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A BIOPSYCHOSOCIAL FRAMEWORK FOR PREDICTING FUNCTIONAL RECOVERY IN PATIENTS WITH MUSCULOSKELETAL DISORDERS

Keywords: musculoskeletal disorders, functional recovery, rehabilitation, psychosocial factors; kinesiophobia, pain catastrophizing, adherence.

Abstract. Musculoskeletal disorders are major contributors to disability worldwide. Although rehabilitation is central to improving functional outcomes, recovery trajectories often differ substantially among patients with similar clinical presentations. This suggests that biomedical factors alone are insufficient to explain rehabilitation response. This review synthesizes current evidence on the psychosocial determinants of functional recovery in patients with musculoskeletal disorders, with particular attention to psychological factors, behavioural patterns, rehabilitation adherence, and social context. The reviewed literature indicates that pain catastrophizing, kinesiophobia, anxiety, depression, low self-efficacy, and negative treatment expectations may influence symptom interpretation, movement behaviour, and engagement with rehabilitation. Behavioural factors, including avoidance, physical activity patterns, self-management, and exercise participation, may further shape recovery by affecting the extent to which patients restore activity and function. Rehabilitation adherence appears to be a key link between psychosocial profile and functional outcome, but remains inconsistently defined and measured across studies. Social determinants may additionally influence the feasibility and effectiveness of rehabilitation. Overall, the evidence supports the relevance of a psychosocial perspective in musculoskeletal rehabilitation and highlights the need for integrated assessment strategies that consider psychological, behavioural, adherence-related, and social contributors to recovery.

Musculoskeletal disorders are among the major global contributors to disability and place a considerable burden on affected individuals, healthcare systems, and societies [1]. They comprise a heterogeneous group of conditions affecting muscles, bones, joints, and connective tissues, often resulting in pain, impaired mobility, reduced work capacity, and diminished quality of life. Recent Global Burden of Disease estimates confirm the increasing prevalence and disability burden of musculoskeletal conditions, with projected growth driven by population ageing, multimorbidity, and persistent functional limitations [2]. Rehabilitation is therefore central to musculoskeletal care as a strategy to restore function, participation, and long-term self-management.

However, functional recovery after musculoskeletal rehabilitation remains highly variable. Patients with similar diagnoses, comparable pain intensity, or apparently similar structural impairment may follow markedly different recovery trajectories. This variability suggests that biomedical indicators alone are insufficient to explain rehabilitation outcomes. The biopsychosocial model,

originally proposed as an alternative to reductionist biomedical thinking, provides a relevant conceptual basis for understanding recovery as the result of interactions between biological, psychological, and social determinants [3]. In musculoskeletal pain and rehabilitation research, accumulating evidence indicates that factors such as baseline disability, pain intensity, emotional distress, fear of movement, catastrophizing, self-efficacy, treatment expectations, social context, and adherence may influence pain-related disability and functional outcomes [4, 5].

Despite this evidence, several conceptual and methodological gaps remain. First, many studies examine predictors of rehabilitation outcomes in isolated domains, focusing separately on clinical features, physical performance, patient-reported outcomes, or psychological variables. Second, patient-reported outcome measures are commonly used as endpoints, but their potential role as baseline predictors and dynamic indicators of recovery trajectories is less consistently integrated into rehabilitation models [6]. Third, although adherence to prescribed exercise and

rehabilitation programmes is increasingly recognized as a determinant of treatment effectiveness, it is often poorly measured, inconsistently reported, or treated as a secondary issue rather than as a potential mediator between psychosocial profile and functional recovery [7]. These limitations restrict the development of clinically useful, multidimensional approaches for early risk stratification and personalized rehabilitation planning.

Therefore, this review aims to synthesize current evidence on biopsychosocial factors associated with functional recovery in musculoskeletal disorders and to emphasize the need for more integrated approaches to rehabilitation assessment and outcome prediction.

SEARCH METHODOLOGY

A literature search was conducted to identify peer-reviewed publications on the psychosocial determinants of functional recovery in patients with musculoskeletal disorders.

The search was performed in major biomedical and multidisciplinary databases, including PubMed/MEDLINE, Scopus, and Web of Science Core Collection. The search focused on English-language studies and included original research articles, systematic reviews, scoping reviews, narrative reviews, meta-analyses, and clinically relevant methodological papers. The search strategy combined the following terms: “musculoskeletal disorders”, “musculoskeletal diseases”, “musculoskeletal pain”, “rehabilitation”, “functional recovery”, “functional outcome”, “physical function”, “disability”, “psychosocial factors”, “psychological determinants”, “pain catastrophizing”, “kinesiophobia”, “fear of movement”, “anxiety”, “depression”, “self-efficacy”, “treatment expectations”, “illness perception”, “health behaviour”, “exercise adherence”, “rehabilitation adherence”, “social support”, “socioeconomic factors”, and “biopsychosocial model”.

Publications were considered eligible if they addressed adult patients with musculoskeletal disorders or musculoskeletal pain conditions and examined at least one psychosocial, behavioural, adherence-related, or social factor in relation to functional status, disability, rehabilitation outcomes, recovery trajectories, or patient-reported outcomes. Studies focused exclusively on surgical techniques, pharmacological treatment without rehabilitation relevance, paediatric populations, neurological rehabilitation, or non-musculoskeletal conditions were excluded. Data from selected publications were synthesized narratively.

PSYCHOLOGICAL FACTORS OF FUNCTIONAL RECOVERY IN MUSCULOSKELETAL DISORDERS

Psychological factors are among the most extensively studied psychosocial domains in musculoskeletal rehabilitation [8]. Pain catastrophizing, kinesiophobia, anxiety, depressive symptoms, low self-efficacy, maladaptive illness perceptions, and negative treatment expectations may influence functional recovery by modifying pain appraisal, movement

behaviour, emotional regulation, and engagement with rehabilitation [8]. Importantly, these factors should not be interpreted as suggesting that musculoskeletal symptoms are psychogenic. They represent clinically relevant modifiers of disability and recovery in conditions in which pain, physical limitations, and behavioural adaptation interact over time.

Pain catastrophizing is commonly described as a maladaptive cognitive and emotional response to pain [9]. It is characterized by magnification of threat, rumination, and perceived helplessness. In musculoskeletal disorders, catastrophizing may contribute to higher perceived pain intensity, avoidance of activity, reduced confidence in movement, and greater disability [10]. Its clinical relevance is associated with symptom burden and in its potential role as a modifiable treatment target. For rehabilitation, catastrophizing is particularly important because patients who interpret pain as threatening may be less willing to perform exercises, tolerate temporary symptom fluctuations, or gradually increase activity. This may lead to a cycle in which pain-related fear and low activity reinforce functional limitation.

Kinesiophobia, or fear of movement, is another key determinant of musculoskeletal disability [11]. Systematic review evidence indicates that kinesiophobia is associated with pain, disability, and quality of life in chronic musculoskeletal pain, although the prognostic strength varies across studies and populations [12]. The clinical implication is that two patients with similar pain intensity may differ substantially in function depending on whether they interpret movement as safe, beneficial, or threatening. In rehabilitation settings, high kinesiophobia may reduce participation in therapeutic exercise, delay progression of activity, and contribute to persistent disability even when tissue healing or inflammatory control is adequate [12].

The fear-avoidance model provides one of the most influential theoretical explanations for these observations. According to this model, pain may lead to recovery when interpreted as non-threatening, but may lead to avoidance, hypervigilance, emotional distress, and disability when interpreted catastrophically. Selective reviews continue to support the relevance of fear-avoidance constructs in musculoskeletal pain, while also indicating that these constructs are embedded within broader psychosocial and contextual systems [13]. Therefore, assessing fear-related constructs may help identify patients at risk of delayed functional improvement and select interventions that combine physical rehabilitation with pain education, graded exposure, or cognitive-behavioural components.

Anxiety and depressive symptoms are also clinically relevant because they may amplify pain experience, reduce motivation, impair sleep, limit participation, and weaken self-management capacity. In chronic low back pain, systematic review evidence suggests that psychosocial variables, including fear of movement, self-efficacy, catastrophizing, depression, anxiety, and distress, are associated with pain and disability

outcomes after conservative treatment [14]. However, the direction of causality can be complex. Psychological distress may worsen disability, while prolonged pain and functional restriction may also increase emotional distress [14]. This bidirectional relationship supports the need to assess psychological status as part of rehabilitation planning.

Self-efficacy may be particularly important as a protective factor. Pain self-efficacy refers to the patient's confidence in performing activities despite pain. Systematic review evidence suggests that self-efficacy may function as both a prognostic factor and a mediator in chronic musculoskeletal pain, although certainty varies across outcomes and study designs [15, 16]. Clinically, higher self-efficacy may support greater persistence with exercise, better coping with symptom fluctuations, and more active participation in rehabilitation. Conversely, low self-efficacy may increase dependency, avoidance, and perceived inability to recover. This makes self-efficacy a particularly attractive construct for rehabilitation because it is potentially modifiable through education, graded goal achievement, feedback, and patient-centred communication.

BEHAVIOURAL PATTERNS

Behavioural patterns represent the practical expression of psychological and contextual influences. In musculoskeletal rehabilitation, behaviour includes physical activity, sedentary time, avoidance, pacing, exercise practice, sleep-related behaviour, self-monitoring, help-seeking, and lifestyle adaptation [17–20]. These behaviours may either facilitate recovery or maintain disability.

Avoidance behaviour is particularly relevant in chronic musculoskeletal pain. When patients avoid movement because of fear, pain anticipation, or low confidence, physical deconditioning, reduced mobility, and impaired participation may follow [21]. This can create a self-reinforcing cycle. Pain leads to avoidance, avoidance reduces capacity, reduced capacity increases difficulty with activity, and increased difficulty confirms the patient's belief that movement is unsafe. This mechanism is clinically important because it explains why passive symptom reduction may be insufficient if patients do not regain confidence and activity tolerance.

By contrast, adaptive behaviour involves gradual activity exposure, pacing, regular therapeutic exercise, and self-management. However, these behaviours require more than information. Patients must believe that activity is safe, understand the rationale for exercise, experience achievable progress, and receive support when symptoms fluctuate. Evidence-based musculoskeletal care increasingly emphasizes active approaches, education, and self-management [22].

Physical activity behaviour is also relevant because low activity may contribute to reduced functional reserve, poorer cardiometabolic health, and lower participation [23]. Nevertheless, the relationship between physical activity and musculoskeletal pain is

not linear. Some patients may underuse movement due to fear, while others may overuse activity without adequate pacing, leading to symptom exacerbation and frustration [24].

Health behaviour should also be interpreted in relation to health literacy and patient understanding. Patients who have limited understanding of pain mechanisms, rehabilitation goals, or expected recovery fluctuations may interpret temporary pain increases as harm [25]. This can reduce exercise engagement and increase dependence on passive care. Pain education and shared goal-setting may therefore act as behavioural interventions by changing the meaning of symptoms and improving the patient's readiness to participate actively in rehabilitation.

Behavioural patterns are also measurable and clinically actionable. Exercise diaries, activity monitors, attendance records, step counts, patient-reported activity scales, sleep questionnaires, and rehabilitation goal tracking can provide useful information [26]. However, these tools should be selected pragmatically, because excessive measurement burden may reduce feasibility in routine care. The most useful behavioural indicators are those that can guide clinical decisions, such as identifying patients who need additional education, motivational support, graded exposure, or simplified home exercise programmes.

REHABILITATION ADHERENCE

Rehabilitation adherence is a central but often underestimated determinant of functional recovery. In musculoskeletal disorders, adherence includes attendance at supervised sessions, completion of home exercises, correct exercise performance, persistence over time, engagement with self-management advice, and willingness to progressively increase activity [7]. It is important to distinguish adherence from simple compliance. Compliance implies passive obedience to professional instructions, whereas adherence reflects an active, negotiated, and context-dependent process shaped by motivation, beliefs, programme acceptability, social resources, and perceived benefit.

The importance of adherence is supported by systematic review evidence showing that predictors of adherence to prescribed exercise programmes in musculoskeletal pain are multidimensional. Shaw et al. grouped predictors into demographic, psychological, programme-related, medical-condition, physical, and social clusters, emphasizing that adherence is influenced by more than patient motivation alone [27]. This finding is important for rehabilitation practice because it shifts responsibility away from blaming the patient and toward identifying modifiable barriers within the rehabilitation programme and care environment.

Psychological factors are closely linked to adherence. Pain catastrophizing and kinesiophobia may reduce willingness to exercise, whereas self-efficacy may increase persistence [12]. In patients after total knee arthroplasty, pain catastrophizing and kinesiophobia were negatively associated with exercise

adherence, while exercise self-efficacy was positively associated with adherence and appeared to mediate the relationship between psychological distress and exercise behaviour [12]. Although this evidence comes from a specific postoperative population, it illustrates a broader mechanism that is relevant to musculoskeletal rehabilitation: patients are more likely to adhere when they feel capable, understand the purpose of exercise, and perceive movement as safe.

Programme-related factors are also essential. Exercises that are too complex, painful, time-consuming, poorly explained, or poorly aligned with patient goals may reduce adherence. On the other hand, programmes that are individualized, feasible, meaningful, and progressively adjusted may support engagement. This suggests that adherence should be considered partly as an outcome of programme design. A technically appropriate programme may fail if it is not acceptable to the patient or cannot be integrated into daily life.

Measurement of adherence remains a methodological weakness in musculoskeletal research. A systematic review of exercise adherence measures in musculoskeletal settings found that available measures vary in quality and acceptability, and that there is no universally accepted approach to measuring adherence across conditions and interventions [28]. This limitation has important implications for evidence synthesis. If adherence is inconsistently defined and measured, it becomes difficult to determine its true relationship with functional recovery or to compare adherence-promoting interventions across studies.

Digital rehabilitation may offer one strategy for improving adherence, although it should not be seen as a universal solution [29, 30]. A systematic review and meta-analysis found that digital rehabilitation programmes can improve therapeutic exercise adherence in musculoskeletal conditions, particularly at mid-term follow-up, but effects may vary by duration, platform design, and patient population [31]. Digital tools may support reminders, feedback, monitoring, and patient-clinician communication, but their effectiveness depends on usability, digital literacy, motivation, and access. In socially disadvantaged or older populations, digital solutions may also introduce new inequalities if not implemented carefully.

SOCIAL FACTORS IN MUSCULOSKELETAL REHABILITATION

Social context influences both the development of musculoskeletal disability and the likelihood of recovery [32]. This domain includes socioeconomic status, education, employment, work demands, social support, family responsibilities, access to care, transport, insurance coverage, geographic location, cultural beliefs, and broader structural determinants of health.

Evidence from low back pain research provides strong support for the relevance of social determinants.

A systematic review and narrative synthesis by Karran et al. examined relationships between social determinants of health and chronic low back pain, highlighting associations between social disadvantage and pain-related outcomes [33]. Although low back pain is only one musculoskeletal condition, it is a useful model because it demonstrates how socioeconomic and occupational contexts can influence pain persistence, disability, work absence, and care-seeking behaviour.

Social support may influence recovery through several mechanisms. Practical support can help patients attend appointments, perform home exercises, manage daily tasks, and maintain activity. Emotional support may reduce distress, improve confidence, and encourage persistence. On the contrary, lack of support, social isolation, family stress, or unsupportive workplace environments may increase the burden of disability and reduce adherence. In occupationally active patients, workplace factors such as job demands, flexibility, supervisor support, and availability of modified duties may strongly affect return to work and perceived recovery [34].

INTEGRATION OF THE FOUR DOMAINS

The four domains discussed above should be understood as interacting components of recovery. For example, pain catastrophizing may increase fear of movement, fear of movement may reduce exercise participation, reduced participation may impair functional gains, and low social support may further weaken adherence. Conversely, high self-efficacy, realistic expectations, supportive family or workplace environments, and feasible rehabilitation plans may create a positive recovery pathway.

This integrated view has practical implications. First, rehabilitation assessment should include brief but validated measures of psychological risk, behavioural engagement, adherence barriers, and social context [35]. Second, rehabilitation planning should move beyond diagnosis-based protocols toward risk-informed and patient-centred strategies [36]. Third, poor adherence should be investigated as a clinical signal requiring problem-solving. Fourth, future research should evaluate whether combining psychosocial variables improves prediction of functional recovery beyond clinical and functional measures alone.

The available evidence supports the importance of psychosocial determinants, but it also highlights methodological limitations. Studies differ in musculoskeletal diagnosis, outcome measures, follow-up duration, instruments, and definitions of recovery (Table). Psychological constructs are often measured more consistently than behavioural or social variables, while adherence remains particularly difficult to define and quantify. Consequently, the current literature supports a psychosocial perspective on functional recovery, but further prospective research is required to determine the relative predictive weight of each domain and their interactions across different musculoskeletal conditions.

Summary of evidence on psychosocial determinants of functional recovery in musculoskeletal disorders

Authors, year and article type	Population / evidence base	Main factors assessed	Outcome	Key findings
Psychological factors				
Tseli et al., 2019 [4] Systematic review and meta-analysis	Patients with chronic musculoskeletal pain undergoing multidisciplinary rehabilitation	Prognostic factors for long-term physical functioning, including psychosocial variables	Physical functioning at ≥ 6 months	The review showed that long-term functional outcome in chronic musculoskeletal pain is influenced by multiple prognostic factors, supporting a multidimensional approach rather than reliance on biomedical variables alone.
Luque-Suarez et al., 2019 [12] Systematic review	63 observational studies; total sample 10,726 people with chronic musculoskeletal pain	Kinesiophobia, commonly assessed with the Tampa Scale for kinesiophobia	Pain intensity, disability, quality of life	The authors reported strong evidence that greater kinesiophobia is associated with higher pain intensity and disability. The review also examined prognostic value using longitudinal studies.
Martinez-Calderon et al., 2018 [15] Systematic review	Longitudinal studies in chronic musculoskeletal pain	Pain self-efficacy	Prognosis of pain and disability	Higher self-efficacy was associated with lower pain and disability, although the quality of evidence varied.
Alhowimel et al., 2021 [14] Systematic review	People with chronic low back pain receiving conservative treatment	Fear of movement, catastrophizing, depression, anxiety, distress, self-efficacy	Pain and disability outcomes	Psychosocial factors were associated with pain and disability outcomes after conservative treatment, although the strength and consistency of evidence differed across variables.
Behavioural patterns				
Fullen et al., 2023 [22] Review / perspective on physical therapy practice	Musculoskeletal pain populations	Person-centred care, self-management, active rehabilitation, behaviour change	Pain-related disability and functional recovery	Contemporary musculoskeletal rehabilitation increasingly emphasizes active care, education, shared decision-making, and behavioural engagement rather than passive treatment alone.
Rehabilitation adherence				
Shaw et al., 2022 [27] Systematic review	Older adults with medical or surgical indications for exercise; included musculoskeletal and other rehabilitation-relevant populations	Predictors of adherence to prescribed exercise	Exercise programme adherence	Positive predictors included self-efficacy and good self-rated mental health, while depression and distance from the exercise facility were negative predictors (PMC)
McLean et al., 2017 [28] Systematic review	Musculoskeletal settings; two-phase review identifying and appraising exercise adherence measures	Exercise adherence measurement	Measurement quality and acceptability	The review found substantial variability in how adherence is measured and highlighted limitations in measurement quality and acceptability.
Zhang et al., 2022 [31] Systematic review and meta-analysis	Patients with musculoskeletal conditions using digital rehabilitation programmes	Digital rehabilitation, therapeutic exercise adherence	Exercise adherence	Digital rehabilitation programmes may improve adherence to therapeutic exercise in musculoskeletal conditions, although effects depend on implementation and patient context.
Zhou et al., 2023 [37] Original observational study	Post-total knee arthroplasty patients	Pain catastrophizing, kinesiophobia, exercise self-efficacy	Exercise adherence	The study provides original evidence that psychological factors can influence adherence both directly and indirectly through self-efficacy.
Social context				
Karran et al., 2020 [33] Systematic review	Studies on chronic low back pain and social determinants of health	Socioeconomic status, education, work-related factors, social determinants	Frequency, severity, disability, work absenteeism and related outcomes in chronic low back pain	The review synthesized evidence that social determinants are meaningfully related to chronic low back pain burden and related outcomes.
Braaten et al., 2021 [34] Systematic review	Adults across countries and physical therapy contexts	Social determinants of health, including predisposing and enabling factors	Physical therapy use	The review found that social determinants influence physical therapy utilization, including factors such as education, socioeconomic position, employment, insurance, transport, and rurality.

In summary, the available evidence indicates that functional recovery in musculoskeletal disorders is shaped not only by clinical status or physical impairment, but also by psychosocial factors that influence rehabilitation engagement and outcomes. Overall, this review highlights the importance of considering psychological, behavioural, adherence-related, and social factors as interconnected contributors

to functional recovery and supports the need for more integrated assessment approaches in musculoskeletal rehabilitation.

Conflict of interest. None.

Funding. The article was prepared within the framework of grant project No. 2025.05/0032, funded by the National Research Foundation of Ukraine through the grant of the President of Ukraine.

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БІОПСИХОСОЦІАЛЬНА ОСНОВА ДЛЯ ПРОГНОЗУВАННЯ ФУНКЦІОНАЛЬНОГО ВІДНОВЛЕННЯ У ПАЦІЄНТІВ ІЗ РОЗЛАДАМИ ОПОРНО- РУХОВОГО АПАРАТУ

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Анотація. Захворювання опорно-
рухового апарату належать до провідних

чинників інвалідизації у світі. Незважаючи на те що реабілітація відіграє ключову роль у покращенні функціональних результатів, процес відновлення може суттєво відрізнятися у пацієнтів із подібними клінічними проявами. Це свідчить про те, що лише біомедичних чинників недостатньо для пояснення результату реабілітації. У цьому огляді узагальнено сучасні дані щодо психосоціальних детермінант функціонального відновлення у пацієнтів із захворюваннями опорно-рухового апарату. Особливу увагу приділено психологічним чинникам, поведінковим патернами, прихильності до реабілітації та соціальному контексту. Проаналізована література свідчить, що катастрофізація болю, кінезіофобія, тривожність, депресивні симптоми, низька самоефективність і негативні очікування щодо лікування можуть впливати на інтерпретацію симптомів, рухову поведінку та залученість пацієнта в реабілітаційний процес. Поведінкові чинники, зокрема уникнення рухової активності, рівень фізичної активності, самоменеджмент та участь у виконанні реабілітаційних вправ також можуть модифікувати процес відновлення, впливаючи на відновлення активності та функціональних можливостей. Прихильність до реабілітації є важливою ланкою між психосоціальним профілем пацієнта та функціональним результатом. Однак у наукових дослідженнях вона досі визначається й оцінюється неоднорідно. Соціальні детермінанти можуть додатково впливати на доступність, здійсненість та ефективність реабілітації. Загалом наявні дані підтверджують доцільність психосоціального підходу в реабілітації пацієнтів із захворюваннями опорно-рухового апарату та підкреслюють потребу в інтегрованих стратегіях оцінювання.

Ключові слова: захворювання опорно-рухового апарату, функціональне відновлення, реабілітація, психосоціальні чинники, кінезіофобія, катастрофізація болю, прихильність до реабілітації.

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Надійшла до редакції/Received: 19.05.2026

Прийнято до друку/Accepted: 22.05.2026