Original Article

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Impact of a Biopsychosocial Pain Management Protocol on Central Sensitization and Fear Avoidance in Patients with Chronic Musculoskeletal Pain

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Abstract:

Objective: Chronic musculoskeletal pain (CMP) is a complex and persistent condition with a high prevalence that considerably affects physical, emotional, and social well-being. It is often influenced by central sensitization and fear-avoidance behaviours. This study aimed to evaluate the effects of a biopsychosocial pain management protocol on central sensitization and fear-avoidance behaviour in individuals with CMP.

Material and Methods: A randomized controlled trial was conducted with 127 participants, of whom 80 were randomly allocated via prospective random sampling into two groups: a biopsychosocial pain management group (n=40) and a regular physiotherapy group (n=40). Participants underwent an 8-week intervention and were assessed at baseline and post-intervention using the central sensitization inventory (CSI), fear-avoidance components scale (FACS), and numerical pain rating scale (NPRS). After two dropouts, statistical analyses were performed on 38 participants per group using paired and independent t-tests, Mann–Whitney U tests, and Wilcoxon signed-rank tests. Intention-to-treat analyses were also conducted, including all 40 participants. All analyses were performed using Jamovi software, version 2.3.28, with statistical significance set at p-value<0.05.

Results: Both groups showed significant improvements across all outcomes after 8 weeks. However, the biopsychosocial pain management group demonstrated significantly greater reductions in CSI (mean reduction=20.55 points, p-value<0.001) and FACS (mean reduction=25.92 points, p-value<0.001) compared to the regular physiotherapy group. Effect size analyses revealed large improvements in the biopsychosocial group, with Cohen's d=1.41 for CSI and 0.71 for FACS.

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Conclusion: Biopsychosocial pain management is more effective than regular physiotherapy alone in managing chronic musculoskeletal pain, particularly in reducing central sensitization and fear-avoidance behaviour. These findings support the integration of biopsychosocial approaches as a crucial component of multidisciplinary care for patients with CMP.

Keywords: biopsychosocial pain management, central sensitization, chronic musculoskeletal pain, fear avoidance, standard physiotherapy

Introduction

Chronic musculoskeletal pain (CMP) remains a major cause of disability and socioeconomic burden globally, affecting physical, psychological, and social well-being. Recent evidence highlights the need for multidimensional, non-pharmacological strategies to manage musculoskeletal pain, reducing long-term reliance on medications and improving patient quality of life[1]. Psychological and psychosocial factors such as anxiety, depression, fear-avoidance, and maladaptive coping have been identified as significant contributors to the chronicity of musculoskeletal pain[2]. Central sensitization (CS), a hallmark mechanism of chronic pain, involves hypersensitivity of central nociceptive pathways, resulting in amplified pain perception[3]. Behavioral and cognitive models, including the fear-avoidance model proposed by Lethem et al., explain how fear of pain leads to avoidance behaviors, disuse, and disability[4–6]. These mechanisms emphasize the importance of addressing both biological and psychosocial contributors to pain persistence.

Conventional biomedical physiotherapy approaches, primarily focused on manual therapy and exercise, often fail to address the cognitive and emotional dimensions of pain[7,8]. The biopsychosocial (BPS) model provides a broader framework that integrates the biological, psychological, and social determinants of pain, promoting individualized and holistic care[9–11].

Recent studies on pain neuroscience education, graded exposure, and cognitive-behavioral approaches have demonstrated significant improvements in central sensitization and pain-related disability[12–14]. Evidence from neuroplasticity-based rehabilitation further supports that psychological and educational interventions can normalize altered brain pathways and reduce chronic pain symptoms[15–16]. Moreover, activity pacing and self-management interventions have been shown to enhance adherence, improve function, and reduce pain catastrophizing[17,18]. Multimodal interventions incorporating mindfulness, relaxation training, and lifestyle modification show synergistic effects when combined with physiotherapy, improving long-term outcomes and self-efficacy[19,20]. Emerging evidence supports the use of psychologically informed physiotherapy and cognitive functional therapy to address maladaptive beliefs, fear-avoidance, and catastrophizing behaviors[21–23]. Furthermore, systematic reviews highlight that multidimensional physiotherapy integrating behavioral, cognitive, and educational strategies yields superior long-term benefits for chronic musculoskeletal pain[24–26].

Despite the theoretical acceptance of the BPS model, there remains limited implementation in physiotherapy-led practice, particularly within Indian healthcare settings. Existing studies are often constrained by small sample sizes, regional variability, and a lack of standardized protocols. Moreover, discrepancies in guideline consensus and challenges in therapist training have hindered widespread application[25–28].

The present study evaluated the effectiveness of a Comprehensive Chronic Pain Management (CCPM) protocol, an operationalized, physiotherapy-led biopsychosocial intervention, designed to target central sensitization and fear-avoidance behaviours among individuals with chronic musculoskeletal pain. The CCPM integrates education on pain mechanisms, activity pacing, graded exposure, relaxation, SMART goal setting, and psychosocial strategies into a structured, patient-centered framework. By translating the BPS model into an actionable physiotherapy protocol, this study bridges the gap between theory and clinical practice, offering a feasible, culturally adaptable, and evidence-based approach to improve outcomes, enhance patient self-efficacy, and reduce the burden of chronic pain on healthcare systems.

Material and Methods

Study design

An outcome assessor-blinded 8-week randomised controlled trial (RCT), single-centre study was conducted. This study protocol describes the design of a single-centre RCT of parallel groups (ratio 1:1). The study protocol conforms with the standard protocol items: recommendations for Interventional Trials (Table 1) (SPIRIT)[29], while the RCT conforms to the Consolidated Standards of Reporting Trials (Figure 1) (CONSORT)[30]. The study was approved by the PP Savani Ethical Review Committee of PP Savani University (dated 11/05/2023). The study has been registered at the clinical trial registry, India (ctri.nic.in) CTRI/2023/05/053340 [Registered on: 31/05/2023] – Trial Registered Prospectively

Sample size calculation

A computer-generated randomization sampling method was used to select and allocate participants to experimental and control groups. The sample size was calculated based on assumptions of a medium to large effect size (A larger Cohen's d indicates a greater group difference, while smaller values reflect smaller differences.), power 0.9, and Type I error á=0.05 considering central sensitization as a primary outcome measure, ensuring adequate power to detect meaningful group differences. Included was the 15% dropout estimation of the total sample size, which is 40+40=80. The sample size was estimated using G Power software version 3.1.9.2. (Germany)[31].

Participants

Men and women aged between 18 and 75 years, with chronic musculoskeletal pain lasting more than 3 months, with or without radiating pain, who attended the participating outpatient physiotherapy centre were included in the study. Among the 127 individuals screened, 80 participants were selected and divided into the experimental or control group. Inclusion criteria required participants to experience daily musculoskeletal pain over the past 3 months, be of either sex within the specified age range, provide evidence of non-specific back pain lasting at least three months (the presence of pain in other areas does not exclude participation), and agree to participate in the study by signing an informed consent form. Conversely, exclusion criteria included pain related to cancer, non-neuromusculoskeletal pain (such as pain from surgery or fractures), cognitive impairments that hinder understanding of intervention content (with a minimum score of 25 required on a Mini-Mental State Examination if necessary for individuals where cognitive impairment was suspected or needed to confirm eligibility), upper motor lesions or cauda equina syndrome, pregnancy, and other clinical conditions that may exacerbate chronic spinal pain (such as chronic fatigue syndrome, fibromyalgia, or complex regional pain syndrome). Additionally, individuals with associated pathologies that significantly impair functionality, those receiving other alternative therapies, and those with rheumatoid arthritis, infective arthritis, or metastases were excluded.

Table 1 The SPIRIT protocol

	Study period				
	Enrolment	**Allocation**	**Post-allocation**		**Close-out**
TIMEPOINT	$-t_1$	0	t_1 Baseline	t_2 8 weeks	t_x
ENROLMENT					
Eligibility screen	X				
Informed consent	X				
Randomization	X				
Allocation to CCPM or Standard physiotherapy		X			
INTERVENTIONS					
CCPM			—	—	
Standard physiotherapy			—	—	
ASSESSMENTS					
Background Data	X	X			
CSI, FACS& NPRS		X			X

CCPM=comprehensive chronic pain management, CSI=central sensitization inventory, FACS=fear-avoidence component scale, NPRS=numberical pain rating scale

Recruitment method

Patients arriving at the centre were scrutinised through a screening form during their first visit. Those who met the inclusion and exclusion criteria were allowed to participate in the RCT. Informed written consent was obtained from interested patients following a verbal explanation and provision of a written patient information sheet.

Randomization and blinding

The study was overseen by two experienced therapists with over 7 years of expertise in musculoskeletal physiotherapy. Simple random sampling was used to allocate participants to the experimental and control groups. Allocation concealment was maintained using a centralized digital randomization system (sealedenvelop.com), and blinding was applied to the outcome assessor to prevent bias. As participants and the therapist could not be blinded to the intervention, only observer blinding was implemented.

Outcome measures

The outcome measures were used before and after 8 weeks of the intervention in both experimental and control groups.

Central sensitization inventory (CSI): The CSI consists of 25 items related to current health symptoms, each rated on a 5-point Likert scale (0="never" to 4="always"), yielding a cumulative score of 0–100. Scores ≥40 indicate the presence of central sensitization.

A reduction of ≥10 points is considered a clinically meaningful improvement[32].

Fear-avoidance components scale (FACS): The FACS contains 20 items, scored from 0 ("completely disagree") to 5 ("completely agree"), with a total possible score of 0–100. Higher scores indicate greater fear-avoidance. A reduction of ≥10 points is considered clinically significant[33].

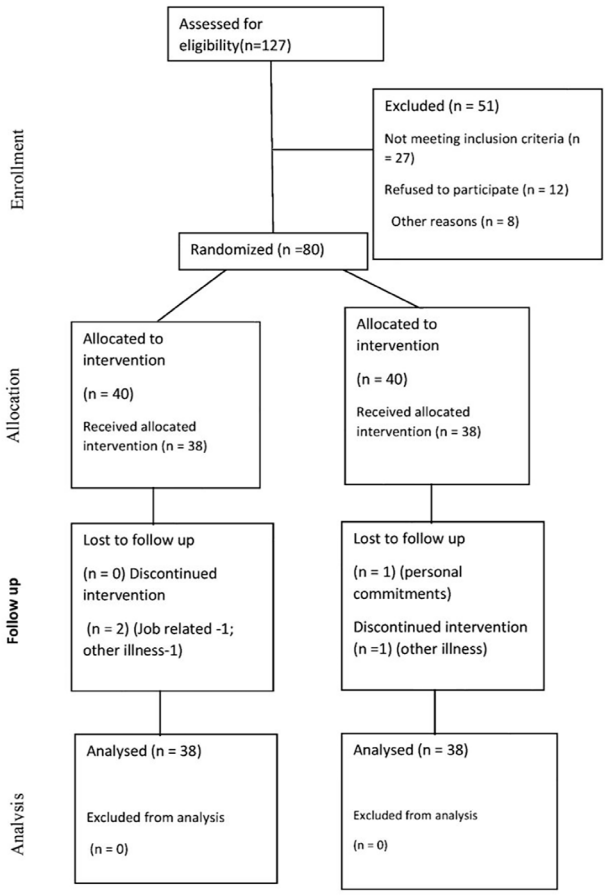


Figure 1 The CONSORT Report Diagram

Numerical pain rating scale (NPRS): Patients rate their current, best, and worst pain over the past 24 hours on a 0–10 scale (0=no pain, 10=worst imaginable pain). The average of the three ratings represents overall pain intensity. A reduction of ≥2 points is considered a clinically meaningful improvement[34].

Interventions

The control group received a standardized physiotherapy program based on the established guidelines, which included recommended electrotherapy modalities and regular exercise[35]. This program was delivered three times per week for eight weeks, with each session lasting 45 to 60 minutes. The experimental group received the same standardized physiotherapy protocol in addition to a biopsychosocial pain management intervention, specifically the comprehensive chronic pain management (CCPM) protocol. CCPM is an evidence-informed, holistic approach for chronic musculoskeletal pain, delivered over 16 structured sessions. Session 1 introduces the CCPM framework and

fundamental pain mechanisms, laying the foundation for understanding chronic pain as a multidimensional experience. Sessions 2 to 4 focus on neurophysiological education, emphasizing neuroplasticity, central sensitization, and the role of the BPS model in interpreting pain beyond tissue pathology. Session 5 enables participants to formulate individualized treatment goals using the specific, measurable, achievable, relevant, and time-bound (SMART) framework to promote achievable and measurable progress. Sessions 6 to 8 address behavioral pacing principles, relaxation techniques, and structured activity scheduling to enhance functional capacity and prevent pain flare-ups. Sessions 9 and 10 incorporate cognitive-behavioral therapy (CBT) methods to facilitate thought modification, coping skill development, and effective action planning. Session 11 introduces distress tolerance and emotional regulation techniques to improve psychological resilience. Session 12 focuses on sleep hygiene education to optimize rest and recovery. Sessions 13 and 14 promote lifestyle modification and self-management strategies, empowering participants to sustain long-term improvements. Finally, Sessions 15 and 16 are devoted to feedback, review, and revision, allowing reflection on progress, reinforcement of learned concepts, and planning for continued self-directed management beyond the structured program. Physiotherapy sessions for the experimental group were conducted three times per week, while CCPM sessions occurred twice per week, with each session lasting 45 to 60 minutes.

Procedure

Training of the physiotherapists to provide the comprehensive chronic pain management physiotherapy practice protocol (Biopsychosocial approach) was given in three phases (once monthly for three consecutive months, 4-6 hrs/session) for 12-16 hrs to make them capable of BPS model practice. Then, screening of the patients started using a screening form based on the ICD-11 classification of chronic musculoskeletal pain[36]. Once they became eligible to participate in the study, they were randomly allocated to either an experimental or control group by an independent allocator. The clinical and demographical outcomes were measured before and after two months of interventions for both groups. The experimental group participants were targeted for other measures during their sessions as per the schedule. Intervention fidelity was ensured through therapist supervision and structured checklists to maintain consistent protocol delivery.

Statistical analysis

The categorical variables are presented in percentages and numerical variables in terms of mean and standard deviations for the demographic and clinical outcomes. The normality of the data was checked using the Shapiro-Wilk test. A chi-square test was used to determine any statistical differences for categorical variables. For the numerical variables with normality, a parametric independent or paired 't' test was used to compare between and within groups. If there was no normality, a non-parametric Mann-Whitney test or a Wilcoxon test was used. If there were more than two levels, a Friedman repeated-measure ANOVA was used. An intention-to-treat analysis was used to assess the response to the intervention, with the baseline evaluation carried forward when necessary to account for dropouts during the follow-up. The effect sizes of the interventions are mentioned as small (d=0.2), medium (d=0.5), and large (d=0.8), based on benchmarks suggested by Cohen[37]. All the analyses were conducted using the software Jamovi, version 2.3.28 Statistical significance was set at p-value<0.05 for all statistical analyses.

Results

The participant demographic characteristics included in the study are described in Table 2, and there were no differences in the baseline measures, showing that the groups were homogenous at the start of the study.

Table 2 Participants' demographics and baseline characteristics

Variable	CCPM group (n=40)	SPT group (n=40)	Test statistics	p-value
Age (mean±S.D.)	49.1±12.3	45.1±13.1	1.43	0.158
Gender, n (%)			0.220	0.639
Male	13 (32.5)	15 (37.5)		
Female	27 (67.5)	25 (62.5)		
Duration of symptoms (months) (mean±S.D.)	38.93±50.02	45.60±59.72	0.533	0.596
Occupation, n (%)			7.22	0.205
Housewife	21 (52.5)	13 (32.5)		
Retired	3 (7.5)	3 (7.5)		
Employed	16 (40)	24 (60)		
Education, n (%)			2.78	0.734
Primary	7 (17.5)	4 (10)		
Secondary	6 (15)	9 (22.5)		
Higher secondary and above	27 (67.5)	27 (67.5)		
Marital status, n (%)			1.51	0.469
Married	36 (90)	35 (87.5)		
Single	4 (10)	5 (12.5)		
Living status, n (%)			1.35	0.508
Joint family	25 (62.5)	24 (60)		
Nuclear family	12 (30)	15 (37.5)		
Alone	3 (7.5)	1 (2.5)		
Comorbidities, n (%)			3.33	0.505
Yes	12 (30)	8 (20)		
No	28 (70)	32 (80)		
Previous surgeries, n (%)			0.125	0.723
Yes	35 (87.5)	36 (90)		
No	5 (12.5)	4 (10)		
Pain locations, n (%) [no. of body areas or sites]			3.23	0.779
≤3	25 (62.5)	24 (60)		
>3	15 (37.5)	16 (40)		
Pain affects mobility/activities, n (%)			3.12	0.077
No	0 (0)	3 (7.5)		
Yes	40 (100)	37 (92.5)		
Pain affects mood, n (%)			0.082	0.775
No	8 (20)	7 (17.5)		
Yes	32 (80)	33 (82.5)		
Pain affects sleep, n (%)			0.267	0.606
No	9 (22.5)	11 (27.5)		
Yes	31 (77.5)	29 (72.5)		
Pain affects recreation/relationships, n (%)			0.453	0.501
No	20 (50)	23 (57.5)		
Yes	20 (50)	17 (42.5)		

CCPM=comprehensive chronic pain management, SPT=standard physiotherapy

Outcome measures evaluation and comparisons

Table 3 displays all the means and standard deviation (S.D.) and within-group statistical comparisons for the SPT group. The results showed significant improvements in primary and secondary outcomes for the SPT group over 8 weeks. Among the primary outcomes, CSI showed a mean reduction of 5.92 (95% CI: 4.35–7.49; p-value<0.001), indicating a substantial decrease in central sensitisation symptoms. Similarly, the Fear-Avoidance Component Scale (FACS) exhibited a mean reduction of 12.79 (95% CI: 9.13–16.45; p-value<0.001), reflecting decreased fear-avoidance behaviours. In terms of secondary outcomes, the Numerical Pain Rating Scale (NPRS) revealed a significant reduction, with a mean difference of 3.21 (95% CI: 2.64–3.78; p-value<0.001), suggesting notable pain relief.

Table 4 displays all the means and standard deviation (S.D.) and within-group statistical comparison for the CCPM group. The results revealed significant improvements in primary and secondary outcomes for the CCPM group over the 8-week intervention period. Among the primary outcomes, the Central Sensitization Inventory (CSI) scores decreased markedly, with a mean difference of 20.55 (95% CI: 16.42–24.69; p-value<0.001), reflecting a substantial reduction in central sensitisation symptoms. Similarly, the Fear-Avoidance Component Scale (FACS) showed a significant reduction, with a mean difference of 25.92 (95% CI: 19.86–31.98; p-value<0.001), indicating reduced fear-avoidance behaviours. In the secondary outcomes, the Numerical Pain Rating Scale (NPRS) scores

Table 3 Participants' baseline and after-intervention results of outcome measures in the regular physiotherapy group

	SPT group (n=38) mean (S.D.)		Mean difference (CI Lower-upper)	t-value	p-value significance
	Baseline	After 8 weeks			
Central sensitization (0-100)	36.08 (14.53)	30.16 (13.38)	5.92 (4.35-7.49)	7.64	<0.001
Fear-avoidance (0-100)	59.79 (15.31)	47 (19.37)	12.79 (9.13-16.45)	7.07	<0.001
Pain intensity (0-10)	7.11 (1.39)	3.89 (1.91)	3.21 (2.64-3.78)	11.36	<0.001

SPT=standard physiotherapy, CI=confidence interval (95%), S.D.=standard deviation

Table 4 Participants' baseline and after-intervention results of outcome measures in the biopsychosocial pain management group

	CCPM group (n=38) mean (S.D.)		Mean difference (CI Lower-upper)	t-value	p-value significance
	Baseline	After 8 weeks			
Central sensitization (0-100)	40.32 (12.15)	19.76 (10.80)	20.55 (16.42-24.69)	10.07	<0.001
Fear-avoidance (0-100)	61.13 (16.53)	35.21 (20.98)	25.92 (19.86-31.98)	8.67	<0.001
Pain intensity (0-10)	7.39 (1.39)	3.63 (1.80)	3.76 (3.08-4.44)	11.20	<0.001

CCPM=comprehensive chronic pain management, CI=confidence interval (95%), S.D.=standard deviation

decreased significantly, with a mean difference of 3.76 (95% CI: 3.08–4.44; p-value<0.001), signifying a notable reduction in pain intensity.

Both groups showed improvement over the 8-week intervention, but the CCPM group demonstrated a greater clinical impact. While the SPT group showed modest reductions in central sensitization, fear-avoidance, and pain, the CCPM group achieved substantial decreases, highlighting its superior efficacy.

Comparative analysis between the groups (intention to treat analysis=40)

Missing data for dropouts were managed using the Last Observation Carried Forward method (LOCF). Over 8 weeks, the CCPM group showed superior outcomes compared to the SPT group. Primary measures favoured CCPM, with significant improvements in CSI (mean difference: 13.77, CI:9.42–18.13; p-value<0.001, large effect) and FACS (mean difference: 11.45, CI: 4.24–18.66; p=0.002, medium effect). NPRS showed no significant differences (mean difference: 0.475, CI: −0.41–1.35; p-value=0.285, small effect) (Table 5 & Figure 2).

Treatment adherence in the CCPM group was excellent, and no adverse events were observed, indicating that the protocol is both safe and well-tolerated.

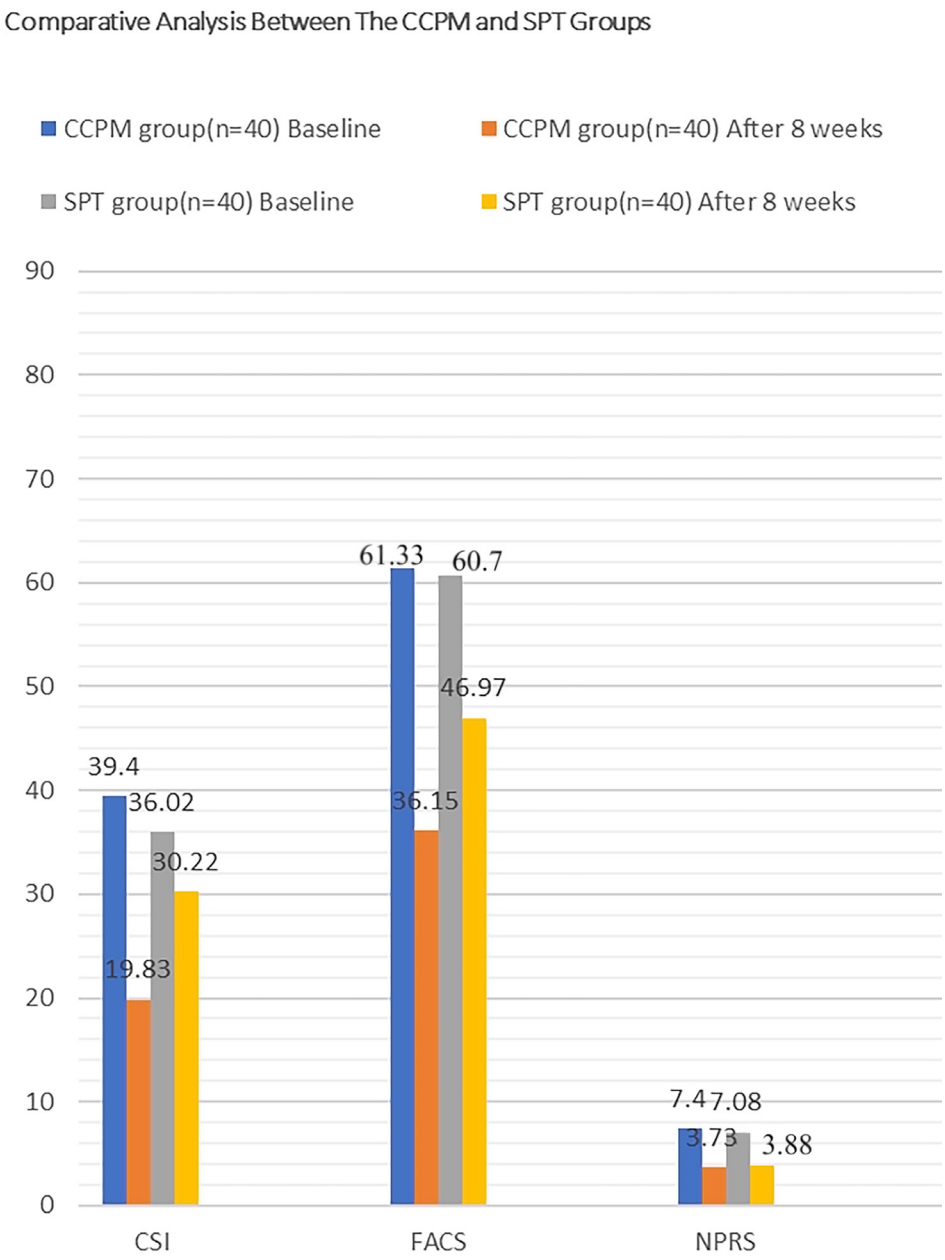
Discussion

The study aimed to evaluate the effect of a Biopsychosocial Pain Management protocol (CCPM) on central sensitization and fear avoidance in patients with

Table 5 Participants' baseline and after-intervention results of primary and secondary outcome measures in the CCPM and SPT groups

	CCPM group (n=40) mean (S.D.)		SPT group (n=40) mean±S.D.		Mean difference (CI Lower-upper)	t-value	p-value significance	effect size (Cohen's d)
	Baseline	After 8 weeks	Baseline	After 8 weeks				
Central sensitization (0–100)	39.40 (12.58)	19.83 (10.59)	36.02 (14.86)	30.22 (14.08)	13.77 (9.42–18.13)	6.30	<0.001	1.41
Fear-avoidance (0–100)	61.33 (16.14)	36.15 (20.91)	60.70 (15.44)	46.97 (20.17)	11.45 (4.24–18.66)	3.16	0.002	0.71
Pain intensity (0–10)	7.40 (1.35)	3.73 (1.89)	7.08 (1.66)	3.88 (1.95)	0.475 (−0.41–1.35)	1.08	0.285	0.24

CCPM=comprehensive chronic pain management, SPT=standard physiotherapy, S.D.=standard deviation, CI=confidence interval (95%)



CSI=central sensitization inventory, FACS=fear avoidance components scale, NPRS=numberical pain rating scale, CCPM=comprehensive chronic pain management, SPT=standard physiotherapy

Figure 2 Comparative Analysis Between the CCPM and SPT Groups

chronic musculoskeletal pain (CMSP). The Comprehensive Chronic Pain Management (CCPM) protocol significantly reduced Central Sensitization Inventory (CSI) scores compared to Standard Physiotherapy (SPT), with a mean difference of 13.77 (p-value<0.001). This finding demonstrates CCPM's superior ability to address complex pain mechanisms. Furthermore, CCPM more effectively reduced scores on the Fear-Avoidance Components Scale (FACS), yielding a mean difference of 11.45 (p-value=0.002), emphasizing the importance of addressing fear-avoidance beliefs for optimal recovery. Both CCPM and SPT significantly reduced pain intensity, with no notable difference between the groups.

Chronic pain is increasingly understood as a disorder of altered neuroplasticity involving maladaptive changes across peripheral, spinal, and supraspinal levels of the nervous system. Peripheral sensitization arises from the sustained release of inflammatory mediators and neuropeptides, which reduce nociceptor thresholds and enhance afferent excitability. At the spinal level, central sensitization is characterized by increased synaptic efficacy through AMPA receptor phosphorylation, intracellular calcium accumulation, and activation of protein kinase pathways that induce long-term potentiation (LTP) in dorsal horn neurons. Cortical reorganization further contributes to chronic pain chronification, with structural and functional alterations observed in the thalamus, insula, anterior cingulate, and somatosensory cortices, reflecting a shift from sensory–discriminative to affective–emotional pain processing. The CCPM protocol is conceptually grounded in these neurobiological mechanisms and aims to reverse or modulate maladaptive plasticity through multimodal interventions. Initial modules emphasize pain neuroscience education, focusing on neuroplasticity and sensitization to promote reconceptualization of pain as a central, modifiable process. Subsequent phases integrate cognitive-behavioral strategies, activity pacing, and relaxation-based autonomic regulation to reduce hypervigilance and maladaptive behavioral patterns. SMART goal setting, cognitive restructuring, and lifestyle modification enhance self-regulation and adherence, while individualized tools such as the pain strategies wheel facilitate context-specific coping responses. Collectively, these evidence-based interventions target the neurocognitive and behavioral substrates of central sensitization, aiming to normalize cortical processing, improve functional connectivity, and restore adaptive pain modulation[3].

Cognitive and behavioural therapies effectively reduce catastrophizing by modifying the brain circuits involved in pain processing, including the prefrontal and somatosensory cortices[38]. Exercise therapy further contributes to pain relief through exercise-induced hypoalgesia, modulating central excitability, and improving function. Cognitive-functional therapy (CFT) integrates behavioural psychology with physiotherapy, addressing maladaptive beliefs, graded exposure, and movement restoration[9,22]. Mindfulness, pacing, and relaxation techniques enhance emotional regulation and self-efficacy, promoting sustained engagement in physical and social activities[39].

Recent evidence highlights the effectiveness of multidimensional physiotherapy approaches that combine psychological and behavioural strategies to achieve long-term reductions in pain and disability [7,8,22–24,40]. These findings align with the present results, reinforcing that comprehensive biopsychosocial interventions outperform conventional biomedical care in improving central sensitization and fear-avoidance outcomes.

However, literature indicates that physiotherapists often face barriers in applying biopsychosocial approaches, including a lack of training, ambiguous clinical guidelines, and limited institutional support[21,25,26]. Strengthening education, implementing structured biopsychosocial frameworks, such

as CCPM, and integrating public health approaches may bridge this gap—particularly in low- and middle-income countries where resource limitations constrain access to multidisciplinary care.

This study adhered to the CONSORT, TiDIER, and SPIRIT guidelines, employing assessor blinding, concealed allocation, and intention-to-treat analysis to reduce bias. Although robust statistical methods and multiple validated outcomes strengthened the findings, limitations include the small, single-centre sample, brief 8-week intervention, and lack of long-term follow-up. Variations in patient expectations and reliance on self-reported data may have introduced bias.

Future research should employ multicentre longitudinal designs with larger samples and objective biomarkers to confirm the sustainability of CCPM's effects. Specific research questions could include: "Do CCPM-induced improvements in central sensitization and fear-avoidance persist long-term?" and "What are the barriers and facilitators to implementing CCPM in clinical settings?" Implementation and cost-effectiveness studies are essential to support translation into policy and practice. Clinicians should engage in continuing professional education on biopsychosocial pain management and adopt evidence-based multidimensional physiotherapy strategies to improve chronic pain outcomes.

Conclusion

The Biopsychosocial Pain Management Protocol demonstrated significant reductions in central sensitization and fear-avoidance behaviors. The results of this study provide substantial evidence regarding the role and benefits of a biopsychosocial comprehensive pain management physiotherapy protocol for addressing central sensitization and fear avoidance in patients with chronic musculoskeletal pain.

Moreover, this highlights the necessity of addressing both the psychological and physiological aspects of pain for improved patient outcomes in physiotherapy clinical practice. Furthermore, implementing this biopsychosocial protocol in regular clinical practice may enhance evidence-based practices in the field of physiotherapy.

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Conflict of interest

The authors declare that they have no competing interests.

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