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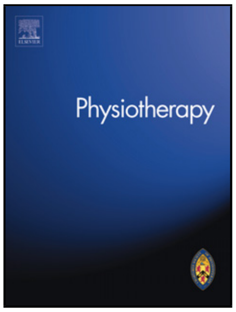

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Movement-based subgrouping in low back pain: synergy and divergence in approaches

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Abstract

Background Classification systems for low back pain (LBP) aim to guide treatment decisions. In physiotherapy, there are five classification schemes for LBP which consider responses to clinical movement examination. Little is known of the relationship between the schemes.

Objectives To investigate overlap between subgroups of patients with LBP when classified using different movement-based classification schemes, and to consider how participants classified according to one scheme would be classified by another.

Design Cross-sectional cohort study.

Setting University clinical laboratory.

Participants One hundred and two participants with LBP were recruited from university, hospital outpatient and private physiotherapy clinics, and community advertisements.

Intervention Participants underwent a standardised examination including questions and movement tests to guide subgrouping.

Main outcome measures Participants were allocated to a LBP subgroup using each of the five classification schemes: Mechanical Diagnosis and Treatment (MDT), Movement System Impairment (MSI), O'Sullivan Classification (OSC), Pathoanatomic Based Classification (PBC) and Treatment Based Classification (TBC).

Results There was concordance in allocation to subgroups that consider pain relief from direction-specific repeated spinal loading in the MDT, PBC and TBC schemes. There was consistency of subgrouping between the MSI and OSC schemes, which consider pain provocation to specific movement directions. Synergies between other subgroups were more variable. Participants from one subgroup could be subdivided using another scheme.

Conclusions There is overlap and discordance between LBP subgrouping schemes that consider movement. Where overlap is present, schemes recommend different treatment options. Where subgroups from one scheme can be subdivided using another scheme, there is potential to further guide treatment. An integrated assessment model may refine treatment targeting.

Keywords: Low back pain; Physiotherapy; Classification

<A>Introduction

Physiotherapists use exercise-based interventions in the management of patients with low back pain (LBP), yet effect sizes for exercise treatments for non-specific LBP are modest (0.07 to 0.61) [1]. This is attributed to failure to recognise heterogeneity within non-specific LBP and failure to individualise treatments. Promising results are emerging when patients and treatments are matched using subgrouping [2–8], but this is not universal [9] and results are mixed [10]. Subgrouping approaches for non-specific LBP share a common premise; more predictable and favourable outcomes will be achieved if similar presentations among individuals are recognised (a subgroup), and an intervention specific to that subgroup is delivered [11]. There are different views on how subgroups should be distinguished [12], with five major schemes that include consideration of movement:

- Treatment Based Classification (TBC) [13];
- Mechanical Diagnosis and Treatment (MDT) [14];
- Movement System Impairment (MSI) [15];
- O'Sullivan Classification Scheme (OSC) [16]; and
- Pathoanatomic Based Classification (PBC) [17].

This means a patient can be classified in five different ways. However, information is limited about how schemes relate to each other. Some schemes prioritise repeated spinal movements to identify individuals who respond to this approach (i.e. MDT, PBC, TBC). Another approach uses key features that predict responsiveness to certain treatment strategies to guide decision-making (i.e. TBC). Other methods identify spinal alignments or movement directions that elicit symptoms, then modify the motion in order to reduce symptoms (MSI, OSC). Some schemes also consider psychosocial factors (i.e. OSC, TBC), which are then used to help guide the appropriate intervention.

Studies are emerging that have examined the relationship between these schemes. Werneke *et al.* [18] investigated overlap between LBP subgroups defined by the TBC [13] and MDT [14] schemes. These schemes use similar assessment criteria so substantial agreement between subgroups was predictable. However, patients classified into one MDT group (i.e. derangement) could be classified into either of two TBC groups with different treatment directives (i.e. manipulation or stabilisation). Given this situation, it remains unclear how clinicians can navigate through classification methods to best manage patients. Furthermore, a survey of physiotherapists revealed inconsistencies in how they classified patients across multiple approaches [19]. Additionally, there was no relationship between assigned subgroups and the intervention delivered, which exacerbates the confusion [19].

It is important to understand the relationship between different schemes in several different circumstances, such as when classification in one scheme is unclear [20]; when different schemes provide alternative views; when a patient is categorised into a subgroup with a purportedly less favourable prognosis (i.e. MDT irreducible derangement); or when a patient is allocated to a more heterogeneous subgroup characterised by a more disabling pain profile (e.g. TBC stabilisation or OSC control multidirectional). In these cases, better outcomes might be achieved with guidance by secondary allocation in another scheme.

Divergence between schemes presents both potential benefits (e.g. individuals allocated to a heterogeneous subgroup in one scheme may be more specifically subgrouped by another) and challenges (e.g. problems with communication between clinicians who use different approaches). This study subgrouped a cohort of patients with LBP presenting for physiotherapeutic care according to the five classification schemes with the aim of improving understanding of the relationship between different schemes by determining: (1) whether there was overlap between subgroups when classified using different approaches; and (2) whether patients classified into a more heterogeneous subgroup or one with a generally poorer prognosis in one scheme could be classified in an alternative manner in another scheme.

<A>Methods

<B>Participant selection

People (*n*=102) seeking treatment for their LBP were recruited from public hospital outpatient, university and private physiotherapy clinics, and community advertisements. This recruitment strategy was used to ensure a broad representation of patients. Ethical clearance was gained from the institutional and hospital medical research ethics committees and all participants provided informed consent.

Inclusion criteria were: age 18–68 years, reported pain of at least 2/10 on a Numeric Pain Rating Scale (NPRS) sufficient to cause them to modify their activities of daily living, and seeking care for LBP. Participants were included regardless of symptom duration, as this would typify a clinical setting. LBP was defined as dominant symptoms between the lower thoracic (T12) and gluteal fold region, or dominant symptoms in the lower extremity due to LBP. A questionnaire and telephone or face-to-face interviews were used to determine eligibility. Participants were excluded if they had serious spinal pathology (i.e. fracture, metastatic disease), neurological disorders, severe spinal structural deformity, previous lower back surgery, pregnancy or other diagnoses that would require modification of the examination. As the TBC and MSI approaches do not categorise sacroiliac joint (SIJ)/pelvic girdle pain within their schemes, participants fulfilling criteria for primary SIJ dysfunction [21]) were excluded. Prior to enrolment, participants were asked if they had imaging results which confirmed more 'specific' diagnoses such as spondylolisthesis, disc herniation with radicular pain, degenerative disc disease with Modic changes, or central or foraminal stenosis. As imaging was not required for participation in the study, diagnoses such as stenosis, spondylolisthesis and nerve root pathology were based upon the movement and symptom criteria outlined in the MDT and PBC schemes rather than diagnostic imaging.

<B>Examination and classification procedure

Subgrouping was informed by pain history, questionnaires, key movement-based tests and decision-making algorithms for each classification system (see Appendices A to E, online supplementary material). Questionnaires included the Roland Morris Disability Questionnaire (RMDQ) [22], NPRS [23], Fear Avoidance Beliefs Questionnaire (FABQ) [24], Pain Related Self-Symptoms (PRSS) Scale [25] and the Pain Self-Efficacy Questionnaire (PSEQ) [26].

Movement tests and classification decision-making algorithms for subgrouping in all schemes were conducted in the context of a structured history and physical examination which incorporated all examination procedures published in guidelines of the developers for each classification scheme [17,27–30]. The assessment was performed in one session and took approximately 1.5 hours to complete. Movement tests were undertaken in a sequential manner with regard to participant position rather than a particular scheme. In other words, all tests in standing from the five schemes were performed together, and so forth for sitting, supine, side lying, prone and four-point kneeling. The repeated-movement testing prescribed in the MDT, PBC and TBC schemes was performed at the end of the examination to avoid potential symptom changes on the modified-movement testing prescribed in the MSI and OSC schemes. 'Directional' terms are used for each scheme, but it is noted that they have different interpretations (e.g. TBC specific exercise extension is a subgroup of individuals who respond favourably to repeated trunk extension movements, whereas MSI extension refers to a subgroup of individuals who have predominant signs and pain provocation in the extension direction).

The OSC scheme also requires decisions on the presence or absence of dominant psychosocial factors and pain mechanisms. OSC decisions on 'dominant' psychosocial factors are based on expert clinical judgement of coping and fear avoidance behaviour [31]. In this study, psychosocial factors were defined by the following criteria: (1) FABQ score using high-risk cut-off values of work >25, (2) physical activity >15 [32], and high-risk cut-off values for (3) PRSS active coping ≤3, (4) PRSS catastrophising ≥3, and (5) PSEQ ≤25 [33]. If a participant had at least three out of five elevated scores from the FABQ (two subscales), PRSS (two subscales) and PSEQ schemes, his/her psychosocial features were considered as 'dominant'. The OSC scheme bases decisions of 'centrally' vs 'peripherally' mediated pain states on pain history criteria [16]. A centrally mediated pain state is defined as widespread non-remitting symptoms that are not aggravated/eased by mechanical factors [31]. Peripherally mediated pain is defined as anatomically localised pain associated with specific and consistent mechanical aggravating/easing factors [31].

Examinations were performed by an experienced clinician (NK) who has board certification in orthopaedics and fellow status in manual therapy. In preparation for the study, NK undertook professional development in each classification scheme (coursework and readings). The introductory coursework consisted of 28 hours for the MDT scheme, 8 hours for the MSI scheme, and 16 hours for the OSC scheme. The TBC scheme does not offer formal coursework, and the PBC coursework is obtained through the MDT curriculum. Prior to this study, a systematic review and a Delphi-format clarification of issues was conducted with each scheme developer/expert to ensure that the examiner had an accurate understanding of the theory and content of each scheme prior to conducting the classification [12]. In this study, subgroup classification by one examiner was considered to be representative of that of a common translation of these schemes into clinical practice by an experienced clinician.

<B>Data management and analysis

The operational criteria and classification algorithm (see Appendices A to E, online supplementary material) defined by the developers/experts of each scheme was used to subgroup each participant across the five schemes: MDT, PBC, TBC, MSI and OSC. The definition and reference standards for all specific tests for each scheme are provided in Appendix F (see online supplementary material). The number of patients in each subgroup for each scheme was calculated. Each scheme was taken in turn to examine the relationship of each patient's subgroup with other schemes, which involved an extensive mapping exercise (Aim 1). For every classification scheme, participants were mapped across the other four schemes for each subgroup allocation in order to determine how participants within a subgroup of one scheme were allocated in other schemes (Aim 2). Data on age, disability, pain intensity, fear avoidance beliefs, coping, catastrophising and self-efficacy were assessed for normal distribution.

<A>Results

Most participants reported persistent, recurrent and localised LBP, and mild-to-moderate scores on questionnaires related to disability, pain intensity and fear avoidance constructs (Table 1). Data on age, disability, pain intensity, fear avoidance beliefs, coping, catastrophising and self-efficacy were normally distributed.

<insert Table 1 near here>

One participant was diagnosed with SIJ/pelvic girdle pain and was excluded from the analysis. Six of the 102 participants had threshold value scores on at least three out of the five questionnaires, and were deemed to have a dominant psychosocial component of their pain disorder (Table 2).

<insert Table 2 near here>

<B>Subgroup allocations (prevalence) based on movement

The prevalence of patients in each subgroup over each of the five schemes is shown in Figs 1 to 5 (left columns). Their allocations across the other four schemes are presented in the other columns (Aim 1). The prevalent subgroups in each scheme were: MDT, reducible derangement/central and symmetrical (n=51); PBC, disc syndrome/reducible (n=52); TBC, specific exercise/flexion (n=36); MSI, extension (n=43); and OSC, control multidirectional (n=37). There was high concordance between classifications that define similar groupings based on response to repeated direction-specific spinal movements (i.e. MDT, PBC, TBC). The mapping also revealed the potential to further subclassify heterogeneous and purportedly poorer prognosis subgroups in another scheme (MDT irreducible derangement in Fig. 1; TBC stabilisation in Fig. 3; OSC control multidirectional in Fig. 5) (Aim 2).

<insert Figs 1–5 near here>

<B>Overlap of subgroups (Aim 1)

A summary of the synergy and divergence between schemes is presented for the most prevalent subgroups.

<C>Schemes using a repeated-movement approach (MDT, PBC, TBC)

There was complete concordance between classifications of reducible derangement (MDT, PBC) and specific exercise (TBC) (Fig. 1). In each scheme, these classifications are based on similar responses to repeated direction-specific trunk movements. Classifications were complimentary between these schemes using repeated movements and MSI and OSC scheme classifications of modified-movement strategies for some participants. For the 15 individuals who responded favourably to repeated extension movements, eight responded to MSI modified-flexion strategies and three responded to OSC modified-flexion strategies (Fig. 3). Similarly, the 36 individuals who responded favourably to TBC repeated flexion movements were more frequently categorised into MSI extension (*n*=23) and OSC control active extension (*n*=10) (Fig. 3). The 12 individuals categorised into the TBC manipulation subgroup were primarily distributed over flexion and extension subgroups in the MSI (flexion *n*=6, extension *n*=4) and OSC (control flexion *n*=5, control active extension *n*=2) schemes. Five of 12 individuals in the TBC manipulation group were classified with OSC multidirectional control problems (Fig. 3).

<C>Schemes using a modified-movement approach (MSI and OSC)

Twenty-three of 43 individuals classified into MSI extension overlapped with TBC specific exercise/flexion (Fig. 4). Eight of 33 individuals classified into MSI flexion responded favourably to the application of repeated extension movements (TBC specific exercise extension subgroup) (Fig. 4). There was good concordance between individuals allocated to a group with a flexion component using MSI and OSC criteria. The 11 individuals categorised as MSI rotation with flexion were predominantly allocated to OSC control flexion (*n*=8), whereas the 14 individuals subgrouped into MSI rotation with extension were primarily allocated into the OSC control multidirectional subgroup (*n*=7) (Fig. 4).

<B>Subdivision of subgroups with higher heterogeneity and/or poorer prognosis (Aim 2)

This analysis was of the TBC stabilisation, OSC control multidirectional and MDT irreducible derangement classifications. The 33 individuals classified into TBC stabilisation could be allocated to other subgroups in the movement (MSI) and motor control (OSC) dysfunction approaches (Fig. 3). Ten of 37 individuals classified into the OSC control multidirectional subgroup were allocated to TBC stabilisation. The remaining individuals were variously allocated to TBC specific exercise/flexion (*n*=12), exercise/extension (*n*=9) and TBC manipulation (*n*=5) (Fig. 5). The 24 individuals who had unfavourable responses to repeated movements (i.e. MDT irreducible derangement, Fig. 1) were variably distributed in other schemes: TBC stabilisation (*n*=15); TBC manipulation (*n*=7); MSI extension (*n*=9); MSI flexion (*n*=8); MSI rotation with flexion (*n*=6); and OSC control multidirectional (*n*=8) and control flexion (*n*=6) (Fig. 1).

<A>Discussion

This study has provided evidence of both concordance and discordance between movement-based subgrouping schemes for LBP. The concordance between different schemes stands to offer the clinician a choice between different treatment approaches. The discussion considers the relationship of the findings of this study to existing information about subgroup prevalence, and the implications of the synergies between schemes for clinical decision-making and communication.

<B>Prevalence

The prevalence of the most common subgroups for each scheme in this study is similar to previous reports [18,31,34–37], but there were discrepancies. The results of the repeated-movements examination in the MDT and PBC schemes in this study favoured flexion (32%), extension (15%) and side-gliding (4%), whereas the study by Long *et al.* [38] favoured extension (83%), side-gliding (10%) and flexion (7%). The prevalence of a rotation component in the MSI scheme in this study was lower than reported previously [39,40]. This may reflect the use of more conservative criteria in this study and/or a reflection of a different population. The prevalence of manipulation in the TBC scheme was lower than reported previously, which may be attributed to population differences. Brennan *et al.* [28] included participants with a symptom duration of <90 days. In contrast, 80 participants in the present study reported a symptom duration of >90 days. Hence, the majority of participants in the present study do not meet the TBC manipulation criteria of recent onset of symptoms <16 days. Comparison of prevalence between studies is limited due to different designs, patient cohorts and analysis strategies.

<B>Synergy between schemes and potential alternative treatment directions

The main aim of this study was to explore the inter-relationships between different schemes towards providing benefits for clinical decision-making at several levels. First, the various classification schemes generally underpin different treatment approaches, and further research to identify which strategies are more effective than other strategies at individual level may be warranted. If a patient was allocated to a similar subgroup across schemes, that would offer the patient different intervention options. Second, the study revealed whether different schemes could offer assessment and treatment alternatives when: (1) patient classification under a certain scheme is unclear; (2) the selected scheme categorises the patient into a subgroup linked with a less favourable prognosis; or (3) the patient is allocated to a more heterogeneous subgroup without strong treatment direction. The following sections highlight the synergies and alternative classification–treatment directions.

<C>MDT scheme

Participants with flexion-biased movement symptoms who responded favourably to the application of repeated lumbar extension also responded favourably to the application of MSI and OSC modified-flexion movement strategies. For these individuals, there are potentially complementary treatment options from at least two schemes. The OSC multidirectional group included individuals who responded favourably to MDT repeated extension or flexion movements, thus providing alternative guidance for individualised treatment within this heterogeneous group.

Also of interest was the mapping of people who responded unfavourably to repeated-movement assessment (MDT irreducible derangement), as the MDT approach offers limited treatment alternatives for such individuals. Notably, individuals allocated to this subgroup were also classified into TBC stabilisation and manipulation; MSI extension, flexion, and rotation with flexion; and OSC control multidirectional and control flexion, which highlights other movement-based treatment options for such patients.

<C>PBC scheme

For the five individuals classified in the PBC non-mechanical disc syndrome subgroup, there were alternative motor-control-based classification–treatment directives in the TBC (stabilisation), MSI (flexion, extension, rotation with flexion) and OSC (control multidirectional, flexion and passive extension) schemes. Likewise, for the four individuals subgrouped as PBC inconclusive, the TBC (stabilisation, manipulation), MSI (flexion, extension, rotation with extension) and OSC (control multidirectional, flexion, active extension) schemes provided alternative classification–treatment avenues.

<C>TBC scheme

Although the TBC stabilisation and MSI and OSC subgroups share the fundamental aim to improve trunk motor control, the focus of the movement assessment and interventions vary between these schemes. To summarise, the TBC stabilisation approach proposes exercises aimed at increasing trunk muscle activity in neutral spine postures [28]; the MSI scheme focuses on directionally-based methods to increase spinal stiffness, improve hip mobility, and enhance coordination between trunk and limbs [41]; and the OSC scheme highlights identification of direction-specific control or movement disorders of the trunk [16]. It was of interest to note how individuals allocated to the TBC stabilisation subgroup, which does not consider directional aspects, were distributed within the MSI and OSC direction-specific categories. Individuals classified into TBC stabilisation had varied motor control dysfunction as classified using the MSI and OSC schemes, but these two approaches concurred. Thus, patients allocated to the TBC stabilisation group had different presentations. This warrants consideration of whether direction-specific trunk exercise prescription (MSI, OCS) enhances motor control rather than a general stabilisation approach (TBC).

The TBC manipulation subgroup aims to identify individuals who would benefit from spinal manipulation, but does not prioritise specific directional impairments. Hence, it was questioned whether people in this manipulation subgroup would preferentially align with certain MSI or OSC direction-specific subgroups. It was found that they were allocated to either MSI and OSC flexion and extension dysfunction subgroups. Thus it is possible that this extra information may help to guide the application of manipulative treatment. Five of 12 individuals in the TBC manipulation group were classified with multidirectional control problems using OSC criteria. Thus the schemes advocate contrasting treatment directives for the same patient; the TBC manipulation subgroup proposes the person would most benefit from increased lumbo-pelvic mobility, whereas the OSC control multidirectional subgroup proposes that the person would most benefit from enhanced trunk motor control. This subset of patients indicates that more research is required to resolve this dichotomy.

<C>MSI scheme

It was hypothesised that flexion- and extension-directed MSI subgroups would align closely with flexion- and extension-directed OSC subgroups, and that MSI combined movement impairment categories would be more commonly distributed into the OSC control multidirectional or control flexion-shift subgroups. There was good concordance between individuals allocated to a group with a flexion component using MSI and OSC criteria. Discordance between MSI and OSC schemes related to the patients classified by OSC as multidirectional control disorders, as patients within each MSI subgroup (except rotation) could be allocated to this subgroup. These observations may reflect the differing criteria used in each scheme, and highlight that translation between the terms used in each scheme cannot be assumed.

The observations of the relationship between direction-specific modified-movement strategies used in the MSI scheme and direction-specific repeated-movement strategies used in the TBC scheme revealed that 23 of 43 individuals (53%) classified into MSI extension overlapped with TBC specific exercise/flexion. In other words, people who favourably responded to modification strategies to movements that were pain provoking in extension also gained symptomatic relief from the application of repeated movements of the spine into flexion. This finding may indicate complementary management strategies or offer an alternative treatment strategy if a patient is non-responsive to the first chosen intervention.

<C>OSC scheme

On the basis of similarities in the criteria used to classify patients into the OSC control multidirectional and TBC stabilisation categories, it was hypothesised that these subgroups would be closely aligned. Criteria for the OSC control multidirectional subgroup include: (1) exhibit combinations of other OSC control impairment subgroups; (2) show multidirectional impairments of lumbo-pelvic control; (3) have an increase in symptoms with multiple directions; (4) demonstrate a decrease in symptoms in neutral spine postures; (5) have positive movement test findings in both flexion and extension directions; and (6) are typified by chronic disabling pain disorders. Criteria for the TBC stabilisation subgroup include: (1) a history of three or more episodes of LBP; (2) presence of standing flexion aberrant motion; (3) a failure to centralise; and (4) a hypermobile lumbar spring test. The hypothesis was not supported, as only 10 of 37 individuals (27%) in the OSC control multidirectional subgroup were allocated to TBC stabilisation. It was found that 22 of 37 individuals (59%) in the OSC control multidirectional subgroup responded favourably to TBC repeated direction-specific trunk movements. The OSC control active extension and control flexion subgroups also responded favourably to repeated direction-specific movements. The diverse parameters offered by the two schemes may highlight a pathway for a combined treatment approach.

<B>Limitations

A limitation of this study was the use of a single experienced assessor, rather than multiple assessors or experts in each classification scheme. This reduces generalisability. However, this approach mimics common clinical practice and is in line with current LBP practice guidelines [42], which advocate that physiotherapists use multiple assessment and treatment approaches. Furthermore, surveys [19,43] of clinical practice patterns have identified that physiotherapists more commonly use a pragmatic assessment and treatment approach in which more than one scheme is incorporated in the treatment decision-making process. Thus, these results should be replicated with classification by experts to confirm the observations. Exact replication of results is, however, unlikely, given that populations will differ and the diversity in inter-rater reliability between schemes. For example, previous studies have demonstrated ‘substantial’ (kappa 60%, MSI) and ‘moderate’ (kappa 40% to 60%, TBC) reliability with the introductory level training undertaken for this study, whereas other studies have demonstrated ‘moderate’ to ‘excellent’ (kappa 40% to 80%, OSC) reliability contingent upon >100 hours of training (OSC), and ‘moderate’ (kappa 40% to 60%, MDT and PBC) reliability contingent upon advanced training (credentialled MDT) [12,44]. With consideration of these challenges, the overall similarity between subgroup prevalence rates within each scheme found in this study and that of previous studies broadly supports the accuracy of classification.

<B>Clinical implications and future directions

People who responded favourably to repeated direction-specific movements (MDT, PBC and TBC schemes) also responded favourably to alternative, modified-movement assessment (MSI and OSC schemes), and vice versa. Understanding why certain individuals may respond to a single vs dual assessment approach could be one direction for future research. Furthermore, those individuals classified into subgroups associated with a poor prognosis or greater heterogeneity could be further subdivided using alternative approaches. This preliminary evidence lends support to incorporating an integrated assessment approach to LBP management. This proposal is supported by others in rehabilitation medicine [45]. Although it is beyond the scope of this paper to determine how this integrated approach should be organised, preliminary suggestions are offered. For instance, in an integrated assessment model, the patient’s response to both direction-specific modified-movement strategies (MSI and OSC schemes) and direction-specific trunk repeated-movement strategies

(MDT, PBC, TBC schemes) could be assessed in order to identify an optimal treatment path. Further, patients allocated to more heterogeneous subgroups in a scheme could be assessed with another approach to gain deeper insight into treatment direction. In this model, there is scope for varying methods of application. Clinicians may begin the assessment using the approach with which they have greatest experience, and add other approaches as required based on clinical reasoning. Further research is required to develop the best practice model, but it is reasoned that implementing a broader assessment and treatment framework may capture different aspects of motor control behaviour and provide a wider range of viable intervention options.

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<A>References

[1] Keller A, Hayden J, Bombardier C, van Tulder M. Effect sizes of non-surgical treatments of non-specific low-back pain. Eur Spine J 2007;16:1776–88.

[2] Fritz JM, Delitto A, Erhard RE. Comparison of classification-based physical therapy with therapy based on clinical practice guidelines for patients with acute low back pain: a randomized clinical trial... including commentary by Gordon SL. Spine 2003;28:1363–72.

[3] van Dillen LR, Sahrmann SA, Wagner JM. Classification, intervention, and outcomes for a person with lumbar rotation with flexion syndrome. Phys Ther 2005;85:336–51.

[4] Harris-Hayes M, Van Dillen LR, Sahrmann SA. Classification, treatment and outcomes of a patient with lumbar extension syndrome. Physiother Theory Pract 2005;21:181–96.

[5] Dankaerts W, O'Sullivan PB, Burnett AF, Straker LM. The use of a mechanism-based classification system to evaluate and direct management of a patient with non-specific chronic low back pain and motor control impairment – a case report. Man Ther 2007;12:181–91.

[6] Vibe Fersum K, O'Sullivan PB, Kvale A, Skouen JS. Inter-examiner reliability of a classification system for patients with non-specific low back pain. Man Ther 2009;14:555–61.

[7] Clare HA, Adams R, Maher CG. A systematic review of efficacy of McKenzie therapy for spinal pain. Aust J Physiother 2004;50:209–16.

[8] Vibe Fersum K, O'Sullivan P, Skouen JS, Smith A, Kvale A. Efficacy of classification-based cognitive functional therapy in patients with non-specific chronic low back pain: a randomized controlled trial. Eur J Pain 2013;17:916–28.

[9] Apeldoorn AT, Ostelo RW, van Helvoirt H, Fritz JM, Knol DL, van Tulder MW, *et al.* A randomized controlled trial on the effectiveness of a classification-based system for sub-acute and chronic low back pain. Spine 2012;37:1347–56.

[10] Henry SM, Van Dillen LR, Ouellette-Morton RH, Hitt JR, Lomond KV, DeSarno MJ, *et al*. Outcomes are not different for patient-matched versus nonmatched treatment in subjects with chronic recurrent low back pain: a randomized clinical trial. Spine J 2014;14:2799–810

[11] Foster NE, Hill JC, Hay EM. Subgrouping patients with low back pain in primary care: are we getting any better at it? Man Ther 2011;16:3–8.

[12] Karayannis N, Jull, GA, Hodges PW. Physiotherapy movement based classification approaches to low back pain: comparison of subgroups through review and developer/expert survey BMC Musculoskelet Disord 2012;13:1–33.

[13] Delitto A, Erhard RE, Bowling RW, DeRosa CP, Greathouse DG. A treatment-based classification approach to low back syndrome: identifying and staging patients for conservative treatment. Phys Ther 1995;75:470–89.

[14] McKenzie R, May S. The lumbar spine, mechanical diagnosis and therapy. 2nd ed. Waikanae: Spinal Publications New Zealand Ltd; 2003.

[15] Sahrmann SA. Diagnosis and treatment of movement impairment syndromes. St. Louis, MO: Mosby, Inc.; 2002.

[16] O'Sullivan P. Diagnosis and classification of chronic low back pain disorders: maladaptive movement and motor control impairments as underlying mechanism. Man Ther 2005;10:242–55.

[17] Petersen T, Laslett M, Thorsen H, Manniche C, Ekdahl C, Jacobsen S. Diagnostic classification of non-specific low back pain. A new system integrating patho-anatomic and clinical categories. Physiother Theory Pract 2003;19:213–37.

[18] Werneke MW, Hart D, Oliver D, McGill T, Grigsby D, Ward J, *et al.* Prevalence of classification methods for patients with lumbar impairments using the McKenzie syndromes, pain pattern, manipulation, and stabilization clinical prediction rules. J Man Manip Ther 2010;18:197–204.

[19] Miller-Spoto M. The consistency of assigning diagnostic labels in orthopaedic clinical practice: a case-based study. APTA Combined Sections Meeting, 8–12 February 2012, Chicago, IL, USA.

[20] Stanton TR, Fritz JM, Hancock MJ, Latimer J, Maher CG, Wand BM, *et al.* Evaluation of a treatment-based classification algorithm for low back pain: a cross-sectional study. Phys Ther 2011;9:1–14.

[21] Laslett M, Aprill CN, McDonald B, Young SB. Diagnosis of sacroiliac joint pain: validity of individual provocation tests and composites of tests. Man Ther 2005;10:207–18.

[22] Brouwer S, Kuijer W, Dijkstra PU, Goeken LNH, Groothoff JW, Geertzen JHB. Reliability and stability of the Roland Morris Disability Questionnaire: intra class correlation and limits of agreement. Disabil Rehabil 2004;26:162–5.

[23] Jensen MP KP. Self-report scales and procedures for assessing pain in adults. In: Turk DC MR, editor. Handbook of pain assessment. New York: Guilford Press; 1992. p. 193–213.

[24] Waddell G, Newton M, Henderson I, Somerville D, Main CJ. A Fear-Avoidance Beliefs Questionnaire (FABQ) and the role of fear-avoidance beliefs in chronic low back pain and disability. Pain 1993;52:157–68.

[25] Flor H, Behle DJ, Birbaumer N. Assessment of pain-related cognitions in chronic pain patients. Behav Res Ther 1993;31:63–73.

[26] Nicholas MK. The Pain Self-efficacy Questionnaire: taking pain into account. Eur J Pain 2007;11:153–63.

[27] McKenzie R. Part A: The lumbar spine mechanical diagnosis and therapy. Brisbane: Prince Charles Hospital; 2009.

[28] Brennan GP, Fritz JM, Hunter SJ, Thackeray A, Delitto A, Erhard RE. Identifying subgroups of patients with acute/subacute 'nonspecific' low back pain: results of a randomized clinical trial. Spine 2006;31:623–31.

[29] Sahrmann SA. Diagnosis and treatment of movement system impairment syndromes: introduction to concepts and application. Dallas, TX: Methodist Dallas Medical Center; 2009.

[30] O'Sullivan PB. Management of chronic low back pain disorders: from a mechanism based bio-psycho-social perspective. Herston: Royal Brisbane Hospital; 2009. p. 38.

[31] Fersum KV, O'Sullivan PB, Kvale A, Skouen JS. Inter-examiner reliability of a classification system for patients with non-specific low back pain. Man Ther 2009;14:555–61.

[32] Calley DQ, Jackson S, Collins H, George SZ. Identifying patient fear-avoidance beliefs by physical therapists managing patients with low back pain. J Orthop Sports Phys Ther. 2010;40:774–83.

[33] Nicholas MK, Asghari A, Blyth FM. What do the numbers mean? Normative data in chronic pain measures. Pain 2008;134:158–73.

[34] Spoto MM, Collins J. Physiotherapy diagnosis in clinical practice: a survey of orthopaedic certified specialists in the USA. Physiother Res Int 2008;13:31–41.

[35] Dankaerts W, O'Sullivan PB, Straker LM, Burnett AF, Skouen JS. The inter-examiner reliability of a classification method for non-specific chronic low back pain patients with motor control impairment. Man Ther 2006;11:28–39.

[36] Kilby J, Stigant M, Roberts A. The reliability of back pain assessment by physiotherapists, using a 'McKenzie algorithm'. Physiotherapy 1990;76:579–83.

[37] Riddle DL, Rothstein JM. Intertester reliability of McKenzie's classifications of the syndrome types present in patients with low back pain. Spine 1993;18:1333–44.

[38] Long A, Donelson R, Fung T. Does it matter which exercise? A randomized control trial of exercise for low back pain. Spine 2004;29:2593–602.

[39] Harris-Hayes M, Van Dillen LR. The inter-tester reliability of physical therapists classifying low back pain problems based on the Movement System Impairment classification system. PM R 2009;1:117–26.

[40] Trudelle-Jackson E, Sarvaiya-Shah SA, Wang SS. Interrater reliability of a movement impairment-based classification system for lumbar spine syndromes in patients with chronic low back pain. J Orthop Sports Phys Ther 2008;38:371–6.

[41] Van Dillen LR, Sahrmann SA, Norton BJ, Caldwell CA, Fleming D, McDonnell MK, *et al.* Effect of active limb movements on symptoms in patients with low back pain. J Orthop Sports Phys Ther 2001;31:402–13.

[42] Rowbotham MC, Gilron I, Glazer C, Rice AS, Smith BH, Stewart WF, *et al.* Can pragmatic trials help us better understand chronic pain and improve treatment? Pain 2013;154:643–6.

[43] Delitto A, George SZ, Van Dillen L, Whitman JM, Sowa G, Shekelle P, *et al.* Low back pain clinical practice guidelines linked to the International Classification of Functioning, Disability, and Health from the Orthopaedic Section of the American Physical Therapy Association. J Orthop Sports Phys Ther 2012;42:A1–57.

[44] Sim J, Wright CC. The kappa statistic in reliability studies: use, interpretation, and sample size requirements. Phys Ther 2005;85:257–68.

[45] Jensen MP. Psychosocial approaches to pain management: an organizational framework. Pain 2011;152:717–25.

Figure 1

Figure 1. Interrelationship of Mechanical Diagnosis and Treatment (MDT) subgroups with other schemes

MDT	PBC	TBC	MSI	OSC
Reducible derangement n=51 (Central/symmetrical, 40; Unilateral/above knee, 11) →	Disc syndrome: Reducible – 51	Specific Ex: Flex – 32 Specific Ex: Ext – 15 Specific Ex: Shift – 4	Flexion – 15 Extension – 23 Rotation – 1 Rotation w/ Flex – 4 Rotation w/ Ext – 8	Cntrl: Multidirect – 21 Cntrl: Flexion – 12 Cntrl: Flex/Shift – 2 Cntrl: Active Ext – 12 Cntrl: Passive Ext – 1 Mvmt: Multidirect – 1 Mvmt: Ext w/ Rot – 2
Irreducible derangement n=24 →	Disc syndrome: Irreducible – 21 Disc syndrome: Non mech – 2 Nerve root – 1	Stabilisation – 15 Manipulation – 7 Traction – 2	Flexion – 8 Extension – 9 Rotation w/ Flex – 6 Rotation w/ Ext – 1	Cntrl: Multidirect – 8 Cntrl: Flexion – 10 Cntrl: Active Ext – 4 Mvmt: Ext w/ Rot – 1 Centrally mediated – 1
Dysfunction n=17 (Flexion, 6; Extension, 8; Side-glide, 3) →	Disc syndrome: Irreducible – 1 Disc syndrome: Non mech – 2 Dysfunction – 13	Specific Ex: Flex – 1 Stabilisation – 12 Manipulation – 4	Flexion – 8 Extension – 5 Rotation w/ Flex – 1 Rotation w/ Ext – 3	Cntrl: Multidirect – 6 Cntrl: Flexion – 5 Cntrl: Flex/Shift – 1 Cntrl: Active Ext – 5
Inconclusive n=7 →	Disc syndrome: Reducible – 1 Disc syndrome: Irreducible – 1 Disc syndrome: Non mech – 1 Inconclusive – 4	Specific Ex: Flex – 1 Stabilisation – 5 Manipulation – 1	Flexion – 2 Extension – 3 Rotation w/ Ext – 2	Cntrl: Multidirect – 2 Cntrl: Flexion – 2 Cntrl: Flex/Shift – 1 Cntrl: Active Ext – 1 Cntrl: Passive Ext – 1
Stenosis n=3 →	Stenosis – 3	Specific Ex: Flex – 2 Stabilisation – 1	Extension – 3	Cntrl: Active Ext – 1 Mvmt: Ext w/ Rot – 2

Figure 2

Figure 2. Interrelationship of Pathoanatomic Based Classification (PBC) subgroups with other schemes

PBC	MDT	TBC	MSI	OSC
Disc syndrome: Reducible n=52	Reduc drngmt – 51 Inconclusive – 1	Specific Ex: Flex – 33; Ext – 15; Shift – 4	Flexion – 15 Extension – 24 Rotation – 1 Rotation w/ Flex – 4 Rotation w/ Ext – 8	Cntrl: Multidirect – 22 Cntrl: Flexion – 12; Flex/Shift – 2 Cntrl: Act Ext – 12; Pass Ext – 1 Mvmt: Multi 1; Ext/Rot 2
Disc syndrome: Irreducible n=23	Irreduc drngmt – 21 Dysfunction – 1 Inconclusive – 1	Stabilisation – 14 Manipulation – 8 Traction – 1	Flexion – 7 Extension – 9 Rotation w/ Flex – 6 Rotation w/ Ext – 1	Cntrl: Multidirect – 7 Cntrl: Flexion – 10; Flex/Shift – 1 Cntrl: Active Ext – 4 Centrally mediated – 1
Disc syndrome: Non mechanical n=5	Irreduc drngmt – 2 Dysfunction – 2 Inconclusive – 1	Stabilisation – 5	Flexion – 2 Extension – 2 Rotation w/ Flex – 1	Cntrl: Multidirect – 2 Cntrl: Flexion – 2 Cntrl: Pass Ext – 1
Dysfunction n=13 (Ext, 6; Flex, 4, Side glide, 3)	Dysfunction – 13	Specific Ex: Flex – 1 Stabilisation – 9 Manipulation – 3	Flexion – 7 Extension – 4 Rotation w/ Ext – 2	Cntrl: Multidirect – 4 Cntrl: Flexion – 3; Flex/ Shift – 1 Cntrl: Active Ext – 5
Inconclusive n=4 Stenosis n=3 Nerve root n=1	Inconclusive – 4 Stenosis – 3 Dysfunction – 1 Irreduc drngmt – 1	Stabil 2, Manip 1 SE: Flex 2; Stabil 1 Stabilisation – 1 Traction – 1	Flex 2; Ext 1; Rot Ext 1 Extension – 3 Rotation w/ Flex – 1	Cntrl: Flex 2, AE 1 Cntrl: AE 1; Mvmt: ExtRt 2 Cntrl: Multidirect – 1 Mvmt: Ext/Rot – 1

Figure 3

Figure 3. Interrelationship of Treatment Based Classification (TBC) subgroups with other schemes

TBC		MDT	PBC	MSI	OSC
Specific Exercise: Flexion n=36	→	Reduc drngmt – 31 Irreduc drngmt – 1 Dysfunction – 1 Inconclusive – 1 Stenosis – 2	Disc: Reducible – 33 Dysfunction – 1 Stenosis – 2	Flexion – 6 Extension – 23 Rotation – 1 Rotation w/ Flex – 1 Rotation w/ Ext – 5	Cntrl: Multidirect – 12 Cntrl: Flexion – 6; Flex/ Shift – 2 Cntrl: Act Ext – 10; Pass Ext – 1 Mvmt: Multi – 1; Ext/Rot – 4
Specific Exercise: Extension n=15	→	Reduc drngmt – 15	Disc: Reducible – 15	Flexion – 8 Extension – 3 Rotation w/ Flex – 1 Rotation w/ Ext – 3	Cntrl: Multidirect – 9 Cntrl: Flexion – 3; Flex/ Shift – 1 Cntrl: Act Ext – 2
Specific Exercise: Shift n=4	→	Reduc drngmt – 4	Disc: Reducible – 4	Flexion – 1 Rotation w/ Flex – 2 Rotation w/ Ext – 1	Cntrl: Multidirect – 1 Cntrl: Flexion – 3
Stabilisation n=33	→	Irreduc drngmt – 15 Dysfunction – 12 Inconclusive – 5 Stenosis – 1	Disc: Irreducible – 14 Disc: Non mechanical – 5 Dysfunction – 9 Inconclusive – 3 Stenosis – 1	Flexion – 12 Extension – 13 Rotation w/ Flex – 4 Rotation w/ Ext – 4	Cntrl: Multidirect – 10 Cntrl: Flexion – 12; Flex/Shift – 1 Cntrl: Act Ext – 9; Pass Ext – 1
Manipulation n=12	→	Irreduc drngmt – 7 Dysfunction – 4 Inconclusive – 1	Disc: Irreducible – 8 Dysfunction – 3 Inconclusive – 1	Flexion – 6 Extension – 4 Rotation w/ Ext – 2	Cntrl: Multidirect – 5 Cntrl: Flexion – 5 Cntrl: Act Ext – 2
Traction n=2	→	Irreduc drngmt – 2	Disc: Irreducible – 1 Nerve root – 1	Rotation w/ Flex – 1 Rotation w/ Ext – 1	Centrally mediated – 1 Mvmt: Ext/Rot – 1

Figure 4

Figure 4. Interrelationship of Movement System Impairment (MSI) subgroups with other schemes

MSI		OSC	MDT	PBC	TBC
Flexion n=33	→	Cntrl: Multidirect – 10 Cntrl: Flexion – 21; Flex/Shift – 1 Cntrl: Act Ext – 1	Reduc drngmt – 15 Irreduc drngmt – 8 Dysfunction – 8 Inconclusive – 2	Disc: Reducible – 15 Disc: Irreducible – 7 Disc: Non mechanical – 2 Dysfunction – 7 Inconclusive – 2	Specific Ex: Flex – 6; Ext – 8; Shift – 1 Stabilisation – 12 Manipulation – 6
Extension n=43	→	Cntrl: Multidirect – 18 Cntrl: Act Ext – 19; Pass Ext – 2 Mvmt: Multi – 1; Ext/Rot – 3	Reduc drngmt – 23 Irreduc drngmt – 9 Dysfunction – 5 Inconclusive – 3 Stenosis – 3	Disc: Reducible – 24 Disc: Irreducible – 9 Disc: Non mechanical – 2 Dysfunction – 4 Inconclusive – 1 Stenosis – 3	Specific Ex: Flex – 23; Ext – 3 Stabilisation – 13 Manipulation – 4
Rotation n=1	→	Cntrl: Flex/Shift – 1	Reduc drngmt – 1	Disc: Reducible – 1	Specific Ex: Flex –1
Rotation w/ Flexion n=11	→	Cntrl: Multidirect – 2 Cntrl: Flexion – 8 Centrally mediated – 1	Reduc drngmt – 4 Irreduc drngmt – 6 Dysfunction – 1	Disc: Reducible – 4 Disc: Irreducible – 6 Disc: Non mechanical – 1	Specific Ex: Flex – 1; Ext – 1; Shift – 2 Stabilisation – 4 Manipulation – 2 Traction – 1
Rotation w/ Extension n=14	→	Cntrl: Multidirect – 7 Cntrl: Flex/Shift – 2 Cntrl: Act Ext – 3 Mvmt: Ext/Rot – 2	Reduc drngmt – 8 Irreduc drngmt – 1 Dysfunction – 3 Inconclusive – 2	Disc: Reducible – 8 Disc: Irreducible – 1 Dysfunction – 2 Inconclusive – 1 Nerve root – 1	Specific Ex: Flex – 5; Ext – 3; Shift – 1 Stabilisation – 4 Traction – 1

Figure 5

Figure 5. Interrelationship of O'Sullivan Classification (OSC) scheme subgroups with other schemes

OSC	MSI	MDT	PBC	TBC
Control: Multidirectional n=37	Flexion – 10 Extension – 17 Rotation w/ Flex – 2 Rotation w/ Ext – 7	Reduc drngmt – 21 Irreduc drngmt – 8 Dysfunction – 6 Inconclusive – 2	Disc: Reducible – 22 Disc: Irreducible – 7 Disc: Non mechanical – 2 Dysfunction – 4 Inconclusive – 1	Specific Ex: Flex – 12; Ext – 9; Shift – 1 Stabilisation – 10 Manipulation – 5
Control: Flexion n=29	Flexion – 21 Rotation w/ Flex – 8	Reduc drngmt – 12 Irreduc drngmt – 10 Dysfunction – 5 Inconclusive – 2	Disc: Reducible – 12 Disc: Irreducible – 10 Disc: Non mechanical – 2 Dysfunction – 3 Inconclusive – 2	Specific Ex: Flex – 6; Ext – 3; Shift – 3 Stabilisation – 12 Manipulation – 5
Control: Flexion/Shift n=4	Flexion – 1 Rotation – 1 Rotation w/ Ext – 2	Reduc drngmt – 2 Dysfunction – 1 Inconclusive – 1	Disc: Reducible – 2 Disc: Irreducible – 1 Dysfunction – 1	Specific Ex: Flex – 2; Ext – 1 Stabilisation – 1
Control: Active Extension n=23	Flexion – 1 Extension – 19 Rotation w/ Ext – 3	Reduc drngmt – 12 Irreduc drngmt – 4 Dysfunction – 5 Inconclusive – 1 Stenosis – 1	Disc: Reducible – 12 Disc: Irreducible – 4 Dysfunction – 5 Inconclusive – 1 Stenosis – 1	Specific Ex: Flex – 10; Ext – 2 Stabilisation – 9 Manipulation – 2
Control: Passive Extension n=2	Extension – 2	Reduc drngmt – 1 Inconclusive – 1	Disc: Reducible – 1 Disc: Non mechanical – 1	Specific Ex: Flex – 1 Stabilisation – 1
Movement n=6 (Extension w/ Rot, 5; Multidirectional, 1)	Extension – 4 Rotation w/ Ext – 2	Reduc drngmt – 3 Irreduc drngmt – 1 Stenosis – 2	Disc: Reducible – 3 Stenosis – 2 Nerve root – 1	Specific Ex: Flex – 5 Traction – 1
Centrally mediated n=1	Rotation w/ Flex – 1	Irreduc drngmt – 1	Irreduc drngmnt – 1	Traction – 1

Fig. 1. Relationship between Mechanical Diagnosis and Treatment (MDT) subgroups and other schemes. For each subgroup of the MDT scheme (left column), columns to the right show how the patients allocated to a subgroup are distributed between the subgroups from each of the other schemes. PBC, Pathoanatomic Based Classification; TBC, Treatment Based Classification; MSI, Movement System Impairment; OSC, O'Sullivan Classification; Ex, exercise; Flex, flexion; Ext, extension; Rot, rotation; Multidirect/Multi, multidirectional; Cntrl, control; Mvmt, movement; AE, active extension; Passive Ext, passive extension; Reduc, reducible; Drngmt, derangement; Irreduc, irreducible; Manip, manipulation; Stabil, stabilisation.

Figure 2. Relationship between Pathoanatomic Based Classification (PBC) subgroups and other schemes. For each subgroup of the PBC scheme (left column), columns to the right show how the patients allocated to a subgroup are distributed between the subgroups from each of the other schemes. Abbreviations as for Fig. 1.

Fig. 3. Relationship between Treatment Based Classification (TBC) subgroups and other schemes. For each subgroup of the TBC scheme (left column), columns to the right show how the patients allocated to a subgroup are distributed between the subgroups from each of the other schemes. Abbreviations as for Fig. 1.

Fig. 4. Relationship between Movement System Impairment (MSI) subgroups and other schemes. For each subgroup of the MSI scheme (left column), columns to the right show how the patients allocated to a subgroup are distributed between the subgroups from each of the other schemes. Abbreviations as for Fig. 1.

Fig. 5. Relationship between O'Sullivan Classification Scheme (OSC) subgroups and other schemes. For each subgroup of the OSC scheme (left column), columns to the right show how the patients allocated to a subgroup are distributed between the subgroups from each of the other schemes. Additional classification levels: Non-specific LBP, 101; Peripherally mediated LBP, 100; Dominant psychosocial factors, 6. Abbreviations as for Fig. 1.

Table 1

Characteristics of the patient sample (*n*=102)

Parameter	
Age in years, mean (SD)	32 (13)
Sex, *n* Female Male	 61 41
Symptoms, *n* Improving Static Worsening Duration ≤4 weeks >4 weeks Distal to knee	 39 30 33 13 89 13
Episodes of LBP, *n* 1 2 ≥3	 1 35 66
Disability (RMDQ), mean (SD) [range]	7 (5) [0 to 22]
Pain intensity (NPRS usual), mean (SD) [range]	4 (2) [1 to 9]
Fear avoidance beliefs (FABQ) Work subscale, mean (SD) [range] Physical activity scale, mean (SD)[range]	 15 (11) [0 to 42] 13 (5) [0 to 24]
Coping (PRSS subscale), mean (SD) [range]	3 (1) [0 to 5]
Catastrophising (PRSS subscale)	2 (1) [0 to 5]
Self-efficacy (PSEQ), mean (SD) [range]	44 (10) [0 to 60]

RMDQ, Roland Morris Disability Questionnaire; NPRS, Numeric Pain Rating Scale; FABQ, Fear Avoidance Beliefs Questionnaire; PRSS, Pain Related Self Statements scale; PSEQ, Pain Self-Efficacy Questionnaire.

Table 2

Number of participants with elevated psychosocial factors (*n*=102)

Parameter	
Fear avoidance (FABQ) Work subscale (*n*) >25 threshold score Physical activity scale (*n*) >15 threshold score	 18 36
Coping (PRSS subscale) (*n*) ≤3 threshold score	31
Catastrophising (PRSS subscale) (*n*) ≥3 threshold score	15
Self-efficacy (PSEQ) (*n*) ≤25 threshold score	3
Participants with ‘dominant’ psychosocial factors (three or more out of five elevated scores) (*n*)	6

RMDQ, Roland Morris Disability Questionnaire; NPRS, Numeric Pain Rating Scale; FABQ, Fear Avoidance Beliefs Questionnaire; PRSS, Pain Related Self Statements scale; PSEQ, Pain Self-Efficacy Questionnaire.