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Domains of chronic low back pain and assessing treatment effectiveness: A clinical perspective

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ABSTRACT

Chronic non-specific low back pain (CLBP) is a common clinical condition that has impacts at both the individual and societal level. Pain intensity is a primary outcome used in clinical practice to quantify the severity of CLBP and the efficacy of its treatment, however, pain is a subjective experience that is impacted by a multitude of factors. Moreover, differences in effect sizes for pain intensity are not observed between common conservative treatments, such as spinal manipulative therapy, cognitive behavioural therapy, acupuncture and exercise training. As pain science evolves, the biopsychosocial model is gaining interest in its application for CLBP management. The aim of this paper is to discuss our current scientific understanding of pain and present why additional factors should be considered in conservative CLBP management. In addition to pain intensity, we recommend that clinicians should consider assessing the multidimensional nature of CLBP by including physical (disability, muscular strength and endurance, performance in activities of daily living and body composition), psychological (kinesiophobia, fear-avoidance, pain catastrophizing, pain self-efficacy, depression, anxiety and sleep quality), social (social functioning and work absenteeism) and health-related quality of life measures, depending on what is deemed relevant for each individual. This review also provides practical recommendations to clinicians for the assessment of outcomes beyond pain intensity, including information on how large a change must be for it to be considered 'real' in an individual patient. This information can guide treatment selection when working with an individual with CLBP.

BACKGROUND

Low back pain (LBP) occurs in 40-85% of people at some point in their lives^{1,2} and remains the leading cause of reduced function and years lived with disability worldwide.^{3,4} Costs of LBP in the United States of America were shown to be as high as US\$102 billion per year.⁵ Furthermore, a systematic review showed that up to 71% of individuals with acute LBP are not fully recovered after one year, which may contribute to the costs of the condition.⁶ Chronic LBP (CLBP) is defined as persistent pain for a period of greater than 12 weeks⁷ and affects approximately 20% of the global population.¹ In CLBP, 85-90% of cases have pain that cannot be determined to arise from a definitive pathoanatomic structure or pathology,⁸ and is therefore termed 'non-specific'.⁹ Specific pathologies that cause LBP include infections, metastasis/tumours, osteoporosis, inflammatory disorders, pregnancy, disc herniation and spinal stenosis for the minority of cases.⁹ Regarding types of pain, nociceptive pain arises from threatened or damaged tissue due to the activation of nociceptors, while neuropathic pain is considered to be caused by lesions in the somatosensory nervous system.¹⁰ Nociceptive and neuropathic causes of pain can originate from specific spinal tissues, with various symptoms, such as the location of pain, numbness and tingling, aggravating and relieving movements, characterising different structures that are affected (e.g. facet joint syndrome, radicular pain and spinal stenosis).¹¹ Moreover, nociplastic pain is defined as pain that is disproportionate to the LBP experience, barely related to spine movement or loading, and may or may not related to psychological factors.¹⁰ To avoid over-diagnosing non-specific CLBP, mechanism-based approaches have been previously suggested and could be followed clinically to help better determine specific nociceptive, neuropathic and nociplastic causes of pain.^{11,12}

The management of non-specific CLBP is complicated by multi-dimensional contributions and consequences, including biological, psychological, and social factors.¹³ Conservative approaches, such as spinal manipulative therapy, cognitive behavioural therapy (CBT), pain neuroscience education (PNE), acupuncture and exercise training have shown some success for reducing pain intensity, but the magnitude of their effect remains modest.⁸ However, less emphasis has been placed on physical function, general deconditioning, social isolation and psychological distress, which are known to be compromised in individuals with CLBP.^{14,15} This review aims (i) to discuss the various

factors that may influence pain intensity at the level of the central nervous system (CNS), (ii) to review the multiple domains affected in individuals with CLBP and (iii) propose outcome measures that capture each domain and highlight treatments that may impact these measures.

FACTORS INFLUENCING PAIN

Pain is a distressing experience that fulfils a protective function essential for survival. It acts as a stimulus to modify behaviours that might be detrimental for tissue integrity and may inform an individual potential or actual tissue damage.¹⁶ Pain is also a personal, subjective experience that is influenced by genetic, sensory, psychological, emotional, cultural and social factors.¹⁶ The impact of such contextual factors can be seen in the pathophysiology of perceived acute pain intensity through both peripheral and central processes.¹⁷ Peripherally, nociceptors are depolarized by noxious stimuli (e.g. mechanical, thermal or chemical stimuli) and the information travels through afferent fibres to the dorsal horn of the spinal cord where the signal may undergo modulation before reaching the supraspinal centers.¹⁸ Multiple brain regions analyse the transmitted information from the periphery with respect to several aspects of the threat (e.g. sensory, awareness, memory, emotional) and depending on the context of the threat, the nociceptive stimuli can be perceived as pain of varying intensity.¹⁹ For instance, descending pathways can facilitate or inhibit the nociceptive information where descending pain modulation pathways lie.¹⁹ It is through this mechanism that pain is influenced by top down contextual and dynamic factors (e.g. perceived threat, anxiety, mood, pain-memories) which will determine the resulting pain experience.¹⁹ In contrast to acute pain where there is a clear protective role, the ongoing experience of pain, definitive of chronic pain conditions, has been suggested to reflect a mismatch between the information on the state of the tissues coming from the peripheral receptors (no acute tissue injury) and the central processing of these information (perceived pain reflecting threat to the tissues).^{20,21} Therefore, pain may move from being an appropriate protective response to becoming overprotective, or results from a heightened state of sensitivity unrelated to tissue pathology.^{20,21} Persistence of this state of enhanced sensitivity of the CNS pain system (in the brain and the spinal cord), can characterize some individuals with CLBP.²⁰

Both the peripheral (e.g. nociceptive terminal) and central nervous systems (e.g. spinal cord and brain) can undergo changes that increase their sensitivity (e.g. increasing synaptic strength via long-term potentiation) so that the efficacy of pain processing and protective reactions can be enhanced (Figure 1).²⁰ Peripherally, tissues (e.g. intervertebral discs) may be characterized by chronic inflammatory states which can increase nociceptive stimulus strength where synaptic terminals lie in individuals with CLBP.²² At the spinal cord, hypersensitivity is increased through pro-inflammatory cytokine release, astrocyte and glial cell activation, which can reduce inhibitory tone and increase synaptic efficiency of ascending nociceptive stimuli (e.g. wind-up mechanism).¹⁷ The presence of an increased wind-up phenomenon can be evaluated by temporal summation paradigms which use brief repetitive mechanical, thermal or electrical stimuli delivered 1–3 times per second for 5 to 10 seconds.²³ In the case of increased wind-up mechanism, the temporal pain response is increased from the first to last repetition.²⁴ This process within the spinal cord may lead to dynamic changes in second order spinal neurons (e.g. dorsal horn) that could be important for the development and maintenance of central sensitization in CLBP.²⁵ It is also believed that central sensitization provides an overarching framework to better understand the transition of large-scale brain network activity in acute to chronic pain.²⁶ In acute or experimental pain conditions, the brain networks activated are those mostly involved in the processing of the sensory-discriminative nature of pain (e.g. somatosensory cortex), whereas in chronic pain, the activity shifts to the brain networks related to emotional processing (e.g. prefrontal cortex).²⁶ These alterations affect the expression and experience of pain as a result of the interplay between physiological (e.g. motor, sensory, autonomic) and psychological (e.g. emotion, cognition, learning) systems.^{26,27} This may explain why behavioural consequences, such as cognitive and memory deficits, exist in people with CLBP.²⁸ It is now widely recognised that the intensity of pain can be moderated by psychological factors arising through neurobiological pathways in CLBP, and that these factors influence disability and the response to treatment.²⁹ Hence, there is an urgent need to increase the consideration of the multidimensionality of pain in the assessment and treatment of CLBP.

<INSERT FIGURE 1 HERE>

CURRENT MANAGEMENT OVER FOCUSES ON PAIN INTENSITY

Clinical treatment guidelines highlight the importance of conservative treatments for individuals with non-specific CLBP.⁷ Conservative interventions, such as PNE,³⁰ CBT,³¹ spinal manipulative therapy and various forms of exercise training have shown some success in treating CLBP.³² Pain intensity is a common outcome used in the treatment of CLBP in clinical practice and is quantified through self-reported scales, such as the visual analogue scale (VAS).³³ The VAS most commonly ranges from 0-100mm, with higher scores indicating a greater pain intensity.³³ A 20mm reduction in pain intensity on the VAS is considered a clinically meaningful change.³³ Meta-analyses in CLBP show differences in pain intensity do not reach the clinically meaningful threshold when interventions are compared.⁸ Therefore, clinicians and patients should consider basing their choice of conservative management on additional outcomes and mutually agreed goals.³⁴ Clinical guidelines in CLBP have moved towards the biopsychosocial model, which may provide clinicians with some insights into additional domains to consider for their patients (Figure 2).^{35,36} Considering that various domains are impacted in CLBP, management could aim to target these outcomes in addition to reducing pain intensity.¹⁴ Therefore, after the patient is subjectively assessed for risk factors and goals, we propose that clinicians should select outcome measures which are relevant to the person they are treating, that can be easily administered in clinical practice settings and that capture the most important domains of the biopsychosocial model, including physical, psychological and social well-being (Table 1).³⁷

<INSERT FIGURE 2 HERE>

<INSERT TABLE 1 HERE>

MULTIDIMENSIONAL ASSESSMENT OF CHRONIC LOW BACK PAIN

Biological and Functional Outcomes

Disability

Disability due to CLBP is restriction performing activities of daily living (ADLs) and could be a more important reason for individuals to seek care than pain intensity.³⁸ A meta-analysis showed highly disabled individuals with LBP were eight times more likely to seek care than those with low

disability.³⁸ Targeting self-reported disability due to LBP with treatment may help reduce the need to seek professional advice (e.g. physiotherapist, physical therapist or exercise physiologist),³⁹ improve the ability of the individual to complete ADLs³⁸ and subsequently reduce health care costs.⁴⁰

Furthermore, clinical guidelines recommend assessing disability should be the highest priority for clinicians.⁴¹ In addition to LBP disability measures, tools such as the Orebro musculoskeletal pain questionnaire⁴² and the Keele STarT Back Tool⁴³ may also be used as an initial screening tool to predict long-term disability.^{42,43} As LBP is a key component contributing to the global burden of disability, self-reported measures of LBP disability and long-term disability prognosis should be considered when assessing the efficacy of CLBP treatments.

Muscular Endurance and Strength

A meta-analysis suggested muscular endurance and strength to be physical factors associated with LBP.⁴⁴ Individuals with CLBP often have reduced trunk muscle endurance and this may partially relate to the reduced physical capacity in this population.⁴⁵ Cross-sectional research in nurses demonstrated that reduced trunk extension endurance is associated with lower work capacities.^{46,47} Nurses with a full work capacity had a 77% higher trunk extension endurance compared to those with work modifications due to CLBP.⁴⁷ Furthermore, a systematic review showed functional status and physical demands may be important prognostic factors impeding return to work in those with CLBP.⁴⁸ Even though causality between CLBP and muscle function cannot be determined, improving trunk muscle endurance may provide important training specificity as it closely relates to occupational demands.⁴⁹ Periods of time away from work may lead to deconditioning towards work-related tasks, and therefore may need to be improved to assist with tasks completion and return to work.⁴⁸ Adequate levels of trunk endurance and overall strength appear to assist with ADLs and could be a prognostic factor for return to work, and should be considered in those with CLBP with high physical requirements.

Performance in Activities of Daily Living

Self-reported measures of disability may not reflect the daily functioning of an individual with CLBP.⁵⁰ Self-report and objective measures of physical function tend to have weak correlations

between each other,⁵¹ which may relate to the presence of psychological factors, such as depression, causing underestimations on self-report disability measures.⁵² Therefore, assessing self-reported and objective measures may be important to assess functional capacities for those with CLBP.⁵¹ However, some measures of performance testing (e.g. stair climbing) have been indicated to be poor at differentiating function between people with CLBP and healthy controls.⁵³ Furthermore, the ability of these measures to track change over time has been questioned, which may relate to a ceiling effect in those who are not highly disabled.⁵⁴ Performance battery tests could be reserved for those who are highly disabled and cannot perform maximal strength and endurance tests to provide applicable results.⁵⁴ Therefore, performance battery tests could be important to distinguish self-reported and objective physical function.

Adiposity

Individuals with CLBP often have an increased body fat percentage⁵⁵ and body mass index (BMI),⁵⁶ which may modulate pain through peripheral sensitisation from increased systemic inflammation.⁵⁷ Furthermore, increased fat infiltration of paraspinal musculature (particularly the lumbar multifidus) has been observed in CLBP,⁵⁸ and could be associated with an increased BMI.⁵⁹ This association is important as changes to paraspinal muscle composition could compromise function of the muscles that control and support the low back.^{60,61} Whilst the exact mechanisms and causality are unknown, adults with CLBP are more likely to present with obesity related comorbidities, such as coronary heart disease.⁶² Individuals with a higher BMI also have greater disability before and after treatment and it may have an important biomechanical influence on functional recovery in those with CLBP.⁶³ For example, those with CLBP and a BMI $>27\text{kg/m}^2$ have a 16% greater risk of remaining highly disabled at one-year.⁶⁴ Therefore, body weight, BMI, waist and hip circumference and waist-to-hip ratio could be assessed in those who are overweight or obese patients with CLBP, particularly as an increased BMI is associated with functional impairments and increased co-morbidities.⁶⁴

Psychological Outcomes

Kinesiophobia and Fear Avoidance

Kinesiophobia is defined as the fear of movement⁶⁵ and interferes with the ability to complete ADLs in individuals with CLBP.⁶⁶ A review showed individuals with disabling CLBP and high fear-avoidance beliefs had a 2-fold worse prognosis at 1-year compared to low fear-avoidance beliefs.⁶⁴ Furthermore, evidence supports the notion that even in individuals without LBP, movements, such as bending, are feared and considered dangerous.⁶⁷ Given that contextual factors play a role in disability, it is possible that fear of particular movements could add to disability, rather than deconditioning alone and could affect compliance to exercise training.⁶⁶ The removal of fear barriers to movement may therefore be important in promoting resumption of ADLs and reduce disability.^{64,66} Assessing and treating kinesiophobia and fear avoidance during management of CLBP may be important to reduce fear and disability, which could subsequently maximise the participation in ADLs.

Pain Catastrophizing

Pain catastrophizing is a state of anxiety towards pain and plays an important factor in the fear-avoidance model.¹³ Common beliefs are held that the low back is vulnerable and fragile, which may lead to higher catastrophizing when pain occurs in this location.⁶⁸ Individuals with CLBP and high catastrophizing are 56% more likely to be disabled than those with low catastrophizing.⁶⁹ Furthermore, one study showed that pain catastrophizing may explain more variance in disability (28%), when compared to pain intensity (3%).⁷⁰ Even though the regression model used in this study did not include other important factors, such as fear-avoidance, catastrophizing may still be better than pain intensity for explaining disability in individuals with CLBP.⁷⁰ Reducing catastrophic thinking may therefore help reduce the burden of disability in individuals with CLBP which may increase engagement in ADLs.

Pain Self-Efficacy

Pain self-efficacy is another important psychological outcome to consider when treating patients with CLBP.⁷¹ Pain self-efficacy reflects an individual's ability to engage with ADLs despite the presence of pain.⁷² Cross-sectional research of individuals with severe disability (measured on the Oswestry disability index) showed lower levels of pain self-efficacy when compared to those with mild-moderate disability.⁷³ This may in part explain why individuals with LBP and high pain self-efficacy

levels are more likely to return to work.⁷⁴ Pain self-efficacy also tends to mediate the relationship between pain and disability more than fear-avoidance.⁷¹ As the course of pain intensity in CLBP fluctuates, it may be important to understand how the individual psychologically deals with times of high pain intensity and if they continue to engage in normal activities.⁷⁵ Therefore, as pain self-efficacy can be used to understand how individuals cope with setbacks (e.g. flare-ups) it forms a potential outcome for treating individuals with CLBP.

Depression and Anxiety

Longitudinal evidence of large samples sizes (pooled $n=2,767$) showed a bidirectional relationship between LBP, depression and anxiety.^{76,77} Furthermore, an epidemiological study in 190,593 community-dwelling adults showed a higher prevalence of depression (25%) and anxiety (19%) in people with CLBP.⁷⁸ Mental health disorders may partially explain disability in those with CLBP⁷⁹ and could be an important factor for recovery from disabling back pain.⁶⁴ Furthermore, a systematic review showed that depression and anxiety are barriers for treatment adherence in various chronic pain conditions.⁸⁰ Given the higher prevalence of these conditions in individuals with CLBP, improving mental health may subsequently improve treatment adherence and effectiveness.⁸⁰ For individuals with CLBP reporting symptoms of depression and anxiety, assessing and treating these factors may be important for functional recovery.

Sleep Quality

Impairments to sleep are commonly reported in individuals with CLBP, with a 55% decrease in sleep quality observed in this population following an increase in pain.⁸¹ An epidemiological study showed CLBP patients to have a 2.4-fold increased risk of sleep problems.⁷⁸ Furthermore, there is the potential for there to be a bidirectional relationship between pain and sleep quality in individuals with CLBP.⁸² For example, every 0.49 point (out of 10 on a visual analogue scale) decrease in sleep quality, pain upon waking is one-point higher on the VAS.⁸² Meanwhile, for every one-point increase in average day time pain intensity, there is a 0.20 point decrease in sleep quality.⁸² Moreover, disturbances to the quality of sleep in individuals with CLBP is moderately correlated ($r=0.42$) to physical disability.⁸³ Therefore, disability in this population may be partially related to sleep quality.

Assessing and restoring sleep quality in those with CLBP who report sleep impairments may be important for reducing disability in this population.

Social Outcomes

Social Functioning

Social functioning is considered as the individual's ability to engage in social activities.⁸⁴ A qualitative review showed that individuals living with LBP felt they struggled to meet social expectations, which may subsequently impact the social identity of the individual.⁸⁵ Particularly, engagement in domestic chores, valued recreational activities and work tasks are impacted in those with CLBP.⁸⁵ A previous study showed significant, albeit modest, correlation between individual perceptions of physical health and level of social interaction.⁸⁶ This is important as the context of the social environment may also be a potential mediator of pain and subsequent social impairment.⁸⁷ It is possible this may lead to a loss of social identity and the perceptions of ability to perform tasks at home and work, therefore contributing to functional impairments,⁸⁶ decreases in the health-related quality of life⁸⁸ and presence of comorbidities, such as depression.⁸⁹ If the client reports limitations to their social functioning, it is important to assess the impact of CLBP on social functioning to help reduce the risk of the individual losing their social identity.

Work Absenteeism

Disability from LBP is highest amongst those of working age and tends to decline after retirement age (i.e. 55yrs).¹³ Accommodating work-related outcomes may be important at both an individual and economic level, as majority of the costs of LBP come from indirect sources, such as work absenteeism and early retirement.⁹⁰ Previous work absenteeism due to LBP has been linked to a 31% less chance of functional recovery in those with CLBP,⁹¹ which may be associated with early retirement from low back issues.⁹² Early retirement due to LBP may lead to lower net wealth than counterparts who do not retire early, causing greater financial stress later in life.⁹² Reducing work absenteeism may be an important outcome measure to maximise functional work limitations and reduce the financial stress of individuals who become work disabled.

Health-related Quality of Life

Quality of life is the self-evaluation of well-being and functioning by an individual.⁹³ CLBP has a negative impact on the quality of life of an individual, particularly through perceptions of physical and mental health.⁸⁸ A cross-sectional study in 1,208 pain clinic patients showed that individuals with CLBP had a lower quality of life compared to other chronic pain conditions, such as headaches and neck pain, as well as the general population.⁸⁸ Importantly, improvements in quality of life may be dictated to a greater extent by disability and psychological improvements rather than pain intensity.^{94,95} Common quality of life questionnaires can measure varying domains including physical functioning, role limitations due to physical functioning, bodily pain, general health perception, vitality, social functioning, role limitations due to emotional and mental health.⁹⁶ Measuring quality of life may provide insight into varying domains impacted in the individual and therefore allow targeted treatment to improve these. Pain intensity is not synonymous with the quality of life, therefore, assessing domains of quality of life may be important to discriminate treatment approaches and determine important client related goals in those with CLBP.

Integrating technological advances into outcomes

Technological advances should be considered by clinicians for the provision of outcomes during treatment of CLBP. Self-management applications have been used in CLBP, which could be used as outcomes or to attain intervention adherence.⁹⁷ For example, fitness applications (with or without the use of a smartwatch) could be used to track daily physical activity and exercise progressions,⁹⁸ weight loss,⁹⁹ diet and nutrition,¹⁰⁰ mood¹⁰¹ and sleep quality.¹⁰² The utility of such applications could be used to quantify day-to-day or week-to-week results of various outcomes, rather than being solely collected at periods where the individual reports back to their health care provider.¹⁰³ As multiple areas can be assessed, it is important to determine the most relevant outcome domain for the individual when selecting which application to utilise.¹⁰³ Therefore, these technologies should be considered alongside standard clinical measures (e.g. functional tests and questionnaires) to potentially provide better tracking of outcome measures for individuals with CLBP.

Outcome selection should be individualised for the patient

Multiple domains and outcomes can be assessed in a patient with CLBP, therefore the clinician should select outcomes based off impacted areas and additional goals.¹⁰⁴ Clinicians should engage in dialogue and listen to their patients to identify the most important clinical outcome measures, outside of pain intensity, for their patient.¹⁰⁴ This may assist with determining the most appropriate intervention to reduce disability and improve quality of life in this population.¹⁰⁴ Furthermore, technological advances (e.g. mobile applications) could be used to assist in the provision of outcome measures and could be utilised for an individual with CLBP.¹⁰³ Given the wide range of measures possible to target, pending what outcomes are deemed relevant for the individual with CLBP, a multidisciplinary approach may best be utilised to maximise outcomes.

A MULTIDISCIPLINARY APPROACH

A multidisciplinary approach is the collaboration of multiple clinicians and should be considered for those with CLBP, as some outcomes require specific interventions.¹⁰⁵ For example, a psychologist may be best placed to provide interventions to improve psychosocial health through changing cognitions and behaviours.¹⁰⁵ Moreover, physiotherapists and exercise physiologists should be considered for improving physical capacity through exercise training, while an occupational therapist could be used to target workplace and daily living contributors to pain and disability.¹⁰⁵ Dietary advice for individuals with CLBP should be delivered by a dietitian, if adiposity is identified as a relevant outcome.¹⁰⁶ Pain physicians can coordinate the medical management of the patient to best determine which clinicians to utilise, and formalise communication between each.¹⁰⁵ Importantly, in private practice settings, clinicians should identify the specific outcomes relevant to their patient and refer on to the appropriate clinician to target these outcomes as necessary. Ultimately, clinicians should engage with a range of health care professionals, including those aforementioned, to establish a multidisciplinary care team capable of providing best-practice management of CLBP.

CONCLUSIONS

CLBP is a common condition that has a large societal and individual burden. Pain reduction is an important outcome for conservative management of people with CLBP, however it should not be the only outcome of interest in clinical practice. The multidimensional nature of CLBP suggests that

various factors play a role in pain and disability and that different individuals may be impacted at different levels for each domain. This suggests that the CLBP management should be adapted to the individual as CLBP can have a detrimental impact on physical, psychological and social health.

Clinicians should engage in dialogue with patients to determine what aspects of these domains are of the most concern. Rather than solely focusing on pain intensity, treatment of CLBP should address alternative outcomes that are mutually agreed by the clinician and patient. Therefore, in line with the biopsychosocial model, we recommend that clinicians should consider assessing a broad range of physical, psychological, social, and health-related quality of life measures in patients with CLBP. We recommend, at a minimum, clinicians should include the Oswestry Disability Index (physical), Pain Catastrophizing Scale or Tampa Scale of Kinesiophobia (psychological), PROMIS social functioning (social) and the SF-12 (health-related quality of life), with additional measures to be based on what is deemed relevant for the individual patient. Ultimately, this will enable enhanced clinical decision making and lead to improved clinical outcomes specific to the individual patient.

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Table 1. Outcomes relevant to consider for the treatment of CLBP in clinical practice.

Domains	Outcome Measures	Validity*	Internal Consistency†	Test-retest Reliability‡	Minimum clinically meaningful difference§	Skill Level Required	Time Required	Treatment Options
Physical								
Self-Report Disability	Oswestry Disability Index ¹⁰⁷	r=0.60-0.74 ^a Moderate-strong	Cronbach α =0.75-0.94 Moderate-strong	ICC=0.84-0.94 Moderate-strong	10% ^{109,110}	Low	5 minutes	Short-Term Exercise Training (Resistance, Aerobic, Stabilisation) ^{111,112}
	Roland Morris Disability Questionnaire ¹⁰⁸	r=0.60-0.74 ^a Moderate-strong	Cronbach α =0.83-0.94 Moderate-strong	ICC=0.53-0.90 Poor-strong	4.9-8.6 points ¹¹⁰	Low	5 minutes	Spinal Manipulative Therapy ¹¹³ CFT ¹¹⁴
								Long-Term: Exercise Training (Resistance, Aerobic, Stabilisation) ^{111,112} CFT ¹¹⁴
Long-Term Disability	Orebro Musculoskeletal	r=0.74 ^b Strong	Cronbach α =0.95 Strong	ICC=0.89 Moderate	28.1 points ¹¹⁵⁻¹¹⁷	Low	10 minutes	Low risk: Reassurance,

Screening	Pain Questionnaire ⁴²							Advice and Education ⁴³
	Keele STarT Back Tool ⁴³	r=0.74 ^b Strong	Cronbach α =0.73 Moderate	ICC=0.90 Strong	NA ¹¹⁸	Low	10 minutes	Medium Risk: Physiotherapy, Physical Therapy and Exercise Training ⁴³
								High Risk: Same as medium risk with the addition of targeted psychological treatment ⁴³
Trunk Endurance Testing	Ito Back Flexion and Extension Endurance ¹¹⁹	NA	Not applicable	ICC=0.90-0.97 Strong	NA ¹¹⁹	Moderate	10 minutes	Resistance Training ^{120,121}
Trunk Strength Testing	Hand Held Dynamometer Testing for Back Extensors ¹²²	r=0.82 ^c Strong	Not applicable	ICC=0.90 Strong	NA ¹²²	Moderate	5 minutes	Resistance Training ^{120,121}
Global Muscle Strength	Repetition Max Testing (1-10RM) ¹²³	NA	Not applicable	ICC=0.91-0.99 Strong	NA ¹²⁴	Moderate	15 minutes	Resistance Training ^{120,121}

	Leg Strength (Leg Press)							
	Upper Limb Strength (Chest Press)							
Performance Battery Testing ¹²⁵	Five Minute Walk Test Sit-to-Stand Test Stair Climbing	NA	Not applicable	ICC=0.74-0.99 Moderate-strong	19-45% ^{125,126}	Moderate	20 minutes	Exercise Training ^{127,128} CBT ¹²⁹
Body Composition ¹³⁰	Weight BMI Waist Circumference Hip Circumference Waist-to-Hip Ratio	r=0.72-0.77 ^d Strong	Not applicable	ICC=0.99 Strong	5% ¹³¹⁻¹³³	Low	5 minutes	Dietary Intervention ¹⁰⁶
<i>Psychological</i>								
Kinesiophobia/Fear Avoidance	Tampa Scale of Kinesiophobia ¹³⁴ Fear-Avoidance Beliefs Questionnaire ¹³⁵	r=0.38-0.62 ^e Moderate	Cronbach α =0.84 Moderate	ICC=0.91 Strong	8 points ¹³⁶⁻¹³⁹	Low	5 minutes	PNE ¹⁴¹ CBT ^{142,143} CFT ¹⁴⁴
		r=0.38-0.62 ^e Moderate	Cronbach α =0.77-0.88 Moderate	ICC=0.90-0.96 Strong	9.4-12.7 points ^{135,136,140}	Low	5 minutes	
Pain Self-	Pain Self-Efficacy	r=0.64-0.85	Cronbach α =0.92	ICC=0.92	8 points ^{72,145}	Low	5 minutes	Exercise

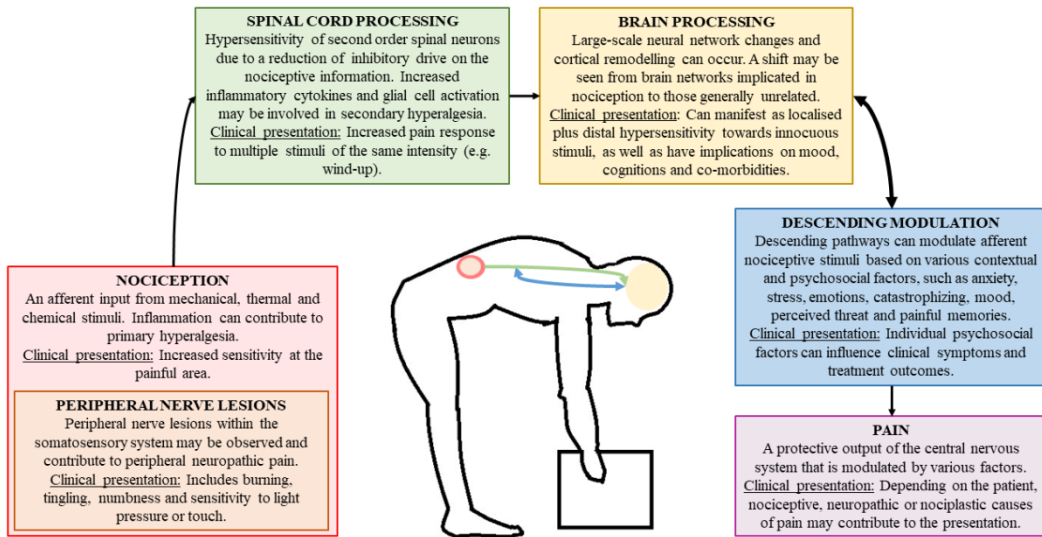
Efficacy	Questionnaire ¹⁴⁴	Moderate- strong	Strong	Strong				Training ¹⁴⁶ PNE ¹⁴⁶
Pain Catastrophizing	Pain Catastrophizing Scale ¹⁴⁷	r=0.31-0.61 ^f Moderate	Cronbach α =0.87- 0.92 Moderate-strong	ICC=0.80- 0.93 Moderate- strong	NA ^{136,148}	Low	5 minutes	PNE ¹⁴¹ CBT ¹⁴²
Depression and Anxiety	Depression Anxiety Stress Scale (21-item) ¹⁴⁹	r=0.40-0.69 ^g Moderate	Cronbach α =0.93 Strong	ICC=0.82- 0.90 Moderate- strong	5 points ^{149,150}	Low	5 minutes	Exercise Training ^{120,121,151} CBT ¹⁵²
Sleep Quality	Pittsburgh Sleep Quality Index ¹⁵³	r=0.72-0.80 ^h Strong	Cronbach α =0.70- 0.83 Moderate	ICC=0.70- 0.86 Moderate	NA ^{154,155}	Low	5 minutes	CBT ¹⁵⁶
<i>Social</i>								
Social Functioning	PROMIS Social Functioning ¹⁵⁷	r=0.45-0.51 ⁱ Moderate	Cronbach α =0.98 Strong	NA	NA ^{158,159}	Low	5 minutes	Exercise Training ^{120,121,151} CBT ^{142,160} CFT ¹¹⁴
Work Absenteeism	Work Productivity and Activity Impairment Questionnaire ¹⁶¹	r=0.54-0.64 ^j Moderate	Cronbach α =0.88- 0.96 Moderate-strong	ICC=0.80- 0.84 Moderate	NA ^{161,162}	Low	5 minutes	Exercise Training ¹⁶³ CFT ¹¹⁴

<i>Other</i>								
Health-related Quality of Life	SF-12 ¹⁶⁴	RV coefficient= 0.64-0.97 Moderate-strong	Cronbach α =0.77-0.80 Moderate	r=0.84-0.91 Moderate-strong	6 points ^{164,165}	Low	10 minutes	Exercise Training (Resistance, Aerobic, Stabilisation) ^{120,121, 151,166} CBT ^{31,142,160}

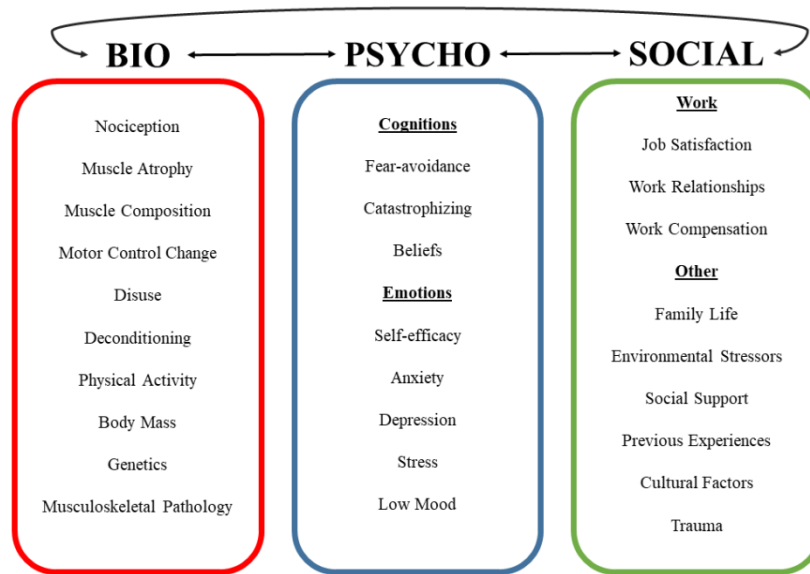
BMI = body mass index, CBT = cognitive behavioural therapy, CFT = cognitive functional therapy, ICC = intraclass correlation coefficient, LBP = low back pain, NA = not available, PNE = pain neuroscience education, PROMIS = Patient Reported Outcomes Measurement Information System

*Validity: correlations of >0.7 are strong, $0.3-0.7$ are moderate and <0.3 are weak.¹⁶⁷ †Internal consistency: For groups Cronbach $\alpha \geq 0.70$ suggested (moderate), for individuals Cronbach $\alpha \geq 0.90$ suggested (strong).¹⁵⁴ ‡Test-retest reliability: For groups ICC ≥ 0.70 suggested (moderate), for individuals ICC ≥ 0.90 suggested (strong).¹⁶⁸ §Minimum clinically meaningful difference is how large a difference needs to be present in a single patient for it to be "real".¹⁶⁹

^aConstruct validity between Oswestry Disability Index and Roland Morris Disability Questionnaire, ^bConstruct validity between the two long term-disability measures, ^cConstruct validity compared to isokinetic back extensor dynamometry, ^dValidity of waist circumference and waist-to-hip ratio comparative to visceral adipose fat measured by computed tomography, ^eConstruct validity between the Tampa Scale of Kinesiophobia and Fear-Avoidance beliefs questionnaire, ^fConstruct validity determined against measures including the Roland Morris, Pain Intensity and Fear-Avoidance beliefs questionnaire, ^gConstruct validity comparative to the Positive and Negative Affects scale, ^hConstruct validity comparative to other sleep scales, ⁱConstruct validity compared to physical and mental composite scores of the SF-12, ^jConstruct validity compared to interviewer methods.



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