantly with pain intensity. Al-Obaidi et al. [34] also observed significant correlations between pain intensity during performance on an isometric strength test and maximum performance on the strength test in a group of 63 subjects with chronic low back pain. More importantly, the same authors reported a higher correlation between pain-related fear and performance on the strength test.

More generic, as opposed to work-related, batteries of performance tests have been examined to determine underlying constructs and relationships with self-ratings on factors such as pain intensity. In a series of studies conducted on patients with back pain, Simmonds et al. [35–37] investigated a battery of back-related performance tests (lumbar flexion, repeated trunk flexion, sit-to-stand, walking, reaching, and the Sorenson truck extension test). They have reported that self-ratings of pain and disability are modestly but significantly associated with functional performance. In addition, they found the Sorenson trunk extension test, long thought to measure trunk endurance, to be most commonly terminated due to back pain [38]. This is consistent with findings from Rashiq et al. [39] who report increased performance levels on this test after administration of pain-relieving medication. Although performance-based functional testing seems to provide some unique information that cannot be obtained through relying on patient self-reports, it appears artificial to consider functional testing as entirely independent of pain perceptions or beliefs.

Table 2. Definitions of various pain-related constructs observed to influence performance-based functional testing

Pain construct	Definition
Pain intensity	Perceived magnitude of pain severity
Pain-related fear	Unpleasant emotion associated with the anticipation of pain; often arises from a belief that pain is a sign of damage or bodily harm and that activities that may cause pain should be avoided
Pain expectations	Pain that is anticipated to accompany a future activity or event
Perceived pain control	A person's perceived ability to independently cope with or manage pain; people with strong pain control beliefs experience less distress and higher function than people with weak convictions of pain control
Pain self-efficacy	People's confidence in their ability to cope with or manage pain, especially during activity; people with low pain self-efficacy may 'give up' quickly in the absence of pain relief

Other Important Pain-related Constructs

Whereas the perception of pain intensity has been found consistently associated with FCE performance, other pain constructs appear to be even more important [40]. The findings of Al-Obaidi et al. [34] related to the important influence of pain-related fear on isometric strength testing have already been described. A number of additional constructs have been identified and examined in the literature, and detailed models of the interrelationship between these factors have been proposed [41]. The fear-avoidance model of disability has been advocated and is rapidly gaining acceptance [42]. Some of the most influential pain constructs appear to be pain-related fear, pain self-efficacy, pain expectations, and perceived pain control. These constructs are defined in Table 2. As is evident from the table, these constructs include cognitive, perceptual, and emotional factors. These variables likely have direct influences on functional ability and indirect influences through altering functional self-efficacy cognitions, although the specific mechanism of how these variables interrelate to influence function is unknown.

Influence on Return-to-work Decisions

If FCE is not completely independent of the pain-related perceptions, cognitions, or emotions of the individuals being assessed, what impact does this have on FCE interpretation and return-to-work decision-making? Primarily, FCE cannot be considered a completely "objective" indicator of functional impairment. FCE and other forms of performance-based functional testing indeed are influenced by physical factors such as strength, aerobic fitness, and gender, and provide some unique information that cannot be obtained through self-report questionnaires [28••,35,43]. However, a degree of "subjectivity" also is inherent to FCE. Pain intensity or other pain-related psychologic factors may alter a worker's performance during testing, or pain may have an important influence on rater maximal ability determinations. Therefore, in insurance and workers' compensation jurisdictions that use FCE to inform claims adjudication processes, FCE results can inform, but should not be relied on to provide objective findings for determining legitimacy of work-related injuries. FCE results are interpreted more correctly as behavioral tests of functional ability, influenced by a multitude of factors including pain and other cognitive, emotional, and physical variables [44]. Although frequent and prolonged discussion about pain during FCE testing is not warranted, at a minimum, performance testing should be accompanied by pre-assessment self-ratings of function and pain intensity. Post-FCE measurements of pain intensity also are recommended and can provide important information related to the individual's response to testing and sustained work activity.

Related to return-to-work decisions, some research has investigated the validity of predictions made using FCE. It appears that FCE results are modestly associated with future recovery outcomes and that the likelihood of return-to-work following FCE is quite good [45–47]. In fact, the likelihood of return-to-work following FCE appears more positive than the prognosis of most chronic pain conditions, which typically is very negative after 6 months or more of work loss. Therefore, the process of FCE may be beneficial for facilitating return-to-work and assisting in re-integrating workers to the workforce. However, a match between FCE performance and required job demands is no guarantee that a worker will experience sustained return [48]. Other factors, including the pain-related constructs discussed in this article, are critical and also must be taken into consideration when forecasting future work status. Cutler et al. [24••] have reported that although FCE measures are important predictors, return-to-work cannot be predicted without taking pain into account. Even then, work status is a volatile outcome by nature and even the best prediction models are not capable of 100% accuracy. Other unknown and often unpredictable factors including economic trends and downsizing have larger influences on work status.

Are Lengthy Functional Capacity Evaluations Needed?

Although return-to-work outcomes following FCE appear positive, the most effective approach and duration of FCE testing are less clear. No data exist directly comparing psychophysical and kinesiophysical FCE testing in terms of effectiveness at facilitating return-to-work. In addition, current FCE protocols are quite diverse and vary in terms of the activities assessed and the duration of testing. Some protocols can be completed within a few hours, whereas others take days. Given the emerging understanding of FCE as a behavioral assessment and the modest predictive ability observed, shorter, less burdensome protocols may be as capable as longer protocols at identifying important recovery barriers. Ruan et al. [49] developed and tested the Functional Assessment Screening Test (FAST) made up of five brief, non-strenuous performance activities. In 188 patients with chronic back pain, the FAST protocol was found to effectively identify individuals with high levels of pain avoidance, dysfunctional pain-coping mechanisms, depression, and self-reported disability. Furthermore, when investigating FCE predictive value, independent researchers have confirmed that most predictive ability rests within only a few FCE items. In workers with chronic back pain, it appears that floor-to-waist lifting and crouching are critical activities and as predictive as entire FCE protocols. Potentially, brief FCE protocols could effectively identify perceptual and psychologic recovery barriers, provide comparable predictive value, and successfully guide return-to-work decisions.

Future Research Directions

Although the mechanism for how pain affects psychophysical FCE seems straightforward, the underlying mechanism for how pain influences kinesiophysical testing is unknown and an avenue for future research. If pain reporting and behavior alter or influence rater judgments, FCE training sessions may need to be modified to adjust for this influence. In addition, the structural mechanisms through which the various pain-related constructs act to influence functional performance also need to be elucidated more clearly. Knowing which factors affect FCE and other functional testing should provide clues for understanding disability more broadly and help improve treatment strategies. Lastly, the optimal 'dosage' or duration of functional testing needs to be examined. Shorter assessments potentially may be as effective at determining barriers to functional work performance as longer, more burdensome, and expensive FCEs.

Conclusions

Functional capacity evaluations are behavioral assessments influenced by pain intensity and other pain-related constructs. Increasing pain levels are consistently associated with reduced FCE performance levels. As such, for purposes of claims adjudication, FCE should not be considered a purely "objective" indicator of functional impairment independent of subject or evaluator perceptions. FCE may have some value for facilitating return-to-work or re-integrating chronically disabled workers into the workforce, although pain factors must be taken into account.

References and Recommended Reading

Papers of particular interest, published recently, have been highlighted as:

- • Of importance
- •• Of major importance

1. King PM, Tuckwell N, Barrett TE: **A critical review of functional capacity evaluations.** *Phys Ther* 1998, **78:**852–866.
2. Abdel-Moty E, Fishbain DA, Khalil TM, et al.: **Functional capacity and residual functional capacity and their utility in measuring work capacity.** *Clin J Pain* 1993, **9:**168–173.
3. Lechner D, Roth D, Straaton K: **Functional capacity evaluation in work disability.** *Work* 1991, **1:**37–47.
4. Geisser ME, Robinson ME, Miller QL, Bade SM: **Psychosocial factors and functional capacity evaluation among persons with chronic pain.** *J Occup Rehabil* 2003, **13:**259–276.
5. Linton SJ: **The relationship between activity and chronic back pain.** *Pain* 1985, **21:**289–294.
6. Leikind BJ, McCarthy WJ: **Firewalking.** *Experientia* 1988, **44:**310–315.
7. Isernhagen SJ: **Return to work testing: functional capacity and work capacity evaluation.** *Orthop Phys Ther NA* 1992, **1:**83–98.
8. Deyo RA: **Measuring the functional status of patients with low back pain.** *Arch Phys Med Rehabil* 1988, **69:**1044–1053.
9. Kool JP, Oesch PR, Bachmann S, et al.: **Increasing days at work using function-centered rehabilitation in nonacute, nonspecific low back pain: a randomized, controlled trial.** *Arch Phys Med Rehabil* 2005, **86:**857–864.
10. Finch E, Brooks D, Stratford P, Mayo N: *Physical Rehabilitation Outcome Measures: A Guide To Enhanced Clinical Decision Making*, edn 2. Toronto: Canadian Physiotherapy Association; 2002.
11. Kovacs FM, Abraira V, Zamora J, et al.: **Correlation between pain, disability, and quality of life in patients with common low back pain.** *Spine* 2004, **29:**206–210.

12.• Gross DP, Battie MC: **Construct validity of a kinesiophysical functional capacity evaluation administered within a worker's compensation environment.** *J Occup Rehabil* 2003, **13:**287–295.

This study examines the association between pain and FCE performance in injured workers. Pain intensity was found moderately correlated with FCE performance.

13. McGorry RW, Webster BS, Snook SH, Hsiang SM: **The relation between pain intensity, disability, and the episodic nature of chronic and recurrent low back pain.** *Spine* 2000, **25:**834–841.

14. Sachs BL, David JA, Olimpio D, et al.: **Spinal rehabilitation by work tolerance based on objective physical capacity assessment of dysfunction: a prospective study with control subjects and 12-month review.** *Spine* 1990, **15:**1325–1332.

15. Strong S, Baptiste S, Clarke J, et al.: **Use of functional capacity evaluations in workplaces and the compensation system: a report on workers' and report users' perceptions.** *Work* 2004, **23:**67–77.

16. Hadler NM: *Occupational Musculoskeletal Disorders,* edn 2. Philadelphia: Lippincott Williams & Wilkins; 1999.

17. Gardener L, McKenna K: **Reliability of occupational therapists in determining safe, maximal lifting capacity.** *Aust Occ Ther J* 1999, **46:**110–119.

18. Snook SH: **Future directions of psychophysical studies.** *Scand J Work Environ Health* 1999, **25(suppl 4):**13–18.

19. Lackner JM, Carosella AM, Feuerstein M: **Pain expectancies, pain, and functional self-efficacy expectancies as determinants of disability in patients with chronic low back disorders.** *J Consult Clin Psychol* 1996, **64:**212–220.

20.•• Lackner JM, Carosella AM: **The relative influence of perceived pain control, anxiety, and functional self-efficacy on spinal function among patients with chronic low back pain.** *Spine* 1999, **24:**2254–2261.

A methodologically sound study examining the influence of pain and self-efficacy beliefs on psychophysical lift performance. Higher pain levels were associated with lower lift performance.

21.• Vowles KE, Gross RT: **Work-related beliefs about injury and physical capability for work in individuals with chronic pain.** *Pain* 2003, **101:**291–298.

Longitudinal study examining the influence of pain on FCE performance. Relationships were examined before and after rehabilitation programs.

22. Burns JW, Mullen JT, Higdon LJ, et al.: **Validity of the pain anxiety symptoms scale (PASS): prediction of physical capacity variables.** *Pain* 2000, **84:**247–252.

23. Fishbain DA, Abdel-Moty E, Cutler R, et al.: **Measuring residual functional capacity in chronic low back pain patients based on the Dictionary of Occupational Titles.** *Spine* 1994, **19:**872–880.

24.•• Cutler RB, Fishbain DA, Steele-Rosomoff R, Rosomoff HL: **Relationships between functional capacity measures and baseline psychological measures in chronic pain patients.** *J Occup Rehabil* 2003, **13:**249–258.

Examines the relationships between FCE performance and pain and other psychologic factors. The authors also examined the ability of FCE and self-ratings to predict return to work.

25. Wallbom AS, Geisser ME, Haig AJ, et al.: **Concordance between rating of perceived exertion and function in persons with chronic, disabling back pain.** *J Occup Rehabil* 2002, **12:**93–98.

26. Isernhagen SJ: **Functional capacity evaluation: rationale, procedure, utility of the kinesiophysical approach.** *J Occup Rehabil* 1992, **2:**157–168.

27. Reneman MF, Fokkens AS, Dijkstra PU, et al.: **Testing lifting capacity: validity of determining effort level by means of observation.** *Spine* 2005, **30:**E40–E46.

28.•• Gross DP, Battie MC: **Factors influencing results of functional capacity evaluations in workers' compensation claimants with low back pain.** *Phys Ther* 2005, **85:**315–322.

Examines the influence of various physical factors, pain intensity, and self-rated disability on FCE performance. Pain and disability ratings were the most important determinants.

29. Reneman MF, Jorritsma W, Dijkstra SJ, Dijkstra PU: **Relationship between kinesiophobia and performance in a functional capacity evaluation.** *J Occup Rehabil* 2003, **13:**277–285.

30. Hart DL: **Relation between three measures of function in patients with chronic work-related pain syndromes.** *J Rehabil Outcome Measure* 1998, **2:**1–14.

31. Fishbain DA, Cutler R, Rosomoff HL, Rosomoff RS: **Chronic pain disability exaggeration/malingering and submaximal effort research.** *Clin J Pain* 1999, **15:**244–274.

32. Kaplan GM, Wurtele SK, Gillis D: **Maximal effort during functional capacity evaluations: an examination of psychological factors.** *Arch Phys Med Rehabil* 1996, **77:**161–164.

33. Mannion AF, Junge A, Taimela S, et al.: **Active therapy for chronic low back pain: part 3. Factors influencing self-rated disability and its change following therapy.** *Spine* 2001, **26:**920–929.

34. Al-Obaidi SM, Nelson RM, Al-Awadhi S, Al-Shuwaie N: **The role of anticipation and fear of pain in the persistence of avoidance behavior in patients with chronic low back pain.** *Spine* 2000, **25:**1126–1131.

35. Simmonds MJ, Olson SL, Jones S, et al.: **Psychometric characteristics and clinical usefulness of physical performance tests in patients with low back pain.** *Spine* 1998, **23:**2412–2421.

36. Novy DM, Simmonds MJ, Lee CE: **Physical performance tasks: What are the underlying constructs?** *Arch Phys Med Rehabil* 2002, **83:**44–47.

37. Lee CE, Simmonds MJ, Novy DM, Jones S: **Self-reports and clinician-measured physical function among patients with low back pain: a comparison.** *Arch Phys Med Rehabil* 2001, **82:**227–231.

38. Simmonds MJ, Lee CE: **Sorensen endurance test: A test of muscle fatigue or pain?** *J Pain* 2001, **2(suppl 1):**12.

39. Rashiq S, Koller M, Haykowsky M, Jamieson K: **The effect of opioid analgesia on exercise test performance in chronic low back pain.** *Pain* 2003, **106:**119–125.

40. Crombez G, Vlaeyen JW, Heuts PH, Lysens R: **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:**329–339.

41. Vlaeyen JW, Linton SJ: **Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art.** *Pain* 2000, **85:**317–332.

42. Lethem J, Slade PD, Troup JD, Bentley G: **Outline of a Fear-Avoidance Model of exaggerated pain perception: I.** *Behav Res Ther* 1983, **21:**401–408.

43. Matheson LN, Leggett S, Mooney V, et al.: **The contribution of aerobic fitness and back strength to lift capacity.** *Spine* 2002, **27:**1208–1212.

44. Rudy TE, Dieber SJ, Boston JR: **Functional capacity assessment: influence of behavioural and environmental factors.** *J Back Musculoskel Rehabil* 1996, **6:**277–288.

45. Gross DP, Battie MC, Cassidy JD: **The prognostic value of functional capacity evaluation in patients with chronic low back pain: part 1. Timely return to work.** *Spine* 2004, **29:**914–919.

46. Matheson LN, Isernhagen SJ, Hart DL: **Relationships among lifting ability, grip force, and return to work.** *Phys Ther* 2002, **82:**249–256.

47. Fishbain DA, Cutler RB, Rosomoff H, et al.: **Validity of the dictionary of occupational titles residual functional capacity battery.** *Clin J Pain* 1999, **15:**102–110.

48. Gross DP, Battie MC: **Functional capacity evaluation performance does not predict sustained return to work in claimants with chronic back pain.** *J Occup Rehabil* 2005, **15:**285–294.

49. Ruan CM, Haig AJ, Geisser ME, et al.: **Functional capacity evaluations in persons with spinal disorders: predicting poor outcomes on the Functional Assessment Screening Test (FAST).** *J Occup Rehabil* 2001, **11:**119–132.