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ORIGINAL ARTICLE

The impact of exercise and psychotherapy on psychosocial outcomes for patients with chronic pain

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Abstract

Purpose This study aimed to quantitatively evaluate the characteristics of patients with chronic pain and differences in their responses to different treatment approaches.

Methods A retrospective review was performed regarding patients with chronic pain who visited an interdisciplinary pain treatment centre between January 1, 2018, and March 31, 2023. The patients were categorised into four groups based on the treatment received: a conventional therapy group treated by medical doctors, an exercise therapy group received additional exercise therapy, a psychotherapy group received additional psychotherapy, and an interdisciplinary treatment group received additional exercise therapy and psychotherapy. Responses to pain-related and psychosocial questionnaire results were compared between baseline and six months post-treatment.

Results Of the 1,967 initial participants, 239 patients met the eligibility criteria and their data were included in the analysis. In the Conventional therapy group, the indicators showed improvement in pain symptoms, excluding the Pain Self-Efficacy Questionnaire (PSEQ) and Hospital Anxiety and Depression Scale-Depression (HADS-D) scores. In the Exercise therapy group, significant improvements in PSEQ (from 28.15 to 33.34, $p < 0.001$) and HADS-D (from 7.17 to 6.35, $p = 0.035$) scores were documented. HADS-Anxiety scores decreased in the Psychotherapy group from 10.36 to 7.91 ($p = 0.028$). The Interdisciplinary treatment group showed a significant reduction in pain catastrophizing scale scores (from 35.15 to 26.31, $p = 0.038$).

Conclusions This study indicated that exercise therapy, psychotherapy, and interdisciplinary approaches might contribute to improvements in psychosocial outcomes amongst patients with chronic pain. Although the effects of exercise therapy were more consistent, psychotherapy and interdisciplinary treatment demonstrated potential benefits.

Keywords Chronic pain · Patient-reported measurements outcomes · Psychotherapy · Exercise therapy

Introduction

Chronic pain presents a serious health challenge for many patients; its appropriate management is an important medical issue [1]. Chronic pain is known to cause both physical pain and various socio-psychological impacts on patients' lives [2, 3].

Exercise therapy contributes to restoring physical function and improving muscle strength, thereby improving patients' quality of life [4, 5]. Psychotherapy focuses on pain coping, stress management, and mental health; in addition, it is thought to increase patients' self-efficacy in pain management [6, 7]. Combining these approaches can provide more comprehensive treatment and improve success rates in pain management [8]. Interdisciplinary treatments, which generally include restorative therapies (e.g. physical therapy and exercise therapy); pharmacotherapy; procedural interventions; behavioural treatments; and complementary and integrative therapies, are expected to be effective in treatment of chronic pain [1].

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However, only a limited number of facilities can provide comprehensive interdisciplinary services; they are not fully covered by insurance in Japan. Due to these limitations, interdisciplinary treatment is not widely accessible to all patients.

There is varying evidence for the effects of exercise, psychotherapy, and interdisciplinary treatment on chronic pain. Exercise therapy alone is suggested to be more effective in treating chronic pain and functional disability than being rest and lifestyle guidance alone. Although some studies have shown benefits of exercise for chronic low back pain [9, 10] and knee osteoarthritis [11],the most effective type of exercise remains unclear [11]. In addition, exercise therapy is said to be more useful for musculoskeletal and widespread pain phenotypes than for neuropathic pain [12]. Psychotherapy, particularly cognitive behavioral therapy (CBT), has been shown to be effective [13, 14]. There are reports indicating that combining CBT with other therapies enhances pain relief [15]. Interdisciplinary management—combining both exercise therapy and psychotherapy—is effective in chronic pain in general [16, 17]. However, in primary care settings, no statistically significant differences have been found in pain intensity, number of pain sites, or health-related quality of life [18]. Overall, interdisciplinary treatment may be effective in chronic pain. However, further research is needed to determine the most effective treatment components and patient variables.

The goal of treating chronic pain is not solely to eliminate pain itself; rather, to improve the quality of daily life and enhance their confidence in performing activities despite pain. In this sense, the provision of interdisciplinary treatment is also valuable as it restores emotional function [19].

Therefore, we hypothesised that by comparing psychosocial scores related to chronic pain, described later, as an objective measure of psychological pain tolerance before and after treatment, we could assess the extent of reintegration into daily life and confidence in engaging in activities of daily living, despite experiencing pain. Although few studies have evaluated the effectiveness of interdisciplinary treatment in Japan, interdisciplinary approaches integrating exercise therapy, psychotherapy, or both are gaining recognition as beneficial strategies for improving symptoms and quality of life in patients with chronic pain [16, 17]. In addition, these approaches are being promoted and recommended by government agencies in Japan [20–22]. This is the first study to focus on Japanese patients with general chronic pain and quantitatively evaluate the differences in their characteristics and responses to treatment. Meeting these aims should ultimately lead to the selection of appropriate treatments tailored to individual patients with intractable chronic pain. We assessed the impact of exercise therapy and psychotherapy interventions on chronic pain management in conjunction with physician treatment using objective pain scores.

Methods

A retrospective evaluation of patients with chronic pain who visited The Jikei University School of Medicine, an interdisciplinary pain treatment centre in Japan, from January 1, 2018, to March 31, 2023, was conducted. Patients with chronic pain were defined as having pain for more than 3 months at the first time of their visit. This retrospective study used the data obtained during routine care for clinical purposes. This study received ethical approval from the Institutional Review Board of The Jikei University School of Medicine, Minato-ku, Tokyo, Japan, on September 19, 2023 (No.: 34–371(11,525)). The requirement for informed consent was waived and opt-outs were implemented before the study was conducted.

Treatment and group

All patients were referred to a pain clinic physician and received routine care. Routine care included medications (nonsteroidal anti-inflammatory drugs, muscle relaxants, tricyclic antidepressants, and anticonvulsants), nerve blocks, and physician consultation.

In patients requiring additional treatment, physicians recommended exercise therapy by a physical therapist and/or psychotherapy by a clinical psychologist. Recommendations for additional treatments were made at the attending physician's discretion rather than uniformly determined at the first visit.

Patients were allocated into four groups:

- Conventional therapy group –received treatment by a pain physician.
- Exercise therapy group –received additional exercise therapy.
- Psychotherapy group –received additional psychotherapy.
- Interdisciplinary treatment group –received both exercise therapy and psychotherapy.

Outcomes

Outcomes were measured using the Japanese versions of the following questionnaires:

- Original Improvement Scale of Pain which was a 7-point scale surveying whether pain improved compared with that 6 months ago. (rated on a 7-point scale: 1 = extremely better, 2 = better, 3 = slightly better, 4 = no change, 5 = slightly worse, 6 = worse, 7 = extremely worse).

- Numerical rating scale (NRS) (assesses current pain on an 11-point scale from 0 to 10, with higher scores indicating greater pain).
- European Quality of Life 5 Dimensions (EQ-5D) (assesses health-related quality of life, including mobility, self-care, usual activities, pain/discomfort, and anxiety/depression; scores range from 0 (death) to 1 (good health) [23, 24]).
- Hospital Anxiety and Depression Scale (HADS) (assesses anxiety and depression, each on a scale from 0 to 21, with higher scores indicating more anxiety (HADS-A) and depression (HADS-D)) [25, 26].
- Pain Catastrophizing Scale (PCS) (assesses catastrophic thoughts of pain on a scale from 0 to 52, with higher scores indicating more catastrophizing thoughts) [27, 28].
- Pain Disability Assessment Scale (PDAS) (assesses disability due to chronic pain, with scores ranging from 0 to 60, with higher scores indicating greater daily life disruption due to pain [29]).
- Pain Self-Efficacy Questionnaire (PSEQ) (measures confidence in performing necessary activities despite chronic pain; scores range from 0 to 60, with higher scores indicating greater self-efficacy [30, 31]).

The score at the initial visit was considered the baseline, and the score after six months was considered the post-treatment one.

Statistical analysis

All statistical analyses were performed using EZR, version 1.61 (Saitama Medical Center, Jichi Medical University, Saitama, Japan) [32]. Descriptive statistics were calculated to describe the demographical characteristics of the participants. Non-parametric Wilcoxon signed-rank tests with related samples were used to compare the values of each measure. The results are presented as both means and medians ± quartiles for numerical data and as frequencies with appropriate proportions for categorical data. Statistical significance was set at a p value < 0.05.

Results

From January 1, 2018, to March 31, 2023, a total of 1,967 patients had their first visit to the pain clinic; 1,667 responded to the initial questionnaire, and 248 patients continued to visit the clinic 6 months later and responded to the questionnaire. Nine patients had a symptom duration of less than three months prior to initial visit and were excluded from the study. The final analysis included data of 239 patients.

The Conventional therapy group, which received only physicians' treatment, included 116 patients (48.5%). The Exercise therapy group comprised 101 patients (42.3%) who received exercise therapy by a physical therapist. The Psychotherapy group included eleven patients (4.6%) who received psychotherapy. The Interdisciplinary treatment group comprised thirteen patients (5.4%) who received both exercise therapy and psychotherapy (Fig. 1). Patients in the Exercise therapy group received an average of 4.92 sessions of exercise therapy, whilst those in the Psychotherapy group received an average of 7.17 sessions of psychotherapy. Patients in the Interdisciplinary treatment group received an average of 5.00 sessions each of exercise therapy and psychotherapy.

The mean age of all patients was 56.8 years; 55.6% were female participants. The median symptom duration before initial assessment was 23 months (interquartile range: 10–54). A total of 235 patients (98.3%) received prior pain treatment at external institutions, including pharmacological therapies and interventional nerve blocks. The patient characteristics and the initial pain scores of each group are presented in Table 1. Patients in the Exercise therapy group tended to have higher PDAS scores compared with the other groups. Patients in the Psychotherapy group tended to have lower emotional functioning scores, as indicated by the HADS, PCS, and PSEQ scores, compared with the other groups. Patients in the Interdisciplinary treatment group tended to exhibit the most severe overall baseline burden, with high HADS-A and HADS-D scores, the highest PCS scores, and the lowest PSEQ and EQ-5D scores, reflecting greater anxiety, depression, catastrophizing, and reduced health-related quality of life.

An original improvement score of pain revealed that 68.4% of all patients improved (scores 1–3) with treatment: 71.1% in the Conventional therapy group, 63.3% in the Exercise therapy group, 70.8% in the Psychotherapy group, and 69.2% in the Interdisciplinary treatment group. However, there were four missing data points in the Conventional therapy group and one missing data point from the Exercise therapy group (Table 2).

In the Conventional therapy group, no statistically significant improvements were observed in the HADS-D and PSEQ scores [HADS-D: 6.57 to 6.49, $p = 0.509$; PSEQ: 30.59 to 32.21, $p = 0.108$]. However, all other outcome measures showed statistically significant improvements after treatment (Table 3). In the Exercise therapy group, the HADS-A score showed a trend towards improvement from 6.72 to 6.01; however, the difference was not statistically significant ($p = 0.056$). The PSEQ score improved from 28.15 to 33.34 ($p < 0.001$), and the HADS-D score improved from 7.17 to 6.35 ($p = 0.035$); all other scores in this group showed statistically significant differences (Table 4). The Psychotherapy group showed an improvement in HADS-A

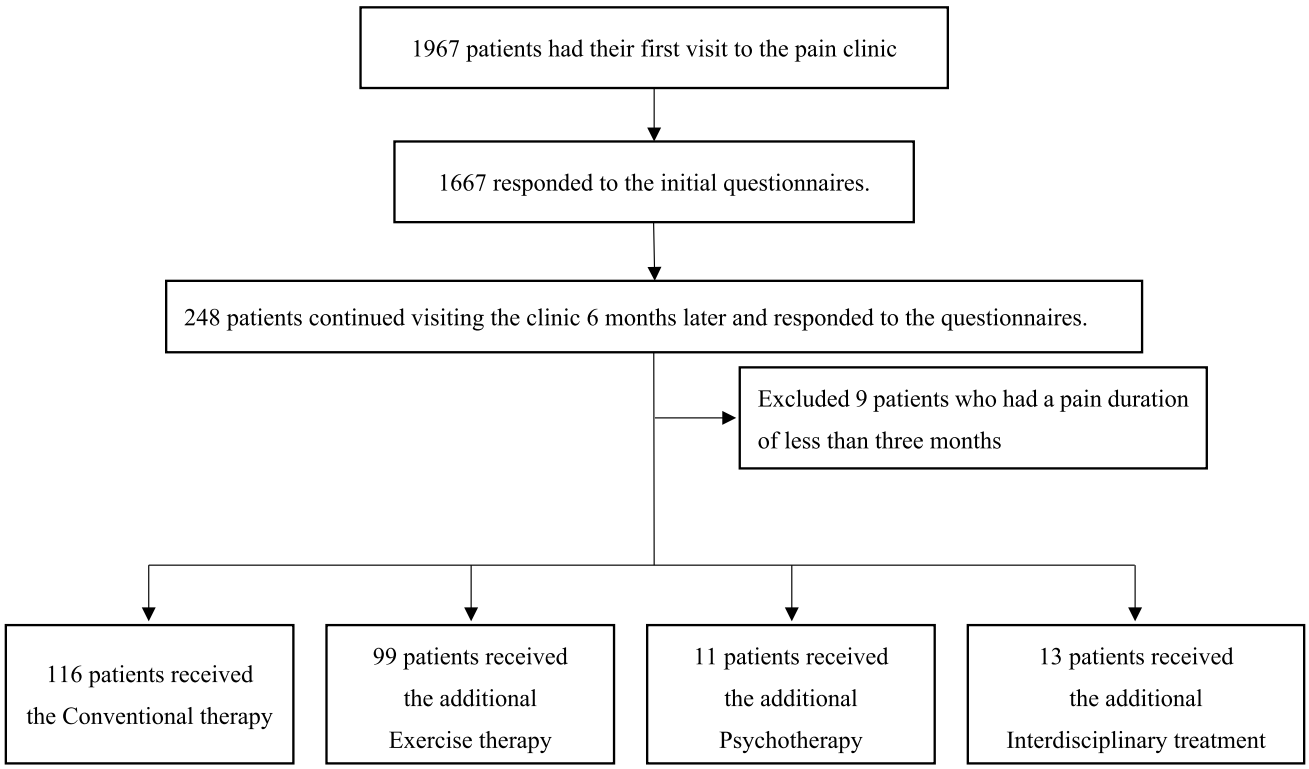

Fig. 1 Patients flow diagram

score from 10.36 to 7.91 ($p = 0.028$); no other scores in this group significantly changed (Table 5). The Interdisciplinary treatment group showed an improvement in PCS score from 35.15 to 26.31 ($p = 0.038$); no other scores significantly changed from pre to post treatment (Table 6). No adverse events related to exercise therapy or psychotherapy were reported in any of the treatment groups.

In addition to the statistically significant differences in NRS scores, our additional analysis revealed that 25.5% of the patients achieved a reduction ≥ 50% in pain intensity (substantial pain relief) and 32.6% achieved a reduction ≥ 30% (moderate pain relief) from baseline Table 7.

Discussion

This study is the first to report a quantitative assessment of pre- and post-treatment pain scores in patients with chronic pain at an interdisciplinary pain centre, demonstrating the value of individualised treatment. Our findings provided valuable insights into the complex interplay between physical and psychological interventions in chronic pain treatment.

Although our study demonstrated a statistically significant reduction in NRS scores, only one quarter of patients (25.5%) achieved substantial pain relief (reduction ≥ 50%) and one third (32.6%) achieved moderate relief (reduction ≥ 30%), suggesting most patients derive modest benefit from treatment protocols in real-world settings. In contrast, approximately 70% of the patients reported subjective improvement on the Original Improvement Scale of Pain. In line with the existing evidence [33], these findings underscore that chronic pain management should move beyond analgesic titration guided solely by NRS scores and incorporate comprehensive psychosocial assessment and intervention.

Compared with conventional therapy alone, additional exercise therapy reduced depressive symptoms (HADS-D) and improvements in pain self-efficacy (PSEQ), outcomes that were not observed in the conventional treatment group. These benefits likely arise from enhanced functional capacity and mastery experiences conferred by structured physical activity, which complement conventional therapy. Exercise interventions have also been shown to alleviate depressive symptoms in other clinical populations [34]. Therefore, incorporating exercise therapy into chronic pain management may provide meaningful psychological benefits, particularly in patients with persistent depressive symptoms or low self-efficacy, and should be considered alongside conventional treatments. The improvement in pain self-efficacy scores within the Exercise therapy group is consistent with previous

Table 1 Patients' demographics and characteristics before treatment

	Overall ($n=239$)	Conventional therapy ($n=116$)	Exercise therapy ($n=99$)	Psychotherapy ($n=11$)	Interdisciplinary treatment ($n=13$)
Gender, n (%)					
Male	106 (44.4)	55 (47.4)	41 (41.4)	4 (36.4)	6 (46.2)
Female	133 (55.6)	61 (52.6)	58 (58.6)	7 (63.6)	7 (53.8)
Age, y	56.75 (±16.38)	59.26 (±16.47)	56.30 (±16.06)	43.55 (±15.10)	49.00 (±11.68)
Height, cm	162.46 (±8.81)	162.52 (±9.19)	162.14 (±8.73)	163.44 (±8.45)	163.62 (±6.56)
Weight, kg	60.32 (±14.94)	59.54 (±14.05)	61.07 (±16.22)	59.68 (±12.18)	62.18 (±15.89)
ICD-11, n (%)					
MG30.0 Chronic primary pain	83 (34.7)	32 (27.6)	34 (34.3)	7 (63.6)	10 (76.9)
MG30.1 Chronic cancer related pain	2 (0.8)	1 (0.9)	0 (0.0)	0 (0.0)	1 (7.7)
MG30.2 Chronic postsurgical or post traumatic pain	25 (10.5)	14 (12.1)	9 (9.1)	0 (0.0)	2 (15.4)
MG30.3 Chronic secondary musculoskeletal pain	93 (38.9)	38 (32.8)	52 (52.5)	3 (27.3)	0 (0.0)
MG30.4 Chronic secondary visceral pain	3 (1.3)	3 (2.6)	0 (0.0)	0 (0.0)	0 (0.0)
MG30.5 Chronic neuropathic pain	32 (13.4)	27 (23.3)	4 (4.0)	1 (9.1)	0 (0.0)
MG30.6 Chronic secondary headache or orofacial pain	1 (0.4)	1 (0.9)	0 (0.0)	0 (0.0)	0 (0.0)
Duration of disease, month					
Mean	50.09	51.02	49.87	66.09	42.77
Median [IQR]	23.00 [10.00, 54.00]	22.00 [8.00, 56.25]	23.00 [11.00, 48.00]	46.00 [6.00, 114.00]	23.00 [10.00, 48.00]
Time to treatment, day					
Exercise therapy					
Mean			50.01		45.77
Median [IQR]			32.00 [12.00, 79.00]		15.00 [7.00, 39.00]
Psychotherapy					
Mean				23.18	55.23
Median [IQR]				19.00 [10.50, 38.50]	60.00 [13.00, 63.00]
Frequency of treatment, n					
Exercise therapy					
Mean			4.92		5.00
Median [IQR]			5.00 [3.00, 6.50]		4.00 [3.00, 7.00]
Psychotherapy					
Mean				7.17	5.00
Median [IQR]				7.00 [6.00, 8.50]	4.00 [4.00, 7.00]
NRS					
Mean	4.79	4.55	5.10	4.18	5.08
Median [IQR]	5.00 [3.00, 7.00]	5.00 [2.75, 7.00]	5.00 [3.00, 7.00]	4.00 [2.00, 7.00]	4.00 [4.00, 6.00]
EQ5D					
Mean	0.48	0.53	0.45	0.39	0.35
Median [IQR]	0.62 [0.16, 0.76]	0.69 [0.17, 0.78]	0.59 [0.16, 0.73]	0.60 [0.02, 0.74]	0.29 [0.03, 0.69]
HADS-A					
Mean	7.00	6.67	6.72	10.36	9.31

Table 1 (continued)

	Overall ($n=239$)	Conventional therapy ($n=116$)	Exercise therapy ($n=99$)	Psychotherapy ($n=11$)	Interdisciplinary treatment ($n=13$)
Median [IQR]	6.00 [4.00, 10.00]	6.00 [4.00, 9.00]	6.00 [4.00, 9.00]	12.00 [7.50, 13.50]	9.00 [6.00, 12.00]
HADS-D					
Mean	7.23	6.67	7.17	9.18	11.00
Median [IQR]	7.00 [4.00, 10.00]	6.00 [3.00, 10.00]	7.00 [5.00, 10.00]	10.00 [6.00, 11.50]	12.00 [8.00, 15.00]
PCS					
Mean	31.08	30.06	31.48	33.36	35.15
Median [IQR]	32.00 [24.00, 39.00]	31.00 [22.00, 39.25]	32.00 [26.00, 38.00]	36.00 [26.50, 39.50]	37.00 [30.00, 42.00]
PDAS					
Mean	19.79	17.22	22.99	16.82	20.92
Median [IQR]	20.00 [10.00, 28.00]	17.50 [6.75, 26.00]	24.00 [16.00, 30.50]	16.00 [7.50, 24.50]	22.00 [12.00, 28.00]
PSEQ					
Mean	28.74	30.59	28.15	23.73	21.00
Median [IQR]	29.00 [19.00, 37.00]	30.00 [21.00, 41.25]	29.00 [19.00, 37.00]	24.00 [13.00, 29.00]	24.00 [18.00, 28.00]

Data are number (%), Mean ± Standard Deviation (SD) or median [interquartile range; IQR]

NRS numerical rating scale, *EQ-5D* European Quality of Life 5 Dimensions, *HADS* the hospital anxiety and depression scale, *PCS* pain catastrophizing Scale, *PDAS* pain disability assessment scale, *PSEQ* pain self-efficacy questionnaire

Table 2 Original pain improvement scale (four data deficiencies in the Conventional therapy group and one in the Exercise therapy group)

	Overall ($n=234$)	Conventional therapy ($n=114$)	Exercise therapy ($n=98$)	Psychotherapy ($n=11$)	Interdisciplinary treatment ($n=13$)
Extremely better; score 1 (%)	23 (9.8)	12 (10.7)	9 (9.2)	1 (9.1)	1 (7.7)
Better; score 2 (%)	37 (15.8)	20 (17.9)	11 (11.0)	2 (18.2)	4 (30.8)
Slightly better; score 3 (%)	100 (42.7)	49 (43.8)	42 (42.9)	5 (45.5)	4 (30.8)
Stable; score 4 (%)	54 (23.1)	24 (21.4)	24 (24.5)	2 (18.2)	4 (30.8)
Slightly worse; score 5 (%)	11 (4.5)	2 (1.8)	9 (9.0)	0 (0)	0 (0)
Worse; score 6 (%)	8 (3.4)	5 (4.5)	2 (2.0)	1 (9.1)	0 (0)
Extremely worse; score 7 (%)	1 (0.4)	0 (0)	1 (1.0)	0 (0)	0 (0)

Values are number (proportions)

research, which suggests that exercise can enhance physical function and pain-coping strategies in chronic pain populations [17].

In the Psychotherapy group, improvements in anxiety (HADS-A) were observed. Consistent with findings in previous studies [35, 36], we suggest that this is because psychotherapy is effective in improving both anxiety symptoms and cognitive aspects of pain in Japanese patients.

The Interdisciplinary treatment group showed a significant reduction in PCS score, supporting the benefits of a holistic approach that integrates both physical and psychological therapies. This finding reinforces the growing consensus that interdisciplinary treatment may offer a more comprehensive solution for chronic pain management by addressing its multifaceted nature [17].

Despite receiving conventional treatments, the limited improvements in the Psychotherapy and Interdisciplinary treatment groups might be explained by their higher baseline levels of psychological distress and disability, the small number of participants in these groups, and low session counts. Specifically, these subgroups began treatment with elevated HADS and PCS scores, suggesting a more refractory clinical profile that could blunt the magnitude of change achievable within the study period. Conventional care and exercise therapy directly engages physical function—through pharmacological modulation, procedural interventions, and structured movement—which more readily translates into reductions in disability as measured by the PDAS. Psychotherapy primarily targets cognitive and emotional processes and does not directly address physical function, which might account for its limited effect on PDAS outcomes. In the Interdisciplinary treatment group, patients underwent a median of 4.0 exercise therapy sessions, compared with the 5.0 sessions in the Exercise therapy group.

Table 3 Study outcomes before and after treatment: Conventional therapy (n = 116)

Conventional therapy ($n = 116$)			
Outcome	Pre	Post	p value
NRS			
Mean	4.55	3.79	
Median [IQR]	5.00 [2.50, 7.00]	4.00 [2.00, 5.00]	< 0.001
EQ5D			
Mean	0.53	0.66	
Median [IQR]	0.69 [0.17, 0.78]	0.74 [0.62, 0.80]	< 0.001
HADS-A			
Mean	6.67	5.82	
Median [IQR]	6.00 [4.00, 9.00]	5.00 [3.00, 9.00]	0.010
HADS-D			
Mean	6.67	6.49	
Median [IQR]	6.00 [3.00, 10.00]	6.00 [3.00, 9.00]	0.509
PCS			
Mean	30.06	25.46	
Median [IQR]	31.00 [22.00, 39.25]	25.00 [17.00, 33.00]	< 0.001
PDAS			
Mean	17.22	15.36	
Median [IQR]	17.50 [6.75, 26.00]	12.00 [5.00, 24.25]	0.040
PSEQ			
Mean	30.59	32.21	
Median [IQR]	30.00 [21.00, 41.25]	31.50 [20.00, 45.00]	0.108

Values are presented as both mean and median [Interquartile range; IQR]

NRS numerical rating scale, *EQ-5D* European Quality of Life 5 Dimensions, *HADS* the hospital anxiety and depression scale, *PCS* pain catastrophizing scale, *PDAS* pain disability assessment scale, *PSEQ* pain self-efficacy questionnaire

Table 4 Study outcomes before and after treatment: Exercise therapy ($n = 99$)

Exercise therapy($n = 99$)			
Outcome	Pre	Post	p value
NRS			
Mean	5.10	4.47	
Median [IQR]	5.00 [3.00, 7.00]	4.00 [2.50, 6.50]	0.013
EQ5D			
Mean	0.45	0.57	
Median [IQR]	0.59 [0.16, 0.73]	0.69 [0.35, 0.80]	0.001
HADS-A			
Mean	6.72	6.01	
Median [IQR]	6.00 [4.00, 9.00]	5.00 [3.00, 9.00]	0.056
HADS-D			
Mean	7.17	6.35	
Median [IQR]	7.00 [5.00, 10.00]	7.00 [3.00, 8.50]	0.035
PCS			
Mean	31.48	26.86	
Median [IQR]	32.00 [26.00, 38.00]	27.00 [19.00, 36.00]	< 0.001
PDAS			
Mean	22.99	17.82	
Median [IQR]	24.00 [16.00, 30.50]	20.00 [7.50, 26.00]	< 0.001
PSEQ			
Mean	28.15	33.34	
Median [IQR]	29.00 [19.00, 37.00]	35.00 [24.00, 43.50]	< 0.001

Values are presented as both mean and median [Interquartile range; IQR]

NRS numerical rating scale, *EQ-5D* European Quality of Life 5 Dimensions, *HADS* the hospital anxiety and depression scale, *PCS* pain catastrophizing scale, PDAS pain disability assessment scale, PSEQ pain self-efficacy questionnaire

The number of exercise therapies was potentially insufficient to produce significant disability improvements.

However, importantly, the Psychotherapy group experienced a significant reduction in anxiety (HADS-A). Moreover, the Interdisciplinary treatment group demonstrated meaningful decreases in pain catastrophizing score (PCS). This indicates that even in more severe cases, targeted cognitive–social strategies may yield clinically relevant improvements. These results underscore the value of incorporating specialised psychosocial therapies into chronic pain management, particularly for addressing aspects of not fully alleviated by standard medical treatments. These findings are also consistent with recent government initiatives in Japan promoting interdisciplinary approaches and highlight the need for expanded insurance coverage and institutional support to facilitate broader implementation in clinical practise.

This study highlights the importance of personalised treatment plans that consider both physical and psychological interventions. Given the observed improvements in specific psychosocial outcomes, healthcare providers should tailor treatment protocols to the individual needs of patients with chronic pain. Furthermore, these findings support the integration of exercise therapy and psychotherapy in pain management centers, emphasising the need for collaboration amongst healthcare professionals from various disciplines.

This study has some limitations. First, some data loss occurred due to patients whose conditions improved within six months and those who discontinued treatment for various reasons. Although this reflects real-world clinical practise, future prospective studies should address this issue more rigorously. Second, the number of therapy sessions varied across treatment groups. On average, the patients received 4.78 sessions of exercise therapy, 7.17 sessions of psychotherapy, and 5.00 sessions in the Interdisciplinary treatment group. However, chronic pain treatment guidelines generally recommend 10–12 sessions for optimal efficacy [3, 4]. Furthermore, whether the number of sessions in this study was sufficient remains unclear. The limited number of sessions might have led to an underestimation of treatment effects. Third, in the absence of a standardised

Table 5 Study outcomes before and after treatment: Psychotherapy (n = 11)

Psychotherapy ($n = 11$)			
Outcome	Pre	Post	p value
NRS			
Mean	4.18	3.27	
Median [IQR]	4.00 [2.00, 7.00]	3.00 [1.50, 5.50]	0.120
EQ5D			
Mean	0.39	0.62	
Median [IQR]	0.60 [0.02, 0.74]	0.69 [0.57, 0.78]	0.155
HADS-A			
Mean	10.36	7.91	
Median [IQR]	12.00 [7.50, 13.50]	9.00 [6.50, 10.00]	0.028
HADS-D			
Mean	9.18	7.82	
Median [IQR]	10.00 [6.00, 11.50]	9.00 [4.50, 10.00]	0.283
PCS			
Mean	33.36	27.00	
Median [IQR]	36.00 [26.50, 39.50]	31.00 [17.50, 35.50]	0.100
PDAS			
Mean	16.82	13.09	
Median [IQR]	16.00 [7.50, 24.50]	13.00 [7.00, 18.50]	0.109
PSEQ			
Mean	23.73	29.18	
Median [IQR]	24.00 [13.00, 29.00]	24.00 [19.50, 34.00]	0.142

Values are presented as both mean and median [Interquartile range; IQR]

NRS numerical rating scale, *EQ-5D* European Quality of Life 5 Dimensions, *HADS* the hospital anxiety and depression scale, *PCS* pain catastrophizing scale, PDAS pain disability assessment scale, PSEQ pain self-efficacy questionnaire

Table 6 Study outcomes before and after treatment: Interdisciplinary treatment (n = 13)

Interdisciplinary treatment (n = 13)			
Outcome	Pre	Post	p value
NRS			
Mean	5.08	4.31	
Median [IQR]	4.00 [4.00, 6.00]	4.00 [3.00, 5.00]	0.353
EQ5D			
Mean	0.35	0.55	
Median [IQR]	0.29 [0.03, 0.69]	0.62 [0.54, 0.73]	0.184
HADS-A			
Mean	9.31	8.46	
Median [IQR]	9.00 [6.00, 12.00]	8.00 [7.00, 11.00]	0.446
HADS-D			
Mean	11.00	11.85	
Median [IQR]	12.00 [8.00, 15.00]	10.00 [7.00, 12.00]	0.506
PCS			
Mean	35.15	26.31	
Median [IQR]	37.00 [30.00, 42.00]	26.00 [20.00, 30.33]	0.038
PDAS			
Mean	20.92	18.69	
Median [IQR]	22.00 [12.00, 28.00]	14.00 [13.00, 27.00]	0.420
PSEQ			
Mean	21.00	21.00	
Median [IQR]	24.00 [18.00, 28.00]	24.00 [15.00, 26.00]	0.701

Values are presented as both mean and median [Interquartile range; IQR]

NRS numerical rating scale, *EQ-5D* European Quality of Life 5 Dimensions, *HADS* the hospital anxiety and depression scale, *PCS* pain catastrophizing scale, PDAS pain disability assessment scale, PSEQ pain self-efficacy questionnaire

referral protocol, our clinicians-based decisions on individual patient profiles: patients exhibiting pronounced functional disability (elevated PDAS scores) were more likely to receive exercise therapy, whereas patients exhibiting higher HADS and PCS scores were deemed suitable for psychotherapy. This approach might have introduced selection bias. As a result, the observed treatment effects might appear relatively smaller, necessitating cautious interpretation of between-group comparisons. In addition, the disease groups were not standardised. Future prospective studies should implement a unified protocol considering the effects of interventional therapies and pharmacological treatments. Moreover, the long-term effects remain unclear, underscoring the importance of extended follow-up to assess the outcome durability. Although no adverse events were observed during exercise or psychotherapy sessions, prospective studies should incorporate systematic safety monitoring. As this was a single-centre study, the generalizability of the findings might be limited. Although long-term follow-up is warranted, it is hindered by staffing limitations and insufficient insurance coverage for non-pharmacological interventions. Addressing these challenges will require multicenter collaboration and systemic reforms to improve accessibility to interdisciplinary care.

Conclusion

This study showed that exercise therapy, psychotherapy, and interdisciplinary approaches might yield distinct psychosocial benefits in chronic pain management. Exercise therapy was associated with improved self-efficacy and reduced depressive symptoms. Psychotherapy might have the potential for alleviating anxiety. In addition, interdisciplinary treatment might reduce catastrophic thoughts of pain. These findings support the integration of exercise therapy and psychotherapy into chronic pain care and emphasise the importance of tailoring interventions to individual patient needs.

Table 7 The percentages of patients who achieved substantial pain relief (at least 50% reduction from baseline) and moderate pain relief (30% reduction from baseline)

	Overall ($n=239$)	Conventional therapy ($n=116$)	Exercise therapy ($n=99$)	Psychotherapy ($n=11$)	Interdisciplinary treatment ($n=13$)
Substantial pain relief (%)	61 (25.5)	34 (29.3)	21 (21.2)	3 (27.3)	3 (27.3)
Moderate pain relief (%)	78 (32.6)	41 (35.3)	28 (28.3)	5 (45.5)	4 (30.8)

Values are number (proportions)

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Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Conflict of interest There are no conflicts of interest for any authors for this project.

References

1. Cohen SP, Vase L, Hooten WM. Chronic pain: an update on burden, best practices, and new advances. Lancet. 2021;397:2082–97.
2. Inoue S, Kobayashi F, Nishihara M, Arai Y-CP, Ikemoto T, Kawai T, Inoue M, Hasegawa T, Ushida T. Chronic Pain in the Japanese Community—prevalence, characteristics and impact on quality of life. PLoS ONE. 2015;10:e0129262.
3. Nakamura M, Toyama Y, Nishiwaki Y, Ushida T. Prevalence and characteristics of chronic musculoskeletal pain in Japan. J Orthop Sci. 2011;16:424–32.
4. Langhorst J, Klose P, Dobos GJ, Bernardy K, Häuser W. Efficacy and safety of meditative movement therapies in fibromyalgia syndrome: a systematic review and meta-analysis of randomized controlled trials. Rheumatol Int. 2013;33:193–207.
5. Ambrose KR, Golightly YM. Physical exercise as non-pharmacological treatment of chronic pain: Why and when. Best Pract Res Clin Rheumatol. 2015;29:120–30.
6. Bernardy K, Füber N, Köllner V, Häuser W. Efficacy of cognitive-behavioral therapies in fibromyalgia syndrome - a systematic review and metaanalysis of randomized controlled trials. J Rheumatol. 2010;37:1991–2005.
7. Heutink M, Post MW, Luthart P, Schuitemaker M, Slangen S, Sweers J, Vlemmix L, Lindeman E. Long-term outcomes of a multidisciplinary cognitive behavioural programme for coping with chronic neuropathic spinal cord injury pain. J Rehabil Med. 2014;46:540–5.
8. Hassett AL, Williams DA. Non-pharmacological treatment of chronic widespread musculoskeletal pain. Best Pract Res Clin Rheumatol. 2011;25:299–309.
9. Chou R, Deyo R, Friedly J, Skelly A, Hashimoto R, Weimer M, Fu R, Dana T, Kraegel P, Griffin J, Grusing S, Brodt ED. Nonpharmacologic therapies for low back pain: A systematic review for an American College of Physicians clinical practice guideline. Ann Intern Med. 2017;166:493–505.
10. van Middelkoop M, Rubinstein SM, Verhagen AP, Ostelo RW, Koes BW, van Tulder MW. Exercise therapy for chronic nonspecific low-back pain. Best Pract Res Clin Rheumatol. 2010;24:193–204.
11. Fransen M, McConnell S, Harmer AR, Van der Esch M, Simic M, Bennell KL. Exercise for osteoarthritis of the knee. Cochrane Database Syst Rev. 2015;1:CD004376.
12. Geneen LJ, Moore RA, Clarke C, Martin D, Colvin LA, Smith BH. Physical activity and exercise for chronic pain in adults: an overview of Cochrane Reviews. Cochrane Database Syst Rev. 2017;4:CD011279.
13. Henschke N, Ostelo RW, van Tulder MW, Vlaeyen JW, Morley S, Assendelft WJ. Behavioural treatment for chronic low-back pain. Cochrane Database Syst Rev. 2010;2010:CD002014.
14. de Williams AC, C, Eccleston C, Morley S. Psychological therapies for the management of chronic pain (excluding headache) in adults. Cochrane Database Syst Rev. 2012;11:CD007407.
15. Khan M, Akhter S, Soomro RR, Ali SS. The effectiveness of Cognitive Behavioral Therapy (CBT) with general exercises versus general exercises alone in the management of chronic low back pain. Pak J Pharm Sci. 2014;27:1113–6.
16. Samwel HJA, Kraaimaat FW, Crul BJP, Dongen RD, Evers AWM. Multidisciplinary allocation of chronic pain treatment: Effects and cognitive-behavioural predictors of outcome. Br J Health Psychol. 2009;14:405–21.
17. Scascighini L, Toma V, Dober-Spielmann S, Sprott H. Multidisciplinary treatment for chronic pain: a systematic review of interventions and outcomes. Rheumatology. 2008;47:670–8.
18. Bults RM, Van Dongen JM, Ostelo RWJG, Nijs J, Keizer D, Van Wilgen CP. Effectiveness of a primary care multidisciplinary treatment for patients with chronic pain compared with treatment as usual. J Clin Med. 2023;12:885.
19. Stanos S, Houle TT. Multidisciplinary and interdisciplinary management of chronic pain. Phys Med Rehabil Clin N Am. 2006;17:435–50.
20. Arai Y-CP, Yasui H, Isai H, Kawai T, Nishihara M, Sato J, Ikemoto T, Inoue S, Ushida T. The review of innovative integration of Kampo medicine and Western medicine as personalized medicine at the first multidisciplinary pain center in Japan. EPMA J. 2014;5:10.
21. Ushida T, Shibata M, Kitahara M, Yabuki S, Sumitani M, Murakami T, Iseki M, Hosoi M, Shiokawa H, Tetsunaga T, Nishie H, Fukui S, Kawasaki M, Inoue S, Nishihara M, Aono S, Ikemoto T, Kawai T, Arai YC. The Effect of Guidance regarding Home Exercise and ADL on adolescent females suffering from adverse

effects after HPV Vaccination in Japanese Multidisciplinary Pain Centers. Pain Res Manag. 2016;2016:1–6.
22. Inoue M, Inoue S, Ikemoto T, Arai Y-CP, Nakata M, Miyazaki A, Nishihara M, Kawai T, Hatakeyama N, Yamaguchi S, Shimo K, Miyagawa H, Hasegawa T, Sakurai H, Hasegawa Y, Ohmichi Y, Ushida T. The efficacy of a multidisciplinary group program for patients with refractory chronic pain. Pain Res Manag. 2014;19:302–8.
23. Tsuchiya A, Ikeda S, Ikegami N, Nishimura S, Sakai I, Fukuda T, Hamashima C, Hisashige A, Tamura M. Estimating an EQ-5D population value set: the case of Japan. Health Econ. 2002;11:341–53.
24. Shiroiwa T, Ikeda S, Noto S, Igarashi A, Fukuda T, Saito S, Shimozuma K. Comparison of value set based on DCE and/or TTO data: Scoring for EQ-5D-5L health states in Japan. Value Health J Int Soc Pharmacoeconom Outcomes Res. 2016;19:648–54.
25. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand. 1983;67:361–70.
26. Kitamura T. Hospital anxiety and depression scale (in Japanese). Arch Psychiatr Diagn Clin Eval. 1993;4:371–2.
27. Sullivan MJL, Bishop SR, Pivik J. The pain catastrophizing scale: Development and validation. Psychol Assess. 1995;7:524–32.
28. Matsuoka H, Sakano Y. Assessment of cognitive aspect of pain : Development, reliability, and validation of Japanese version of pain catastrophizing scale. Jpn J Psychosom Med. 2007;47:95–102.
29. Yamashiro K, Arimura T, Iwaki R, Jensen MP, Kubo C, Hosoi M. A multidimensional measure of pain interference: reliability and validity of the pain disability assessment scale. Clin J Pain. 2011;27:338–43.
30. Nicholas MK. The pain self-efficacy questionnaire: Taking pain into account. Eur J Pain. 2007;11:153–63.
31. Adachi T, Nakae A, Maruo T, Shi K, Shibata M, Maeda L, Saitoh Y, Sasaki J. Validation of the japanese version of the pain self-efficacy questionnaire in japanese patients with chronic pain. Pain Med. 2014;15:1405–17.
32. Kanda Y. Investigation of the freely available easy-to-use software "EZR" for medical statistics. Bone Marrow Transplant. 2013;48:452–8.
33. Meints SM, Edwards RR. Evaluating psychosocial contributions to chronic pain outcomes. Prog Neuropsychopharmacol Biol Psychiatr. 2018;87:168–82.
34. Xie Y, Wu Z, Sun L, Zhou L, Wang G, Xiao L, Wang H. The effects and mechanisms of exercise on the treatment of depression. Front Psychiatr. 2021;12: 705559.
35. Niknejad B, Bolier R, Henderson CR, Delgado D, Kozlov E, Löckenhoff CE, Reid MC. Association between psychological interventions and chronic pain outcomes in older adults: A systematic review and meta-analysis. JAMA Intern Med. 2018;178:830–9.
36. Yang S-Y, McCracken LM, Moss-Morris R. Psychological treatments for chronic pain in East and Southeast Asia: A systematic review. Int J Behav Med. 2016;23:473–84.